

**MOSQUITOES, MALARIA AND MALADIES  
AMONG MEN USING MARSHES**

**Is the Contraction of Diseases in Wetlands a Question of Use?  
Behaviours, Risk Assessments and Perceptions  
from the Ewaso Narok Swamp, Kenya**

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I wish  
to give an account  
of the kinds of waters,  
namely,  
of such as are wholesome  
and such as are unwholesome,  
and  
what bad  
and  
what good effects  
may be derived from water;  
for water contributes  
much towards  
health.

Hippocrates

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## **Mosquitoes and Maladies among Men using Marshes. Summary**

Worldwide, the pressure on the most precious resource of all – water – is increasing. In environments where water is scarce, as is the case in semiarid areas in rural East Africa, fragile wetland ecosystems are increasingly being tapped in order to combat food insecurity and to provide important life-support systems in otherwise uninhabitable landscapes. It is this extensive use, however, which makes their interaction troublesome in terms of health outcomes, given that wetlands are known sources of disease-causing microorganisms and invertebrates (Anthonj et al. 2016, Derne et al. 2015). Thus, wetlands are not only a blessing, but may also be a curse.

Assuming that people using marshes for different purposes are at different risk of contracting water-related infectious diseases while at the same time being highly dependent on staying physically healthy in order to maintain their livelihoods from the natural resources provided by the wetlands, this study addresses the ramifications of wetland use and disease exposure by presenting a case study from the Kenyan Ewaso Narok Swamp. The floodplain of the semiarid East African highlands, a point of concentrated anthropogenic activities, served for investigating the four most prominent wetland user groups, namely smallholder and commercial farmers, pastoralists and people working in the service sector. Mixed methods were adopted and included a cross-sectional survey and observational assessment (n=400), as well as in-depth interviews with the target population (n=20), key informants and experts (n=8). Special attention was directed to malaria, onchocerciasis, typhoid fever, diarrhoeal diseases, trachoma and schistosomiasis, with these diseases representing the four categories of water-related disease transmission as defined by Bradley (1974).

The grounded theoretical model shows that different wetland uses entail different health risk factors. Exposure to infectious agents depends upon the type of use, occupational characteristics, time and duration spent in wetlands. Water-related infectious disease transmission is mostly driven by the intensity of users' physical contact to water, characteristics of pathogens and vectors of disease. Whereas several publications have linked crop production to the contraction of diseases, fewer are available on health risks identified with the use of domestic water or with pastoralism in wetlands.

Health risk assessments from the Ewaso Narok Swamp relating syndromic surveillance of self-reported abdominal complaints, fever, skin and eye conditions of wetland users to multiple risk factors in descriptive, univariate and multivariate analyses reveal that the contraction of diseases mainly takes place in the domestic domain, whereas the occupational risks play a minor role in the investigated population. Unsafe water sources, little or discontinuous water supply, inadequate sanitation and poor hygiene, as well as poor environmental hygiene (WASH) are high risk factors. Safe water supply, good sanitation and frequent cleaning of latrine, as well as frequent handwashing, on the other side, are the main

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protective factors, and so are the prevention of stagnant water near the home and the use of mosquito bed nets. Besides human behavioural practices in the domestic domain, cultural aspects and health beliefs mattered in the exposure as well as the prevention of any sort of water-related infectious diseases.

Perceptions of the people in and around the Ewaso Narok Swamp revealed that the awareness level towards water-related health risks, the connections between wetlands and adverse health effects and the environment-animal-human health nexus is generally high. Particularly unsafe water, inadequate sanitation, poor hygiene and environmental pollution were being regarded as responsible risk factors for infectious diseases, in particular for diarrhoeal diseases and typhoid fever. Moreover, the wetlands' water resources providing mosquito breeding sites were rated as harmful and exposing users to malaria. The presence of neglected tropical diseases in such environments was perceived as a challenge to public health. Occupational factors, such as the use of pesticides in agricultural crop production and environment- and climate-related features were widely perceived risk factors as well, but understood as way less hazardous than risks in the domestic domain.

Differences between different user groups became apparent in terms of health-related behaviour, actual health risks and health risk perceptions. Farmers rather find irrigation practices risky, fear mosquitoes on their fields, as well as the effects of agrochemicals used. As the statistical analyses reveal these concerns are justified, as they actually expose to diseases. Adapted to these perceptions and their occupational characteristics, the farmers are more likely to use protective gears during their field work. The pastoralists perceive unsafe and lacking WASH as risky, unhygienic environments and the presence of flies. All these factors are very pronounced in their nomadic living environments (which at the same is their workplace) due to the remoteness of their homesteads and the proximity to their livestock – and indeed increasing their risk of contracting eye conditions. The service sector workers have a comparably low perception on health risks arising from wetland use compared to the other groups, which is not surprising. Neither do they live close the Ewaso Narok Swamp, nor do they use or depend upon it for the maintenance of their livelihoods. Therefore, they lack experience of and exposure to risks associated with the marsh.

The relevance of these ramifications results from the growing population, increasing use and modification of wetlands in East Africa, all of which accelerate the pollution of wetlands, as well as the presence and proliferation of pathogens, with the users' behaviour determining their risk of contracting diseases. The most efficient way in breaking the transmission routes is the safe water, adequate sanitation and good personal and environmental hygiene. This study from the Ewaso Narok Swamp, however, reveals that WASH is highly insufficient for large parts of the wetland users, lagging far behind the nationwide average for rural populations in the Republic of Kenya. Thus, even though the users understand the situation and risks that come along with inadequate WASH: as long as

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improved infrastructure and options are lacking, the prevention of diseases in wetlands will remain difficult. Wetlands expose their users to different water-related infectious diseases, while at the same time the necessary infrastructure to stay healthy or get adequately treated is not sufficiently provided. This transforms wetland use and disease exposure into an enhancing vicious circle with transmission routes difficult to be disrupted and with risk perceptions only limitedly mattering as long as options to proactively act or to react are not in place.

This study points to wetlands as being a two-sided coin, acting as a driver for development, but also as an impediment in terms of human health. The inhabitants of wetlands gain water, nutrition and food security, but pay a high prize and ill-health in return.

As falling ill impairs the users' (agricultural) productivity and quality of life, it is crucial to integrate the framework on use-related disease exposure into wetland management activities and the concept of wise wetland use (Horwitz et al. 2012), health education programmes and disease prevention and control strategies. Such would present good starting points for a health-adapted wetland management, which is of crucial importance, given the peculiarities of such fragile vulnerable ecosystems as are semiarid wetlands. Along with findings from the other studies conducted within the *GlobE Wetlands in East Africa* project, the results from this work have been integrated into a holistic Health Impact Assessment guidance document for wetlands. Besides, the results may contribute to the health and environmental sustainability targets of the United Nations Sustainable Development Agenda.

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## **Mücken und Krankheiten bei Menschen in Feuchtgebieten.**

### **Zusammenfassung**

Weltweit steigt der Druck auf die Kostbarste aller Ressourcen: Wasser. In Regionen, die unter Wasserknappheit leiden, wie es vor allem in semiariden Gebieten des ländlichen Ostafrikas der Fall ist, werden zur Gewährleistung der Nahrungssicherheit und für wichtige Lebenserhaltungssysteme zunehmend fragile Feuchtgebietsökosysteme in andernfalls unbewohnbaren Landschaften erschlossen. Dass Feuchtgebiete bekanntermaßen Quellen von Krankheitserregern sind (Anthonj et al. 2016, Derne et al. 2015), lässt die menschliche Nutzung und Interaktion gesundheitlich problematisch werden. Damit sind Feuchtgebiete Segen und Fluch zugleich.

Ausgehend von der Annahme, dass einerseits unterschiedliche Nutzungsarten unterschiedliche Expositionsrisiken gegenüber wasserbezogenen Infektionskrankheiten mit sich bringen, während andererseits die Nutzung solcher Ökosysteme einen guten allgemeinen Gesundheitszustand voraussetzt, befasst sich diese Studie mit den Zusammenhängen zwischen Feuchtgebietsnutzung, Krankheitsexposition und -last. Die Überschwemmungsebene Ewaso Narok Swamp im semiariden kenianischen Hochland, ein Zentrum verstärkter anthropogener Aktivität, diente als Untersuchungsgebiet, in dem vier Nutzergruppen untersucht wurden: Kleinbauern, kommerziell arbeitende Bauern, Pastoralisten und im Dienstleistungssektor tätige Menschen. Ein ‚mixed method‘ Ansatz wurde angewandt, welcher eine Querschnitts- und Beobachtungsstudie (n=400), sowie Leitfadeninterviews mit der Zielbevölkerung (n=20), Schlüsselpersonen und Experten (n=8) beinhaltete. Ein besonderes Interesse galt den Infektionskrankheiten Malaria, Onchozerkose, Typhus, Durchfall, Trachom und Schistosomiasis, welche die vier Kategorien wasserbezogener Krankheitsübertragung nach Bradley (1974) repräsentieren.

Die gegenstandsbezogene Theoriebildung dieser Studie zeigte, dass unterschiedliche Feuchtgebietsnutzungen unterschiedliche Gesundheitsrisikofaktoren beinhalten und dass die Exposition gegenüber Infektionserregern von der Art der Nutzung, Besonderheiten im Arbeitsalltag und der im Feuchtgebiet verbrachten Zeit abhängt. Die Übertragung wasserbezogener Infektionskrankheiten ist insbesondere durch die Intensität des physischen Kontakts der Nutzer mit Wasser, durch Pathogeneigenschaften und durch Vektoren bestimmt. Während einige frühere Publikationen Landwirtschaft in Feuchtgebieten mit Krankheiten in Verbindung gesetzt haben, identifizierten nur wenige Veröffentlichungen Gesundheitsrisiken, die mit der häuslichen Wassernutzung oder mit Pastoralismus in Feuchtgebieten einhergehen.

Im Rahmen der Risikoabschätzungen aus dem Ewaso Narok Swamp, bei der Syndromüberwachungen selbstberichteter Abdominalbeschwerden, Fieber, Haut- und Augenerkrankungen der Feuchtgebietsnutzer im Rahmen deskriptiver, univariater und multivariater Analysen mit zahlreichen Risikofaktoren in Verbindung gesetzt wurden,

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konnte gezeigt werden, dass die Übertragung von Krankheiten in der untersuchten Bevölkerung insbesondere im häuslichen Umfeld stattfindet, während arbeitsbezogene Risiken eine eher untergeordnete Rolle spielen. Unsichere Trinkwasserquellen, eine geringe oder unterbrochene Wasserversorgung, unzureichende Sanitärversorgung sowie mangelhafte persönliche und Umwelthygiene (WASH) bildeten wichtige Risikofaktoren. Eine sichere Wasser- und Sanitärversorgung, das regelmäßige Reinigen von Sanitäreinrichtungen und regelmäßiges Händewaschen dagegen erwiesen sich als herausragende protektive Faktoren, ebenso wie die Vermeidung stehender Gewässer im häuslichen Umfeld und die Nutzung von Moskitonetzen. Neben häuslichen Verhaltenspraktiken spielten außerdem kulturelle Aspekte und die vorherrschenden Gesundheitsvorstellungen eine wichtige Rolle sowohl in der Exposition gegenüber, als auch in der Prävention von jeglicher Art wasserbezogener Infektionskrankheiten.

Die Wahrnehmungsstudie offenbarte, dass die Bevölkerung im und um den Ewaso Narok Swamp über ein ausgeprägtes Bewusstsein bezüglich wasserbezogener Gesundheitsrisiken, der Verbindung zwischen Feuchtgebieten und negativen Gesundheitseffekten und dem Nexus von Umwelt-, Tier- und menschlicher Gesundheit verfügt. Vor allem die unsichere Wasser- und Sanitärversorgung, schlechte Hygiene und Umweltverschmutzung wurden als verantwortliche Risikofaktoren für Infektionskrankheiten, v.a. für Durchfallerkrankungen und Typhus, benannt. Darüber hinaus wurden die Moskitobrutplätze in Feuchtgebieten als gefährlich bewertet, v.a. in Bezug auf Malaria. Das Auftreten vernachlässigter Tropenkrankheiten wurde als Herausforderung für die öffentliche Gesundheit thematisiert. Arbeitsbezogene Risikofaktoren, wie die Nutzung von Pestiziden in der Landwirtschaft sowie umwelt- und klimabezogene Aspekte wurden ebenfalls als Risiken wahrgenommen, jedoch im Vergleich zu häuslichen Risiken als weit ungefährlicher wahrgenommen.

Unterschiede zwischen den Nutzergruppen wurden in Bezug auf ihr Gesundheitsverhalten, ihr abgeschätztes Risiko und ihre Risikowahrnehmung ersichtlich. Die Bauern beispielsweise erachteten insbesondere Bewässerungspraktiken, Moskitos auf ihren Feldern und die Wirkung von Agrochemikalien als risikoreich – Bedenken, die sich in den statistischen Analysen als berechtigt zeigten. Passend zu diesen Wahrnehmungen und arbeitsbezogenen Risiken trugen Bauern eher Schutzkleidung während ihrer Feldarbeit. Die Pastoralisten sahen in der unsicheren und nicht vorhandenen Wasser- und Sanitärversorgung, in mangelnder persönlicher und Umwelthygiene und dem Vorhandensein von Fliegen Gesundheitsrisiken – Gegebenheiten, die in ihrem nomadischen Lebensumfeld (das gleichzeitig den Arbeitsplatz bildet) durch die Abgelegenheit ihrer Hütten und die Nähe zu Vieh sehr ausgeprägt sind und tatsächlich auch das Risiko von Augenerkrankungen verstärken. Die im Dienstleistungssektor beschäftigten Befragten dagegen nahmen Gesundheitsrisiken durch die Nutzung von Feuchtgebieten nur in vergleichsweise geringem Maße wahr, was nicht überraschend ist, da sie weder in der Nähe des Ewaso Narok Swamp leben, noch auf diesen zur Erhaltung ihrer Lebensgrundlage

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angewiesen sind. Aus diesem Grund fehlt ihnen die Erfahrung mit und die Exposition gegenüber Risiken, die mit dem Feuchtgebiet assoziiert sind.

Die Relevanz dieser Zusammenhänge ergibt sich aus der wachsenden Bevölkerung, sowie der steigenden Nutzung und Modifikation von Feuchtgebieten in Ostafrika, welche die Verschmutzung dieser Ökosysteme und die Verbreitung von Pathogenen verstärkt. Dabei determiniert das Verhalten der Nutzer deren Risiko, krank zu werden. Wie diese Studie zeigt, sind sichere Wasser- und Sanitärversorgung sowie gute persönliche und Umwelthygiene die effizientesten Maßnahmen zur Durchbrechung der Übertragungswege. Diese Studie aus dem Ewaso Narok Swamp offenbart aber auch, dass die Wasser- und Sanitärversorgung von Feuchtgebietenutzern weit hinter dem nationalen Durchschnitt ländlicher kenianischer Bevölkerung zurückliegt. Obwohl die Nutzer die Situation und die Risiken verstehen, die mit diesem Mangel einhergehen: Solange verbesserte Infrastruktur fehlt, wird die Prävention von Krankheiten in Feuchtgebieten nahezu unmöglich bleiben. Entsprechend exponieren Feuchtgebiete ihre Nutzer gegenüber verschiedenen wasserbezogenen Infektionskrankheiten, ohne dass gleichzeitig die notwendige Infrastruktur verfügbar ist, um diese zu verhindern oder zu behandeln. Diese Verbindungen verwandeln Feuchtgebietenutzung und Krankheitsexposition in einen Teufelskreis, dessen Übertragungswege schwer durchbrochen werden können und deren Wahrnehmung ohne Konsequenzen bleibt, solange keine Handlungsoptionen existieren.

Feuchtgebiete wirken somit gleichzeitig als Entwicklungsmotor und als Entwicklungshindernis. Die Bewohner erhalten Wasser als Lebens- und Nahrungssicherungsgrundlage, bezahlen dafür aber einen hohen Preis zulasten ihrer Gesundheit.

Erkrankungen beeinträchtigen die (landwirtschaftliche) Produktivität und die Lebensqualität der Nutzer. Aus diesem Grund ist es wichtig, das Modell der nutzungsbezogenen Krankheitsexposition in Aktivitäten des Feuchtgebietenmanagements und das Konzept der nachhaltigen Feuchtgebietenutzung (Horwitz et al. 2012), Gesundheitsaufklärungsprogramme und Präventions- und Kontrollstrategien zu integrieren. All das sind sinnvolle Ansatzpunkte für ein gesundheitsförderndes Feuchtgebietenmanagement, welches hinsichtlich der Besonderheiten solcher fragiler und vulnerabler Ökosysteme in semiariden Gebieten mit höchster Wichtigkeit behandelt werden sollte. Gemeinsam mit den Erkenntnissen anderer im Rahmen des Projekts *GlobE Wetlands in East Africa* realisierter Forschungsprojekte wurden Ergebnisse dieser Studie in ein holistisches Health Impact Assessment Dokument für Feuchtgebiete integriert. Desweiteren dient diese Studie als Beitrag zur Erreichung der Gesundheits-, Umwelt- und Nachhaltigkeitsziele der Agenda für Nachhaltige Entwicklung der Vereinten Nationen.

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## Acronyms

AIDS	Acquired Immune Deficiency Syndrome
AMREF	African Medical and Research
ANOVA	Analysis of Variance
APOC	African Programme for Onchocerciasis Control
AU	African Union
BMBF	Bundesministerium für Bildung und Forschung
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
CDC	Center for Disease Control and Prevention
CHW	Community Health Worker
CI	Confidence Interval
DALYs	Disability Adjusted Life Years
DHO	District Health Officer
<i>E.coli</i>	Escherichia coli
EHO	Environmental Health Officer
ERC	Ethics Review Committee
FBO	Faith-Based Organization
G/E	Gastroenteritis
GIRE	Gestion Integree des Ressource en Eau
GIZ	Gesellschaft für International Zusammenarbeit
GoK	Government of Kenya
GPS	Global Positioning System
GWP	Global Water Partnership
HACCP	Hazard Analysis and Critical Control Points
HAMS	Hygiene & Assainissement en Milieu Solaire
HDI	Human Development Index
HIA	Health Impact Assessment
HIV	Human Immunodeficiency Virus
IHPH	Institute for Hygiene and Public Health, University of Bonn
IHME	Institute for Health Metrics and Evaluation, Kenya
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
JMP	Joint Monitoring Programme
KEMRI	Kenya Medical Research Institute
KDHS	Kenya Demographic and Health Survey
KNBS	Kenya National Bureau of Statistics
KU	Kenyatta University
LC	Local Chief
LENWRUA	Lower Ewaso Narok Water Resources Users Association, Kenya
MDG	Millennium Development Goals
MEA	Millennium Ecosystem Assessment

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MEMR	Ministry of Environment and Mineral Resources, Kenya
MoH	Ministry of Health, Kenya
NBI	Nile Basin Initiative
NGO	Non-Governmental Organization
NHSSP	National Health Sector Strategic Plan, Kenya
NTD	Neglected Tropical Disease
ODI	Overseas Development Institute
OR	Odds Ratio
PCA	Principal Component Analysis
PHAST	Participative Hygiene and Sanitation
PHO	Public Health Officer
REMA	Rwanda Environment Management Authority
RTI	Respiratory Tract Infection
SAFE	Trachoma strategy: Surgery, Antibiotics, Facial and Environmental Hygiene
SDG	Sustainable Development Goals
SES	Socioeconomic Status
SSA	Sub-Saharan Africa
SPSS®	Statistical Program for Social Sciences
STI	Sexually Transmitted Infection
SWAp	Sector-Wide Approach
TB	Tuberculosis
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNHABITAT	United Nations Human Settlement Programme
UNICEF	United Nations Children’s Fund
URTI	Upper Respiratory Tract Infection
USAID	United States Agency for International Development
WASCO	Water & Sanitation Cooperative
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
WHOCC	World Health Organization Collaborating Center
WRM	Water Resources Management
WRMA	Water Resource Management Authority

**A glossary on important terms is provided in Annex 1.**

---

# 1 GENERAL INTRODUCTION: WETLANDS AND DISEASES

## 1.1 Wetlands: Meaning and implications on health

Worldwide, the pressure on the most precious resource of all – water – is increasing. As populations are growing and need to be fed, water becomes ever more essential for survival. From a safe distance and environments where access to water is natural, one would only be limitedly be concerned. However, in environments, where water is scarce, the picture is different: fragile ecosystems need to be tapped for the water resources that they provide in order to combat food insecurity. This is the case in many East African settings, especially in rural semiarid areas. There, wetlands often constitute the only water resources; providing water free of charge, in otherwise uninhabitable landscapes (Dixon and Wood 2003, Finlayson et al. 2015, Horwitz et al. 2012, McCartney and Rebelo 2015, Silvius et al. 2000).



Source: Nicol et al. (2015)

**Figure 1: The meaning and use of wetlands**

Wetlands constitute a resource of great economic, social, cultural, and recreational value<sup>1</sup> (Ramsar 1971<sup>2</sup>, Sakané et al. 2011). Such ecosystems fulfil diverse ecological functions, have direct and indirect benefits, and provide fundamental ecosystem services (Horwitz et al. 2012, Hughes and Hughes 1992, Turner et al. 2000). On a regional and local level, they are extraordinarily important life-support systems that are beneficial places from which individuals, communities and populations derive their livelihoods (Finlayson et al. 2015, Horwitz et al. 2012, Horwitz and Finlayson 2011, MEA 2005a, Mitchell 2013, MEMR 2012, Rebelo et al. 2010).

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<sup>1</sup> The value of wetlands is widely recognized. To protect wetlands, the Ramsar Convention promoted the wise use of wetlands through local and national actions and international cooperation.

<sup>2</sup> The Ramsar Convention on Wetlands (Ramsar 1971) is an intergovernmental environmental agreement that embodies the commitments of its member countries to maintain the ecological character of their wetlands of international importance and to plan for the 'wise use', or sustainable use, of all of the wetlands in their territories.



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Wetlands are being traded as food baskets with an immense productive potential, attracting people by promising abundant water resources, food security, land, ecosystem services and prosperity (Amler et al. 2016, McCartney and Rebelo 2015, Silvius et al. 2000). As a consequence, such ecosystems are becoming subject to increasing in-migration and extensive use: for agriculture, livestock farming and pastoralism, fishery, the collection of natural materials, the extraction of surface water for domestic use and drinking. It is this extensive use, however, both occupational and domestic, which threatens to deplete the capacities of wetlands, making them become more and more 'unhealthy', contributing to the degradation and contamination of water. The high dependence towards wetlands and the exposure to water makes the users' interaction with wetlands troublesome in terms of health outcomes, given that wetlands are known sources of disease-causing microorganisms and invertebrates (Anthonj et al. 2016, Derne et al. 2015). Coupled with the degradation of water resources, the field for the contraction of diseases is opened. Thus, wetlands are not only a blessing, but may also be a curse.

Human health depends on the interaction between humans and their surrounding physical, chemical and biological environments (Cook and Speldewinde 2015, Myers et al. 2013, Parkes and Horwitz 2009). Or, as formulated by Stevens (2010), '*human well-being requires a healthy environment, local and global, to be well in*'. This, in turn, means that environments, if not healthily and sustainably used, can adversely affect human health. Now what about wetlands and marshes? As long as these ecosystems are sustainably used, the health benefits might outweigh the health threats. The extent to which the good outweighs the bad commonly depends on site-specific factors including exactly how people interact with wetlands and how wetlands are managed (McCartney and Rebelo, 2015). But again, where pressure on and multiple use of water resources involve the degradation of water quality and quantity (Berthe and Kone 2008, Beuel et al. 2016, Finlayson et al. 2015, Horwitz et al. 2012, MEA 2005a;b, Mulatu et al. 2015, Rebelo et al. 2010, Skov 2015), water-related disease contraction in wetlands may not be underestimated as a public health threat (Dale and Connelly 2012, Derne et al. 2015, Patz and Confalonieri 2005). According to Johnson and Paull (2011), freshwater environments play multiple roles in disease relationships, often functioning as reliable points of species interaction and pathogen exchange between terrestrial and aquatic organisms. Human exposure to pathogens in wetland settings can be categorized according to exposure through the service provided, e.g. drinking contaminated wetland water, and, where services are eroded, the conditions giving rise to exposure, e.g. mosquito habitats favoured by modification of the wetland (Horwitz and Roiko 2015) and the variable risks arising according to the season (Finlayson 2011, Hongo and Masikini 2003, Neogi et al. 2014).

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## 1.2 Epistemological interest, research gaps and research objectives

One can easily hypothesize that people using wetlands for different purposes might be at different risk of contracting diseases. Given the immense importance of these ecosystems for their users, whose livelihoods are dependent upon their interaction with water resources, and who depend upon being physically healthy in order to maintain their livelihoods from the natural resources provided by the wetlands, this is a vital aspect in terms of health and wetland management. However, despite the extensive use of wetlands in East Africa, the literature base is not very broad, case studies are lacking and little is known about use-related disease exposure. Therefore, this study aims at helping to fill the knowledge gap on contracting diseases in East African wetlands, which is likely more complex than just being close to water and potentially exposed to pathogens. Besides the type of use and associated risk factors, what might also matter are health knowledge and perceptions of disease transmission pathways. Risk perceptions reflect the subjective judgements towards health hazards and therefore play a pivotal role in health risk behaviour, influencing the health protection and actual exposure to diseases. As such human behavioural practices have the potential of increasing or reducing health risks and the contraction of diseases, they are subject to investigation as well. Besides, the available infrastructure, socioeconomic status, cultural and other factors might play a role in the exposure to and transmission of diseases. Since wetlands are not really made for humans to live in and instead are desired by wetland managers to be under nature conservation, it can be assumed that such ecosystems per se are not well equipped and even 'underserved' when it comes to human health infrastructure: This likely applies both to health-protective options and to healthcare provision. The provision of safe water, a precondition for human health, may be limited, waste management unavailable, sanitation insufficient. Health facilities might be distant and difficult to access and this may affect the health-seeking behaviour of those suffering from ill-health. Thus, the coverage and access to water, sanitation and hygiene and health infrastructure will be part of this study also. The preliminary consideration is that different wetland uses expose to different diseases in wetlands, while at the same time, the necessary infrastructure to stay healthy or get treated is not provided. If that is really the case is elaborated in this case study from the Kenyan Ewaso Narok Swamp, a floodplain of the semiarid East African highlands (Becker 2013).

In order to shed more light on the ramifications of wetland use and disease exposure, three main objectives will be followed by various methods (Table 1):

1. Identifying water-related infectious diseases that can be present in wetlands and associating them with the most prominent wetland uses.
2. Assessing health risks arising from wetland use and link it to the users' health-related behaviour.
3. Estimating the level of health knowledge and health risk perception towards these diseases by wetland users in the Ewaso Narok Swamp.

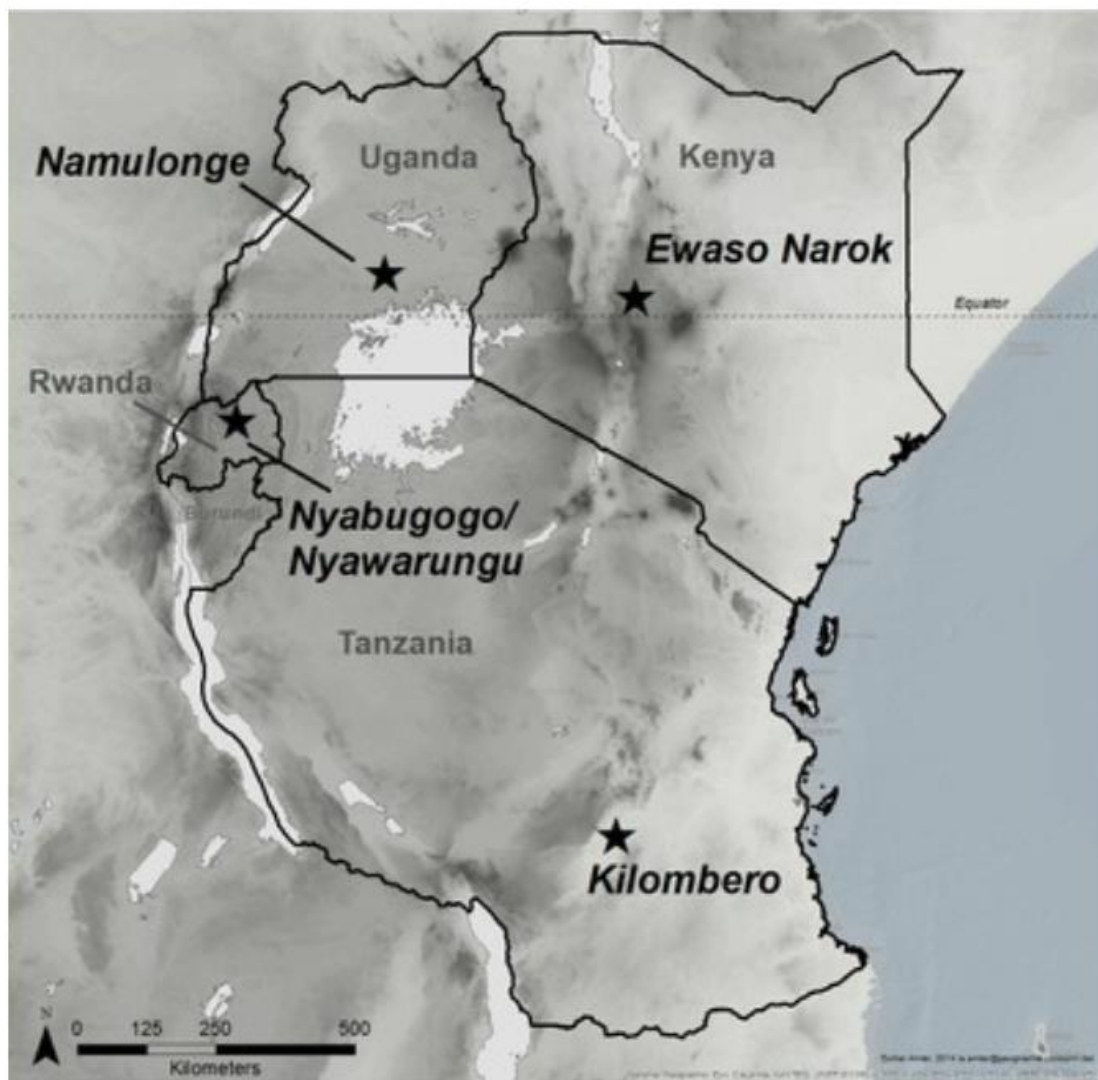
**Table 1: Operationalization of the research question and activities**

Objectives and sub-questions	Sources	Methods used	Addressed in
<b>Objective 1: To identify water-related infectious diseases that can be present in wetlands and associate them with different uses.</b>			
<ul style="list-style-type: none"> <li>▪ Which water-related diseases can be present in wetlands?</li> <li>▪ In what way is malaria linked to wetlands?</li> <li>▪ In what way is schistosomiasis linked to wetlands?</li> <li>▪ In what way is onchocerciasis linked to wetlands?</li> <li>▪ In what way are diarrhoeal diseases linked to wetlands?</li> <li>▪ In what way is typhoid fever linked to wetlands?</li> <li>▪ In what way is trachoma linked to wetlands?</li> <li>▪ Are wetland-related diseases a question of wetland use?</li> <li>▪ Does the use of wetland water for domestic purposes expose to the diseases?</li> <li>▪ Does the use of wetlands for crop production expose to the diseases?</li> <li>▪ Does the use of wetlands for pastoralism expose to the diseases?</li> <li>▪ Does the use of wetlands for fishery expose to the diseases?</li> <li>▪ Does the collection of building materials in wetlands expose to the diseases?</li> <li>▪ Does the use of wetland water for domestic purposes expose to the diseases?</li> </ul>	International research journals	Systematic literature review	Chapter 1.4.5 Chapter 3
<b>Objective 2: To assess health risks arising from wetland use and link it to wetland users' health-related behaviour.</b>			
<ul style="list-style-type: none"> <li>▪ What is the self-reported burden of disease of wetland users?</li> <li>▪ Does the self-reported burden of symptoms differ between different user groups?</li> <li>▪ What are potential reasons for different groups being exposed to different symptoms?</li> <li>▪ What is the wetland users' domestic water, sanitation and hygiene situation like?</li> <li>▪ How do wetland users behave towards health and disease?</li> </ul>	Individuals Experts	Household survey Observational assessment In-depth interviews Feedback meeting	Chapter 4 <sup>3</sup>
<b>Objective 3: To estimate the level of health knowledge and health risk perception among wetland users.</b>			
<ul style="list-style-type: none"> <li>▪ What is the wetland users' level of knowledge on wetland-related diseases?</li> <li>▪ Does the health knowledge differ between different user groups?</li> <li>▪ Do wetland users know about potential health risks in wetlands?</li> <li>▪ Does the health risk perception related to wetlands differ between different user groups?</li> </ul>	Individuals Experts	Household survey In-depth interviews Feedback meeting	Chapter 5

<sup>3</sup> Parts of this chapter have been published (Anthonj et al. 2016).

---

The investigation of water-related diseases, health risk perception and behaviour in the Ewaso Narok Swamp, Kenya was part of the project *'GlobE Wetlands in East Africa - reconciling future food production with environment protection'*, funded by the German Federal Ministry of Education and Research<sup>4</sup>. The multilateral research project aimed at assessing 'the status quo of wetlands' contribution to food security and the sustainability of current wetland uses along climatic and social gradients' in Kenya, Tanzania, Uganda and Rwanda (Map 1). Besides this present PhD thesis, numerous other studies were carried out under the multidisciplinary GlobE project, covering environmental, economic and social aspects related to wetlands<sup>5</sup>.



**Map 1: GlobE Wetlands in East Africa project region**

One topic of special consideration was the human health impact of wetlands (Becker 2013), delivering an understanding about public health aspects associated with wetland ecosystems by

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<sup>4</sup> Further reading at <https://www.wetlands-africa.de/> (grant number FKZ 031A250).

<sup>5</sup> In this thesis, fellow colleagues' research projects are cited where relevant and applicable.

- 
- Development of a tool for health assessment
  - Assessment of physical health aspects
  - Assessment of mental and social health aspects
  - Wetland malaria risk assessment
  - Guidance for health-sensitive wetland management

Relating to the requirements of the work package human health impacts of wetlands, this present PhD project started in November 2013 with the aim of assessing physical health aspects in wetlands. Since wetlands are increasingly used for agricultural production worldwide and especially in East Africa, and since agricultural production demands physical strength and good health of farmers, the researcher decided to concentrate her work on potential adverse health effects arising from wetland use. A preliminary focus was set on water-related health risks and diseases.

### **1.3 Introduction to the research context**

#### **1.3.1 The Republic of Kenya: wetlands, people and health**

Kenya is located in East Africa immediately at the equator at latitudes of 6°S to 6°N, covering an area of about 590,000 km<sup>2</sup> (UN 2014<sup>6</sup>). Kenya borders Tanzania to the South, Uganda to the West, the South Sudan to the North West, Ethiopia to the North, and Somalia to the East, as well as the Indian Ocean. The administrative structure divides the Republic of Kenya into seven provinces and one area via Central, Coast, Eastern, Nairobi Area, North Eastern, Nyanza, Rift Valley, and Western with Nairobi being the administrative capital of the country. Kenya's terrain is very diverse; the topography rises from the coastal plains to the Eastern edge of the East African Plateau, and the Great Rift Valley.

The climate within the country is diverse and tropical along the coast line, but moderated by the diverse topography in the West of the country and arid in the interior part of the country. The central highland regions are substantially cooler than the coast, with the coolest (highest altitude) regions at 15°C compared with 29°C at the coast. Temperatures vary little throughout the year. Seasonal rainfall in Kenya is driven mainly by the migration of the Inter-Tropical Convergence Zone influenced by the El Niño Southern Oscillation phenomenon. There are two distinct rainy seasons, the 'short' rains in October to December and the 'long' rains in March to May with an average rainfall of 50 to 200 mm which varies greatly, exceeding 300mm per month in some localities. The onset, duration and intensity of these rainfalls also vary considerably from year to year (McSweeney et al. 2012). The variations in rainfall result in flooding or drought which has a strong impact on agricultural production.

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<sup>6</sup> Country statistics and official UN data available at <http://data.un.org/CountryProfile.aspx?crName=kenya>.

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The hydrography of Kenya is subdivided into six major basins, namely the Lake Victoria North, Lake Victoria South, Rift Valley, Ewaso Ng'iro, Tana and Athi basins. Transboundary wetlands include Lake Victoria, Lake Turkana, Lake Jipe, Lake Chala as well as the Mara River<sup>7</sup>. Owing to its diverse geography, Kenya is endowed with a variety of wetland types that range from riverine, lacustrine, palustrine, estuarine, marine, to human-made. Wetlands are the most physically and chemically heterogeneous of all aquatic ecosystems in the country. Wetland reserves make up approximately 3-4 % of the Kenyan surface area, which corresponds to about 14,000 km<sup>2</sup>, fluctuating in size according to the season (Amler et al. 2015, MEMR 2013).

In recent years, more and more natural wetlands have been transformed into agriculturally used and irrigated land. The Government of Kenya is keen to achieve a balance between utilization and conservation of the environment for a sustainable socioeconomic development and a healthy environment as stated in the Vision 2030 (GoK 2007). Though in some wetlands the guidelines provided by the Ramsar Convention are implemented, about 80% of the wetlands are not seriously conserved or sustainably used. No comprehensive wetlands policy is available and degradation threatens these ecosystems.

Kenya has a population of about 46 million people (Table 2), and is characterized by its ethnic variety. The population is growing at the population rate of 2.1 %. Kenya remains a low income country with about 48% of its population living below the national poverty line. The UNDP's HDI<sup>8</sup> index placed Kenya at rank 147 (UNDP 2014<sup>9</sup>). Therefore, the Government of Kenya aims for new initiatives towards pro-poor economic growth. By realizing the goals of the national Vision 2030, Kenya shall turn from a low-income to a developed country with a strong economy by 2030. According to WHO (2014<sup>10</sup>), 76% of the Kenyan population live in rural areas and heavily depend on natural resources, farming and related activities for their livelihoods.

Just like other low income countries in Sub-Saharan Africa, Kenya is facing numerous health challenges of the total population; mothers, children and vulnerable groups in particular. The discrepancies in terms of income, household wealth, infrastructure, and health are tremendous when comparing different geographic settings and different population groups. Generally, the overall morbidity and mortality are high and present an unhealthy picture, although health indicators have been showing a positive trend (WHO 2015a).

The Government of the Republic of Kenya addresses water, sanitation and hygiene (WASH) and environmental health according to the Vision 2030 and the Sustainable Development Goals (SDG) by various programs and policies, highlighting the importance regarding development, poverty reduction and health. However, the health of many Kenyans remains

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<sup>7</sup> Transboundary water resources are managed by international initiatives like the Nile Basin Initiative (2013).

<sup>8</sup> The HDI index ranks 182 countries in a league table based on education, income, and access to health care.

<sup>9</sup> UNDP Kenya Country Profile available at <http://hdr.undp.org/en/countries>.

<sup>10</sup> WHO Kenya Country Profile available at <http://www.who.int/gho/countries/ken.pdf?ua=1>.

deeply affected due to poverty, lack of education and insufficient WASH. Still, only 62% of the people have access to improved drinking water sources and 30 % of the population has access to improved sanitation facilities, while about 13 % practice open defecation (WHO and UNICEF 2015). Although the Kenyan Ministry of Health puts a lot of effort in improving the health system, water-related infectious diseases such as malaria and diarrhoeal diseases make up many of the health concerns.

**Table 2: Population and health indicators for Kenya**

<b>Population</b>	Total population	46,050,414
	Population density (pop/km <sup>2</sup> )	73.9
	Life expectancy at birth [years]	53
	Median age [years]	19.5
	Employment rate [%]	60
	Literacy rate (aged 15 and older) [%]	87
	Poverty gap at \$1.90 a day [%]	11.7
	Gini <sup>11</sup> index	48.51
<b>Nutrition</b>	Underweight (weight for age) [%]	11
	Stunted (height for age) [%]	26
<b>Child health</b>	Under-five mortality rate (deaths per 1,000 live births)	49
	Infant mortality rate (dying between birth and age 1 per 1,000 live births)	36
	Immunization among children (12-23 months) [%]	97
<b>Maternal health</b>	Total fertility rate (children/woman)	3.14
	Maternal mortality rate (per 100,000 live births)	510
<b>General health</b>	Health expenditures [% of GDP]	5.7
	Total government health funding (per capita) [KES]	1,585
	National Health Insurance Fund (NHIF) coverage [%]	26.7
	Physicians density (per 100,000 population)	0.2
<b>WASH</b>	Improved drinking water sources (urban vs. rural)	82 / 57
	Improved sanitation facilities (urban vs. rural)	31 / 30

Sources: MoH (2015), WHO (2016), WHO/UNICEF JMP (2015), KNBS (2015), KDHS (2014)

According to the WHO (2012), the top ten causes of mortality in Kenya include HIV and AIDS, lower respiratory infections, diarrhoeal diseases, malnutrition and malaria, among others. In terms of morbidity, malaria is the leading cause. It accounts for one third of all new cases reported, followed by respiratory diseases, skin conditions, diarrhoea, and intestinal parasites. Major reasons for health-seeking at health facilities include injuries, urinary tract infections, eye infections, rheumatism, and other infections. According to Muga (2004), these ten conditions make up nearly four fifths of the total outpatient cases. This pattern has persisted for the past decade.

<sup>11</sup> The Gini index is a measure of the deviation of the distribution of income among individuals or households within a country from a perfectly equal distribution. A value of 0 represents absolute equality, a value of 100 absolute inequality. Source: The World Bank 2016, available at: <http://hdr.undp.org/en/content/income-gini-coefficient>

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Considering this challenging health landscape, the provision of adequate health services is a key factor in improving health outcomes for Kenyans, in both the short- and long-term. Through its Vision 2030, the Government of Kenya wishes to achieve '*a high quality of life [for] all its citizens by the year 2030*', emphasizing the health of its citizens and the improvement of health service delivery (KDHS 2014). However, the Kenyan healthcare system struggles to meet appropriate service delivery to those suffering from ill-health, with the level and access to services varying by region (Turin 2010). The shortage of health professionals accelerates the tense health situation (KNBS 2015).

The Kenyan health sector comprises the public system, which is administered in a hierarchical structure from the top down by the Ministry of Health (MoH)<sup>12</sup>, and parastatal organizations. The public system consists of national referral hospitals, County and Sub-County referral hospitals, health centres, and dispensaries (MoH 2015).

Challenges of limited availability, access and quality pose barriers to potential users, who can often not afford the relatively expensive fees for medical services, appointments and drugs, especially in the light of increasing poverty levels (IHME 2014). Nationwide, about 4,700 health facilities provide services and the public sector accounts for the largest share (51%). The public sector is supplemented by the private sector, which contains private for-profit, non-governmental (NGO), and faith-based organization (FBO) facilities, undertaking special health services and reaching mainly the communities. All are supported by the MoH and external donors to different extents (training, drug stocks, vaccines, funds). The private sector is steadily growing and covers over 40 percent of the health services in Kenya – mainly curative and very few preventive services provided by nurses, midwives, clinical officers and doctors. Numerous health-oriented NGOs operate throughout the country; however, it is difficult to determine the population covered (Muga et al. 2004). As outlined in the National Health Sector Strategic Plan II (NHSSP II), the Kenyan health system relies on a sector-wide approach (SWAp), which aims at integrating the efforts of all providers, in the system in order to achieve 'health for all' (Turin 2010). Besides the health facilities, pharmacies play a role in health services, too, with pharmacists and pharmacy technologists providing health assistance. Human resources for health is low compared to the total population, especially in remote settings and in regions of low socioeconomic development (IHME 2014, KNBS 2015). According to the WHO (2016), there are only 0.2 physicians, 0.86 nurses and midwives, 0.05 pharmaceutical workers and 0.1 other health workers per 1,000 Kenyans.

Yet, generally, the utilization of services is determined by the patients' ability to pay, and those who cannot afford, may fail to seek care and not be treated (Chuma & Okungu 2011). The healthcare utilization rate in Kenya is approximately 77 percent for those who are sick (Turin 2010), which means that, if these numbers are reliable, 23 percent of the population

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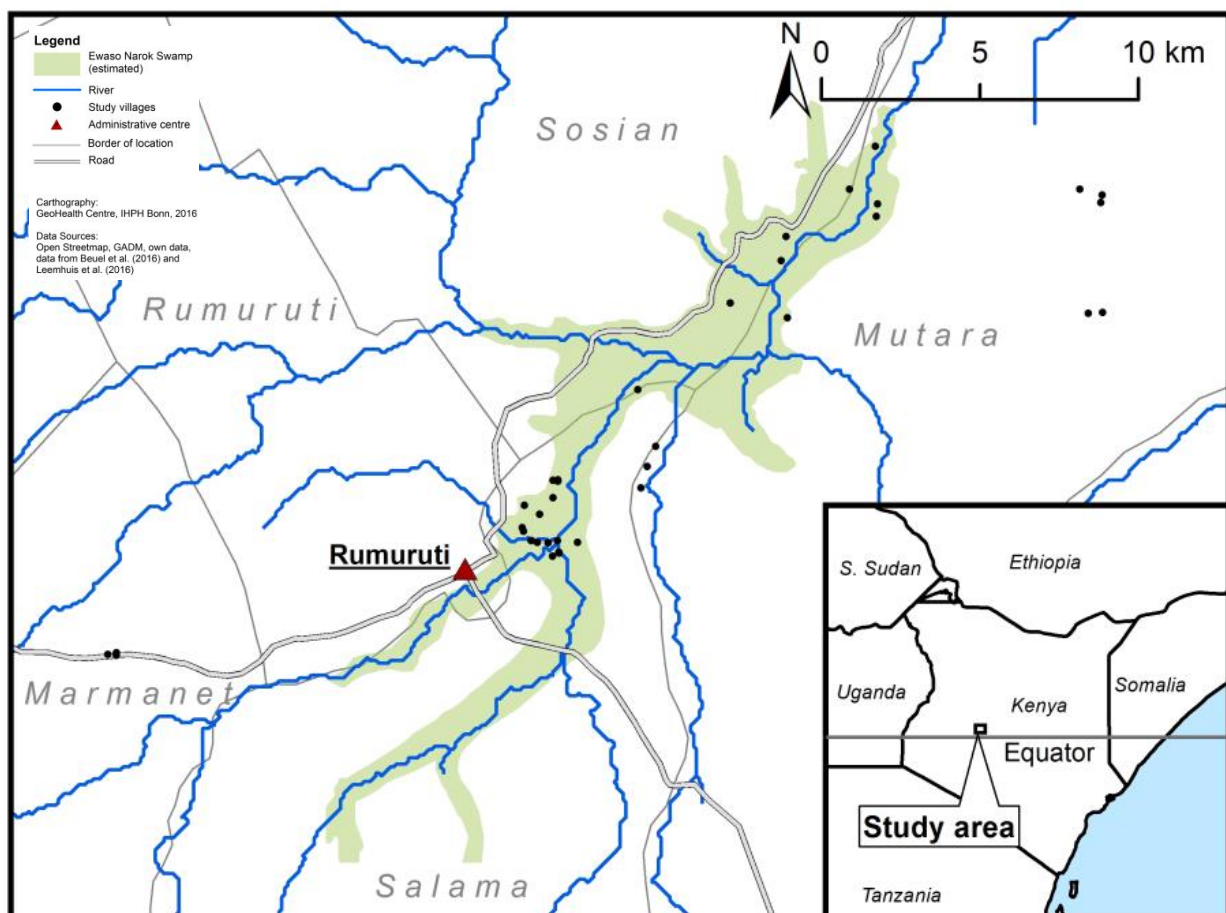
<sup>12</sup> The Ministry of Health plays a coordinating and capacity-building role in ensuring that all services offered are in line with established policies and standards (KDHS 2014).



does not seek care. Besides costs, major barriers in the healthcare utilization include geographic barriers and large distances. Besides conventional western health options, individuals in many communities seek traditional health services provided by healers as their source of primary medicine, which may be used by up to 80 percent of Kenyans. Numbers about such alternative options are, however, not included in the official health statistics (Turin 2010).

### 1.3.2 A floodplain in the semiarid East African highlands: the Ewaso Narok Swamp

The Ewaso Narok Swamp is a highland riverine wetland on the Laikipia plateau in Kenya. Located in a semiarid area where water forms a highly precious resource, characterized by erratic and unreliable rainfall, the wetland forms a biogeographical island with immense ecological and socioeconomic importance; and is point of concentrated anthropogenic activities due to the freshwater provided (Thenya 2011, Photo 1, Map 2).



**Map 2: The Ewaso Narok Swamp**

The wetland is part of the Upper Ewaso Ng'iro North basin, which belongs to the overall Ewaso Ng'iro catchment area, Kenya's largest drainage system (Bours 2016<sup>13</sup>, LENWRUA et

<sup>13</sup> Within the GlobE Wetlands project, a Msc research project was conducted by Mr. Bours that addressed irrigation water requirements and their influences on downstream river discharges in the Ewaso Narok Swamp. He well characterized the hydrological regime of the study area within his theses (Bours 2016).

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al. 2012, Mungai et al. 2004), located by the equator in the centre of the country and covering an area of approximately 15,200 km<sup>2</sup>, varying in altitude from 800 to 5,200m a.s.l. (Mungai et al. 2004, Wiesmann et al. 2000). The area hosts the Ewaso Narok sub-basin in the West, the Southern Ewaso Ng'iro Mt. Kenya sub-basin, and the Lowland sub-basin to the North-East and falls under the Rift Valley, Central and Eastern Provinces (Gichuki 2002). The basin's mountainous Southern part is dominated by the tertiary volcanoes of Mt. Kenya, the South-Western side by the Nyandarua ranges (Aberdares), the western part by various mountains and fault line volcanic ridges along the Rift Valley. Towards the North, decreasing altitudes characterize the low plains (Bours 2016, Mungai et al. 2004).

The Ewaso Narok Swamp is located at the Western side of the Mount Kenya at around 1,800m altitude, covering an area of 81km<sup>2</sup> and a catchment area of 2,610km<sup>2</sup>, representing a typical alluvial highland floodplain with an average temperature of 17°C and 700mm annual precipitation (Beuel et al. 2016, Leemhuis et al. 2016, Mwita 2013). Both the drainage systems of the permanent Ewaso Narok and Pesi rivers that originate from the Aberdares and the Ol Bolossat catchment along the southern boundary of the overall basin feed the swamp. The scarce surface water levels vary according to the season: seasonal as well as ephemeral streams in the area dry up during the dry season and provide only minor contributions to the wetland's water resources, underlining the importance of the few perennial rivers in supplying water (Boy, 2011, Thenya 2001, Wiesmann et al. 2000). The area consists of tropical highland climate, varying in relation to the complex topographic situation. The precipitation is highly seasonal and related to the movement and position of the ITCZ, shaping the long rains from March to May, the continental rains from July to August, and the short rains from October to December (Ulrich et al. 2012). According to Roden et al. (2016), the spatiotemporal distribution and intensity of precipitation is a key variable that influences the agro-ecological potentials of the area. During the long rains, flooding occurs and inundates water over large areas, creating immense challenges for the people inhabiting and using the wetland, who, according to Thenya (2001) cause such floods by de-vegetation and excessive land use. The Ewaso Narok Swamp represents a remnant of a series of once numerous wetlands which formerly existed in Laikipia, most of which have been drained in the pursuit of food sufficiency (Becker 2013, Mwita 2013). The area surrounding the swamp holds natural savannah vegetation with evergreen and semi evergreen bushlands and thickets, whereas the wetland is characterized by papyrus (Beuel et al. 2016). However, the natural vegetation has become scarce in the course of human activity (Mwita 2013).

The area of the Ewaso Narok Swamp has been subject to considerable land use transformation processes in the past decades (Heinichen 2015, Mungai et al. 2004, Mwita 2013, Thenya 2001, Ulrich et al. 2012, Wiesmann et al. 2000). During colonial times and before the 1970s, the dominant land use was large scale ranching and nomadic pastoralism, whereby the wetlands were used as a source of water and grazing land. Ever since the

Independence in 1963, an increase in human activities, swamp occupation and a transformation into high density small-scale farming have been taking place as a consequence to a reallocation of land and the subsequent population increase (Roden et al. 2016). While in 1990, the population density was less than 10 persons km<sup>2</sup>, it is currently estimated to range from 20 persons km<sup>2</sup> to more than 50 (close to Rumuruti) (Becker 2013). The in migration facilitated a great diversity and a ‘cosmopolitan’ population, representing many different tribes in a rather small area (Heinichen 2015).



a. Impression from the dry season (2015); b. impression from the rainy season (2016).

**Photo 1: The Ewaso Narok Swamp during the dry and rainy seasons**

Immigration has been remarkable due the soils’ fertility and water availability attracting people from water scarce areas by promising water resources, food security, livelihoods, land and high economic potential (Heinichen 2015, Mwita 2013). This population growth has led to increased competition for the already limited natural water resources (Ulrich et al. 2012): Nowadays, the Ewaso Narok Swamp is used more extensively than ever. As other

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wetlands, it enables year-round crop production (Sakané et al. 2011), provides pasture land for livestock grazing, (limited) fish resources, building materials, and of course, water resources (Beuel et al. 2016, Dixon and Wood, 2003). The semiarid Ewaso Narok Swamp serves farmers, pastoralists and domestic users, livestock and wildlife. The use is intensified especially during the dry season, when the swamp forms the only water resource in the area for the communities' survival (Becker 2013, Heinichen 2015, Mwita 2013, Thenya 2001).

This intensive use and increasing pressure as well as the overexploitation of the water resource is – besides due to climate variability, rural impoverishment and attraction of wetland produce on Kenya's markets - also a result of the wetland being public governmental land that provides people free access to its ecosystem services. At the same time it lacks a clear policy on the use or management (Leemhuis et al. 2016, MEMR 2013, Mwita 2013, Thenya 2001). Overall, the land use transformations have led to ecosystem alteration, habitat modification, destruction of the wetland functioning and the reduction and deterioration of the available water resources, tending towards an unsustainable use of the environment, all of which results in conflicts<sup>14</sup>: between different wetland users such as farmers and pastoralists, conflicts between pastoralist groups, upstream and downstream communities, humans and livestock, humans and wildlife and in terms of resource management (Heinichen 2015, Mungai et al. 2004, Mwita 2013, Roden et al. 2016, Wiesmann et al. 2000).

The waste management in the Ewaso Narok Swamp is poor and so is the sanitation infrastructure, making many of the people use the wetland as an alternative dumping ground (Thenya 2001). In the face of strong population growth and extensive wetland use, combined with the water scarcity and high use of agrochemicals, this poses increased ecological and health-related risks. More than before, the unsafe water supply, sanitation and hygiene situation and related diseases are the challenging swamp's inhabitants as many use its water as drinking water (Boy 2011).

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<sup>14</sup> Within the GlobE Wetlands project, a Msc research project was conducted by Ms. Heinichen that addressed wetland-use-related conflicts and resource management in the Ewaso Narok Swamp (Heinichen 2015).



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### 1.3.3 Characterizing the different user groups in the Ewaso Narok Swamp

Different groups make use of the Ewaso Narok Swamp, and those that were part of this research will be presented in the following. They include smallholder farmers, commercial farmers, pastoralists and service sector workers. By introducing to those groups, this subchapter anticipates some results gathered within this study. Although the reader might expect them in the results chapters, the presentation of the study at this point is considered necessary in order to capture the situation on-site.

Three groups safeguard their livelihoods mainly from the use of the Ewaso Narok Swamp.

Close to the town of Rumuruti, smallholder farmers clear and drain the swamp for smallscale subsistence crop cultivation. They mainly use the fringe of the swamp near their houses for growing beans and maize. Water from the wetland is extracted for domestic use and for agricultural irrigation. They do mainly manual work, rarely using irrigation equipment, and apply manure for application to their fields.

The commercial farmers grow horticultures such as tomatoes, cabbage and fruits for large-scale sale and mainly use the North and Southeastern side of the swamp. They usually work in very close proximity to the water and conduct intensive irrigation activities, often in combination with high concentrations of agrochemicals.

The pastoralists mainly inhabit the Eastern area which is unsuitable for agricultural production, remote and distant from service provision and infrastructure. They use the wetland for herding cattle, goats and camels to the water source, especially in the dry season, and for collecting building and thatching materials for their temporary houses. The pastoral groups live a semi-nomadic lifestyle in higher and drier areas and some perform 'agro-pastoralism'. They also use the wetland for the collection of medicinal plants.

Moreover, all of the user groups extract wetland water for domestic and drinking water purposes; the share, however, differs strongly.

Another group, which can be considered as 'non-users' or 'rare-users' are the people working in the service sector in nearby Gatundia, whose prime workplace is not the Ewaso Narok Swamp, but retail, shops with occupations including sellers, tradespeople, mechanics and boda-drivers<sup>15</sup>. Their work lives mainly take place in central areas with adequate infrastructure and supply.

Besides these groups' occupational characteristics and environments (Photo 2), with higher or lower dependence upon the Ewaso Narok Swamp and the water resources it provides, what also differs are their wetland uses, as well as demographic and socioeconomic, infrastructural factors (Table 3).

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<sup>15</sup> A boda is a mototaxi which is commonly used all over Kenya as a mode of transport.



a. Smallholder farmers (sh); b. commercial farming (co); c. pastoralism (pa); d. people working in the service sector (se) (2015, 2016).

**Photo 2: User groups of the Ewaso Narok Swamp**

In terms of demographic characteristics, the widest variations become apparent concerning household structures, location, socioeconomic status and education: the pastoralists have the largest household sizes, most children in their households and the lowest level of school education as compared to the other groups. Moreover, they have the lowest socioeconomic status<sup>16</sup> and live farthest away from overall and from health infrastructure<sup>17</sup>. The service sector workers have the highest SES, highest education levels and best access to health infrastructure, as well as the smallest household sizes, respectively.

**Table 3: Sociodemographic characteristics of samples representing user groups**

	Smallholder farmers (n=106)		Commercial farmers (n=95)		Pastoralists (n=99)		Service sector workers (n=100)		Total (n=400)	
	n	%	n	%	n	%	n	%	n	%
<i>Gender</i>										
Female	75	70.8	29	30.5	48	48.5	20	20.0	171	42.8
Male	31	29.2	66	69.5	51	51.5	80	80.0	229	57.3
<i>Age</i>										
aged <=35 years	25	23.6	31	32.6	48	48.5	35	35.0	139	34.8
aged 36-49	31	29.2	35	36.8	26	26.3	38	38.0	130	32.5
aged >50 years	50	47.2	29	30.5	25	25.3	27	27.0	131	32.8
<i>Education</i>										
No formal education	39	36.8	14	14.7	<b>63</b>	<b>63.6</b>	6	6.0	124	31.0
Primary incomplete	33	31.1	30	31.6	21	21.2	16	16.0	100	25.0
Primary complete	33	31.1	50	52.6	15	15.2	78	78.0	176	44.0
Secondary	18	17.0	29	30.5	8	8.1	<b>40</b>	<b>40.0</b>	95	23.8
Post-secondary	2	1.9	2	2.1	0	0.0	<b>16</b>	<b>16.0</b>	20	5.0
<i>Household size</i>										
4 or less HH members	45	42.5	45	47.4	18	18.2	<b>60</b>	<b>60.0</b>	168	42.0
5 to 7 HH members	50	47.2	45	47.4	<b>60</b>	<b>60.6</b>	40	40.0	195	48.8
8 or more HH members	11	10.4	5	5.3	<b>21</b>	<b>21.2</b>	0	0.0	37	9.3
<i>Children in household</i>										
No children	32	30.2	19	20	7	7.1	28	28.0	86	21.5
1 to 3 children	54	50.9	57	60	42	42.4	69	69.0	222	55.5
4 or more children	20	18.9	19	20	<b>50</b>	<b>50.5</b>	3	3.0	92	23.0
<i>Socioeconomic status</i>										
very low SES (no assets)	5	4.7	0	0.0	<b>12</b>	<b>12.1</b>	0	0	17	4.3
low SES	46	43.4	21	22.1	<b>59</b>	<b>59.6</b>	13	13	139	34.8
middle SES	28	26.4	36	37.9	32	32.3	<b>32</b>	<b>32</b>	128	32
high SES	32	30.2	38	40.0	8	8.1	<b>55</b>	<b>55</b>	133	33.3
<i>Distances</i>										
Distance to the wetland (mean) [km]	2.5		1.5		4.5		14		5.6	
Distance to health facility (mean) [km]	3.9		8.5		11.4		1.2		6.3	

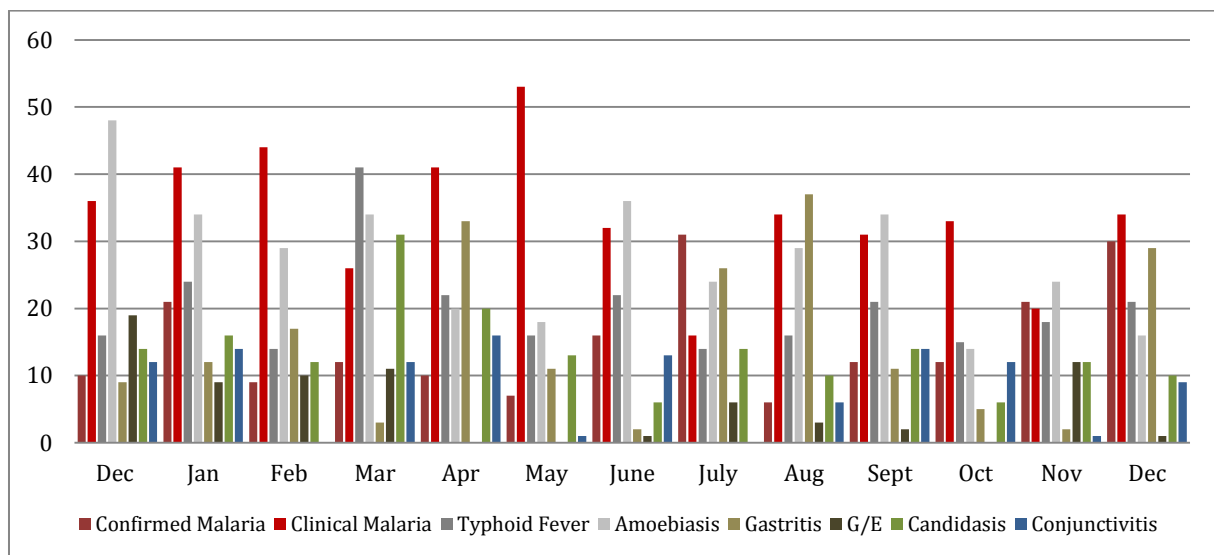
\*The outliers are printed in bold.

<sup>16</sup> The socioeconomic status was calculated by Principal Component Analysis and is explained in the Chapter 2.4.2. Detailed information on the assets that were the basis for the calculations are available in the digital annex.

<sup>17</sup> More detailed information on the households' distances to the Ewaso Narok Swamp, the nearest river or stream, tarmac road, health facility and shop is available in the digital annex.

### 1.3.4 Prevalent diseases in the Ewaso Narok Swamp

The inhabitants of the Ewaso Narok Swamp are faced with numerous prevalent diseases. By presenting them at this stage, results gathered within this study are anticipated. This is done in order to create a better understanding of the situation and to approximate the burden of disease in the area. Information of the area's largest and central District Hospital on admissions in the year preceding this study's survey<sup>18</sup> indicate the following (Figure 2): Clinical and confirmed malaria and different gastrointestinal diseases, typhoid fever and diarrhoeal diseases mainly drive people suffering from ill-health to seek medical consultation at the hospital. Skin and eye conditions are important reasons to go see a doctor also, albeit for lower numbers of people. Although the admissions are quite high throughout the whole year, all diseases' admission rates reveal to slightly differ according to the season, with clinical malaria admissions peaking by the end of the rainy season in May, confirmed malaria peaking in July, typhoid fever peaking at the beginning of the rainy season, in March, as well as candidiasis, amoebiasis in December, and conjunctivitis in the dry seasons, both in January and September. These diagnoses underline the relevance of studying the water-related infectious diseases in wetlands. What remains undiscovered from this data, however, is which user group the admitted patients belong to.



\*The acronym G/E stands for gastroenteritis.

**Figure 2: Rumuruti district hospital admission from December 2013 – December 2014**

According to the MoH (2016), the Rumuruti District has a total of nine health facilities. Numbers on health staff, doctors, nurses, clinical officers and pharmacists, however, are lacking. According to Turin (2010), the Rift Valley, which Laikipia and the Ewaso Narok Swamp belong to, has the lowest coverage in terms of healthcare in Kenya.

<sup>18</sup> The data was obtained from the district health officer at Rumuruti district, as described in Chapter 2.3.2.6.



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## 1.4 The conceptual framework

### 1.4.1 Preliminary considerations and focus on WASH

By addressing aspects at the interface of wetland environments and physical environmental conditions, specifically, water, and human health, health risks and health-related behaviour, this thesis embraces concepts of the disciplines medical and health geography, branches of geography (Meade and Earickson 2005).

Human health and geographies are inextricably linked (Gatrell and Elliott 2015: 3). The place of residence, environmental conditions and access to ecosystem services affect the human well-being. Landscapes can serve as therapeutic landscapes that stimulate a positive mental well-being, and in the case of wetlands in semiarid areas, contribute to livelihoods and survival. At the same time, place and environment may determine the communities' and individuals' health risks and exposure to diseases, as well as available health systems and services in terms of prevention, treatment and care.

These interconnections between health and geography trace back more than 2,000 years, when Hippocrates (460-377 BC) stated in his work *'On airs, waters and places'*, that whoever wishes to investigate human health properly should not only consider the geographical peculiarities of each locality, seasons of the year, characteristics of water, such as quality and quantity, but also human behaviour, different lifestyles and habits (Barrett 2000, Hippocrates 2009). Thereby, Hippocrates was the first one to relate health and disease to the environment, an 'old partnership', as described by Kistemann et al. (1997). Leonard Ludwig Finke, who mapped and published all available medical facts of the then known world in the 18<sup>th</sup> century, is described as the founder of medical geography (Barrett 2000, Kistemann and Schweikart 2010). A pioneer in medical geography and cartography, as well as applied modern epidemiology was John Snow, who identified the London Broad Street pump as the source of an intense cholera outbreak in 1854. He was the first one to plot the location of cholera deaths on a dot-map, and consequently determining the source of infection by drinking water from that pump by disease mapping (McLeod 2000, Snow 1857). These links between the environment, water quality and disease and the visualization on a map laid the foundation for this partnership between health, diseases and geography (Kistemann et al. 1997). The investigation of causes of relationships between the geosphere and diseases in space and time (Jusatz 1983) and the application of geographical concepts and methods to health-related problems (Hunter 1974) gained increasing attention ever since (Kistemann et al. 1997). Besides this described disease ecology or geographic epidemiology, medical geography also addresses health systems and services, their acceptance, accessibility and use by people suffering from ill-health (Mayer 1982). Both concepts have been merged in the geography of health (Verhasselt 1993).

The focus of medical geography on spatio-temporal disease patterns and disease mapping was in the following reformed and developed further, not only thematically, but also

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methodologically (Kearns 1993, Kearns and Moon 2002, Kistemann and Schweikart 2010). This cultural turn reinvented the geography of health, in which medical geography shifted to a new confident, recognized and distinct discipline (Rosenberg 2016) with more attention placed on broader social models of health and healthcare, sense of place (Kearns 1993, Relph 1976, Tuan 1977), therapeutic landscapes (Gebhard and Kistemann 2016, Gesler 1992, Kearns et al. 1998, Völker and Kistemann 2011), physical, mental and subjective well-being (Atkinson et al. 2012, Fleuret and Atkinson 2007) and health inequalities (Curtis 2009).

A focus was set on interdisciplinarity through adaptation of public health, epidemiological and sociological methodologies, drawing on social, political and economic theories and building on the understanding of ecological principals and processes (Falkenberg 2016, Kistemann et al. 1997). Traditional mapping and quantitative approaches were complemented by additional research methods in geographies of health since this cultural turn, including mixed methods, a focus on qualitative and participatory research, subjective feelings towards places, health beliefs and health-related behaviour.

In the context of developing countries, aspects related to geography and health mainly address infectious diseases and environmental (change-related) health risks (Hagget 1994), the epidemiological transition and inadequate health systems, inadequate water supply, sanitation and hygiene, as well as limited preventive measures. Here, health geography is closely linked to geographical development research, to urban-rural differences, socioeconomic disparities, the dependence on natural ecosystems and other aspects (Butsch and Sakdapolrak 2010, Gatrell and Elliott 2015).

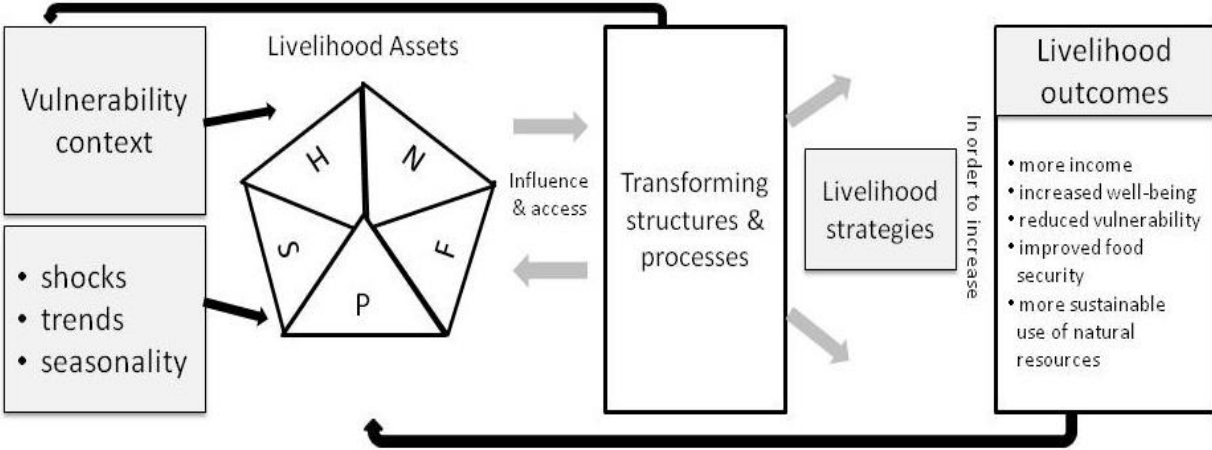
This compilation shows that medical and health geography are highly multidisciplinary, and besides medicine, public health, geography and cartography touching environmental science, hydrology, meteorology, climatology, social science, anthropology, development studies, behavioural science and many others. This interdisciplinarity constitutes the strength of the concepts and underlines the importance of geography as an integrative discipline (Anthamatten and Hazen 2011, Kistemann et al. 2010).

Following up on this, various theoretical concepts and framework help to approach health risk perception and health-related behaviour and to assess health risks in the Ewaso Narok Swamp in Kenya. These are being presented in this chapter: In order to get an understanding on vulnerable populations and sustainable livelihoods, the first of which wetland users are, the second of which healthy wetland use aims at, Chapter 1.4.2 deals with the basics of the *sustainable livelihood framework*. In the second part, the term risk is defined and the idea of applying risk assessment to health is presented (Chapter 1.4.3), before theories of risk perception are being delineated. Routes of disease transmission are displayed with reference to water-related infectious diseases (Chapter 1.4.4) and wetlands

(Chapter 1.4.5), before theories of health behaviour are introduced (Chapter 1.4.6), making reference to health-protective and health-seeking behaviour.

**1.4.2 The sustainable livelihood framework: A reference to wetlands**

The *sustainable livelihoods framework* is an approach rooting in the *concept of vulnerability* which was introduced by Timmermann (1981). The approach was developed further by Robert Chambers and the Institute of Development Studies in Sussex, taken up by the Department of International Development and others (Bohle 2011: 754, Figure 3). Accordingly, livelihoods include the capabilities, assets and activities required for the means of living (Chambers & DFID in McCartney et al. 2015). Central to these concepts are factors that facilitate a sustainable livelihoods security in the context of risky living conditions. Every individual, group or society, referred to as actors, has a base vulnerability of different extent that determines the level of vulnerability towards external events such as shocks, that may be of ecological nature (e.g. droughts, overuse of resources) or also human-centered (disease outbreaks). The *livelihoods framework* adopts this context of vulnerability, arguing that actors are possessors of different livelihood assets. These include human capital including knowledge, capacities and health; natural capital such as land, water and soil; financial capital like income and credit; physical capital such as infrastructure, production goods and other possession; and social capital, including social networks and status (Obrist et al. 2007).



Sources: DFID (2001) and Bohle (2011)

**Figure 3: The sustainable livelihoods framework**

The access to the assets depends on the scope of action and is, as well as the vulnerability, also determined by the exposition towards a shock, trends and seasonality, as well as by transforming structures (Anthonj et al. 2015). According to Obrist et al. (2007), the availability of assets is influenced by forces such as economy, politics, technology or climatic events or conflicts that people have very limited control over, referred to as their vulnerability context. The higher the amount and diversity of assets that an actor can access,

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the lower is the vulnerability and the bigger are the capacities to develop alternative livelihood strategies, the activities and choices that people make in order to achieve desired livelihood outcomes (McCartney et al. 2015) and coping capacities, both in everyday life situations and during hardships (Krüger 2003: 11). Following this theory, assets and capitals can be accumulated and switched: human capital can increase financial capital if used to earn money, which can be invested into housing (physical capital) and so on.

The sustainable livelihoods approach has also been used in the context of wetlands. Such productive ecosystems contribute to livelihoods, to the wealth of those accessing them. The benefits can be translated into health, a – as they authors put it - key component of human capital that contributes strongly to the productivity. This, in turn, can be turned into financial capital. ‘Good health’ is considered as a desired outcome of livelihood strategies and therefore both an asset for and outcome of livelihoods. Ill-health, on the other hand, makes individuals less productive than healthy ones, constraining their livelihood options in wetlands (McCartney et al. 2015).

As wetland societies predominantly depend on the services that wetlands provide, these ecosystems and the services entailed may be viewed as part of the livelihood strategies and assets for the rural poor in the form of natural capital. Provisioning services (water supply, cultivation, fisheries, livestock grazing, building materials and medicinal use), regulating services (flood buffering, water storage in dry seasons, groundwater recharge, water purification, climate regulation, erosion control) and supporting services (nutrient cycling, soil formation) form an integral part of their livelihoods and can be transformed into human capital, providing options for health: directly through the provision of medicinal plants and indirectly through food security, water supply and building materials. Wetlands can contribute to financial capital through the utilization and sell of the resources provided, contributing to household income and socioeconomic status. Physical capital arises from the wetland materials used for shelter, as tools, instruments and for making clothes. Social capital lies in the institutions that traditionally manage the wetlands, the local involvement and cultural heritage wetlands provide. This approach, however, assumes that wetlands are entirely positive for health, since they attract settlers, leaving out health risks associated to the use of wetlands. Obrist et al. (2007), referred to wetlands as natural environments increasing people’s vulnerability to health risks in the context of livelihoods.

#### **1.4.3 Framing risks, risk assessments and risk perceptions. A reference to health**

In order to provide a theoretical basis on health risks, the value of risk assessments and the idea of complementing rather objective quantitative risk assessments with subjective risk perceptions, a cross section through those fields is provided in the following section.

Risk assessments usually adopt either the reductionist biomedical approach, where health is considered within a series of disease categories and the health sector structure addressing

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these through the healthcare service delivery, or the social or public health model where health is considered to be '*a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*' (WHO 1946).

Determinants influencing health cover every area of human activity and include fixed factors such as genes and gender, social and economic factors such as employment, poverty, infrastructure, lifestyle and behaviour, access to services such as health, social services, education, as well as environmental determinants, ranging from water quality to disease vectors (Fewtrell et al. 2008).

Risk is a concept which has been attempted to be defined across multiple disciplines. There is no commonly accepted definition - neither in the sciences, nor in the public understanding. All risk definitions include some potential event which entails a potential loss or undesirable outcome and they commonly distinguish between reality and possibility (Renn 1998, Rohrmann 2008, Gray and Wiedemann 1999). According to Rohrmann (2008), three elements are inherent in risk, including the physical and/or social and/or financial outcomes due to a hazard that have a (mostly adverse) impact on what humans value (such as health), the possibility of occurrence (uncertainty) and a formula to combine these elements within a particular time frame (Rohrmann and Renn 2000). *Hazard* is usually negatively connoted in this context and refers to a situation, event or substance that can become harmful for people, nature or human-made facilities. Whether the types of harm must be physically measurable or can also be socially perceived or constructed: the emphasis given to likelihood or probability, and the types of evidence used all vary between different approaches to risk (Gray and Wiedemann 1999). Whereas hazards are a physical entity, risks are not (Rohrmann 2008) and quantifying 'risk' is not an easy task and requires careful methodological approaches. By referring to potential of 'real' consequences, risk is both a social construction and a representation of reality.

Risk assessment is one tool of risk analysis, which also covers risk management and risk communication. Risk assessment qualitatively or quantitatively characterizes and estimates potential adverse health effects associated with exposure of individuals to hazards; for instance by applying the metric Disability Adjusted Life Year (DALY) which measures the comparison between different scenarios and produces an objective measure of overall risk (Fewtrell et al. 2008). According to Renn (1998), technical assessments provide the best estimate for judging the average probability of an adverse effect linked to an activity entailing risks. Classical risk assessments characterize the relationship between exposure and the incidence of health effects by identifying the hazards (e.g. water-related disease), undergoing an exposure assessment (human activities, lifestyle), as well as a dose-response assessment, the latter of which is necessary because a potential exposure to the hazard does not necessarily mean that the health impact is inevitable (Fewtrell et al. 2008). Health impacts and risks may be unevenly distributed in characteristics of the population and whereas for one population group the aspect under consideration may pose a risk, it may be

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beneficial to another group, depending on their sociodemographic, socioeconomic and cultural background, on nutrition, the immune status and genetic factors, on environmental factors, infrastructure, health service provision and also, importantly, on risk perception and health-related behaviour patterns (Bergler et al. 2000). Besides, people are risk averse if the stakes of losses are high and risk prone if the stakes for gains are high (Renn 1998, Rohrman and Renn 2000)

Risk management focuses on specific, linear chains of cause and effect over short time periods, is typically associated with cost-benefit decision-making, and concentrates on avoiding negative outcomes. It is also potentially a tool for informing and implementing sustainability (Gray and Wiedemann 1999). However, the interactions between human activities and health-related consequences are very complex and may only superficially be captured by risk assessments, as such may only reflect numerical expert judgments. In order to add depth and grassroots aspects to risk assessments, the social experience of risk, which broadens assessments by intuitive perceptions of actual adverse effects and evaluation of the risk context, the non-physical impacts and the associations between the risk, society and culture, can be integrated by adopting public and individual risk perceptions (Renn 1998, Rohrman 2008).

Within the social sciences, people's views on risks are usually labelled risk perception (Rohrman and Renn 2000). Risk perception refers to people's intuitive judgments and evaluations of hazards they are or might be exposed to (Rohrman 2008) and in social science includes a multitude of undesirable effects that people associate with a specific cause (Renn 1998). As described by Bergler et al. (2000), not the objective, but the subjective probabilities relating for example to the personal risk of infection, make a given risk a personal risk. This indicates to potential strength of risk perception analyses: the ability to predict and explain what kinds of people will perceive which potential hazards to be how dangerous (Wildavsky and Drake 1990). Risk perceptions are interpretations of the world, the evaluation of which is influenced by a multitude of individual and societal factors, going beyond the classic hazard attributes just like a typology of worldviews (Rohrman and Renn 2000) and based on experiences, beliefs, attitudes, judgements and feelings, as well as the wider social, cultural and institutional processes (Pidgeon 1998).

The most widely held theory is the knowledge theory, stating, that people perceive risks because they know them to be dangerous. According to Holdren (1983), people worry most about the risks that seem most directly to threaten their well-being at the moment. As described by Wildavsky and Drake (1990:44), it is, however, not clear, whether perceptions and knowledge coincide and can be measured by the individual's level of knowledge, since studies revealed that known risks are often underestimated (Bergler et al. 2000). Besides, the personality theory is applicable to risk perception, and socio-psychological determinants play a role as in individuals being either more or less risk averse, seeking to take or reject risks (Wildavsky and Drake 1990). Often, risks within the own area of responsibility are

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underestimated, whereas external risks, the own ability to avert risks and the ability to control risks are overestimated (Bergler et al. 2000). Relating to public reactions towards hazards, the political theory considers risk perception as depended upon characteristics such as gender, age, social class, as well as other factors. The cultural theory of risk considers group-specific rationalities that members of different cultural groups apply when selecting concerns about risks and evaluating consequences of activities, much, dependent upon values and beliefs (Renn 1998). All these influences make perceptions complex, multi-layered and diverse, contradictory and partly irrational (Bergler et al. 2000).

According to Rohrman and Renn (2000), estimations of seriousness (risk magnitude) and judgements about acceptability of risks are closely related in risk perception, since most people integrate information about the magnitude of the risk and qualitative factors into their overall judgement about the (perceived) seriousness of a respective risk. There can, however, be a considerable gap between subjective perception and objective risks of the general public and how experts think about and how non-professionals judge and evaluate risk (Renn 1998; Rohrman and Renn 2000). This is because laypeoples' understanding and views on risks are intuitive, less formal and precise than experts' statements, not necessarily reflecting an objective level or scientific assessment of risk (Renn 1998). *'However, laypeoples' basic conceptualization of risk is much richer than that of experts and reflects legitimate concerns that are typically omitted from experts risk assessments'* (Slovic 1987).

The patterns governing risk perception are highly complex and since they reflect individual intuitive understanding, one should be careful with the interpretation of results reduced to probabilities or consequences. Although risk perceptions can be quantified by socio-psychological scaling and survey techniques, risk perception does not equal risk. The understanding of 'risk' in natural and social sciences tends to clash and one should not mix 'real' or 'actual' risk as counterparts to 'perceived risk' (Rohrman 2008). Given the reach of hazards and the diversity of exposed populations, cross-cultural and interdisciplinary mixed-method research is essential.

Although public perceptions might be biased, heterogenic and manipulated by the media, they reflect the state of (lack of) information and the basic values of the people affected by risks. The public may have knowledge which is not readily available to experts. For this reason, 'technical' risk analysis is increasingly complemented by social-science approaches in order to expand how risk is conceptualized in order to understand how humans experience, rate and evaluate risks they are (or might be) exposed to (Rohrman and Renn 2000). The social science perspectives on risk broaden the scope of undesirable effects, include other ways to express possibilities and likelihood, expand the understanding of 'perceived' reality and help to explain how individuals and societies at large 'socially construct' their view on undesirable realities (Renn 1992).

The majority of risk perception studies address negative impacts. An increasing focus is, however, also set on the complex relationships between perceived riskiness and benefits of risk sources. The risk judgements are usually extended to factors of risk acceptance and can be linked to actual behaviour in risk situations (Rohrmann and Renn 2000). Stimuli perceived as risks are likely to gather influence and have consequences on human behaviour (Pidgeon 1998). And if, for instance, subjectively hazardously rated diseases are linked to a low subjective infection risk, then that could explain why preventative measures are neglected at an increasing level (Bergler 1995). According to Renner et al. (2008), perceiving a health threat is the most obvious prerequisite for the motivation to change risk behaviours, hazard prevention and for coping with adverse events, such aspects should inform and influence risk management (Rohrmann and Renn 2000).

#### 1.4.4 Routes of disease transmission: A reference to water-related diseases

Numerous attempts have been made to classify transmission routes of diseases related to water. *'Water-related disease is a diverse assemblage'*, since disease-causing agents or hazards can directly affect human health through bacteria, viruses, protozoa, helminths, chemicals and personal physical factors, originating from human or animal excreta, industry or natural or modified ecosystems, entering the body through ingestion, inhalation, wounds or the intact skin, with symptoms differing according to the disease or condition (Bartram and Hunter 2015:21). Numerous factors may be underlying, ranging from malnutrition, poverty, demography to climate, housing and use of health services.

This work adapts the so-called Bradley classification (White et al. 1972:162), covering infectious diseases related to water supply and distinguishing between four broad and non-exclusive classes of diseases, provided in the Table 4. The classification is useful, as it provides not only information and understanding on the transmission, but also shows entry points towards disease prevention.

**Table 4: Bradley Classification of water-related diseases**

Category	Route of transmission	Examples
Waterborne	<i>'Where water acts as a passive vehicle for the infecting agent'</i> , referring to the pathogen or chemical ingested by the intake contaminated water.	typhoid fever, plant fertilizer-related health risks
Water-washed (or water-scarce)	<i>'Infections that decrease as a result of increasing volume of available water'</i> , including person-to-person transmission because of a lack of water for hygiene.	scabies, trachoma, <i>Shigella</i> dysentery
Water-based	<i>'Where a necessary part of the life cycle of the infecting agent takes place in an aquatic animal'</i> , found in intermediate organisms living in water or spending part of life cycle in water.	schistosomiasis, guinea worm
Vector-related	<i>'Those infections spread by insects that breed in water or bite near it'</i> , transmitted by insects that breed in water or near water.	dengue, malaria, onchocerciasis



Waterborne diseases are caused by the ingestion of diverse viral, bacterial, protozoal and helminthic pathogens in water and are thus determined by water quality of water source and point of use, the water transport and water storage, the safety of water in terms of proximity to animal and human faeces, as well as chemical hazards (Ashbolt 2004, Bartram and Hunter 2015:23, Hunter 2010, Scholz 2015). Typhoid fever is a typical example of a waterborne disease.

Water-washed disease transmission is driven by the availability, access and use of water for personal, food and domestic hygiene. This category of disease transmission refers to water as a preventative factor of person-to-person transmission when sufficiently and safely available, adversely affecting human health when not adequate or enough for personal hygiene, e.g. in the case of trachoma or diarrhoeal diseases (Bartram and Hunter 2015:27).

The water-washed transmission category has been proposed to be modified into a category of water access-related diseases which would also include respiratory diseases such as pneumonia (Bartram and Hunter 2015:34). Water-based diseases cover those with agents of disease spending part of their lifecycle in water, with infection occurring through ingestion of the infested water – as do waterborne diseases – or through direct entering of the skin in the case of schistosomiasis (Bartram and Hunter 2015:29). The fourth of Bradley’s categories is the water-related insect vector transmission route, with insects breeding in or near natural or man-made water sources acting as vectors transmitting diseases though biting humans with the most prominent example being malaria. All of these different water-related transmission pathways are to be considered when investigating the contraction and risk of water-related diseases in wetlands.

Besides the Bradley Classification, another concept of relevance in wetlands is the framework on faecal-oral disease transmission introduced by Wagner and Lanoix (1958, Bartram and Hunter 2015: 23, Figure 4). As wetlands serve as hydrological sinks, accumulating all kinds of effluents, wastewaters, sewage and pollutants introduced from public, agricultural and domestic sources, human and animal faeces, water-borne disease transmission caused by faecal-oral pathogens needs to be underlined.

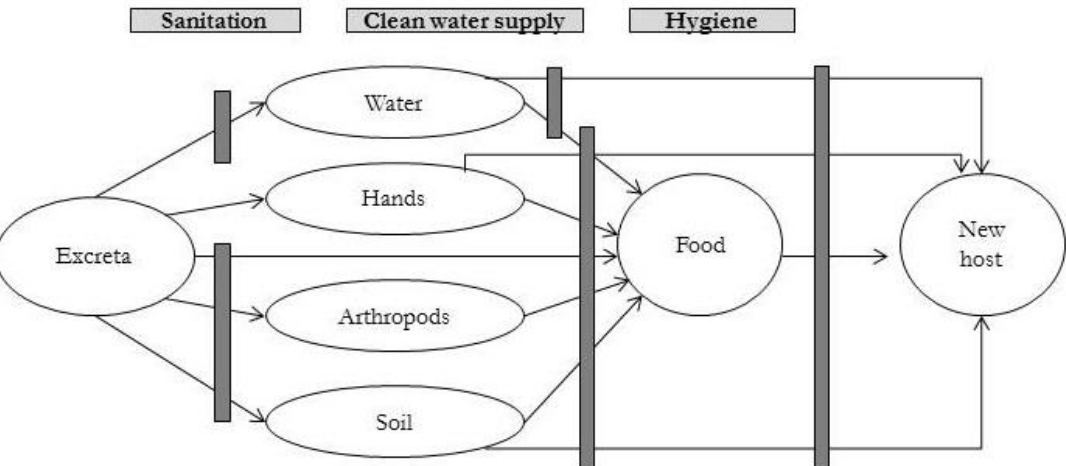


Figure 4: Faecal-oral disease transmission

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Following this theory summarized in the 'F-diagram', excreta-related pathogens are transmitted via numerous routes, including fluids (water), flies (arthropods), fingers (hands) and fields (soil), either via food or directly into the organism of a new host, where they cause disease. Fomites are sometimes added to the transmission factors (Bartram and Hunter 2015:23).

In wetland environments, all these routes of transmission play a role. And so do the primary and secondary barriers, including sanitation, clean water supply and hygiene (Curtis et al. 2000), referred to as WASH, all of which are crucial preconditions for human health and well-being and critical in the prevention of diseases transmission in such settings (Cairncross et al. 2010, Curtis and Cairncross 2003, Exner et al. 2001, Fewtrell et al. 2005, Gentry-Shields and Bartram 2014, Prüss et al. 2002, Prüss-Üstün et al. 2014, Tsegai et al. 2013, WHO 2014). Water, sanitation and hygiene are closely inter-related and interdependent, with each of the three individual domains influencing the other, and thus can be looked at from a nexus perspective.<sup>19</sup>

#### **1.4.5 Panorama of important water-related diseases in wetlands**

When reviewing public health in wetlands, Appleton (1983) distinguished the role of wetlands as transmission sites for waterborne diseases, the role of such waterbodies as breeding sites for mosquito vectors and the role of water habitats in the transmission of diseases in which neither the pathogen nor the vector have any association with the natural water bodies. Not only natural wetlands, but also human-made water bodies, and water bodies from human settlements and household environments need to be considered as sites hosting infective agents in wetlands (Resh 2010).

In the following, out of each Bradley's categories of differing transmission pathways, a closer look to those with special importance in wetlands is taken: vector-related diseases (malaria, onchocerciasis), waterborne diseases (typhoid fever, diarrhoeal diseases), water-washed (or water-scarce) diseases (trachoma, diarrhoeal diseases), and water-based diseases (schistosomiasis).

##### **1.4.5.1 Malaria**

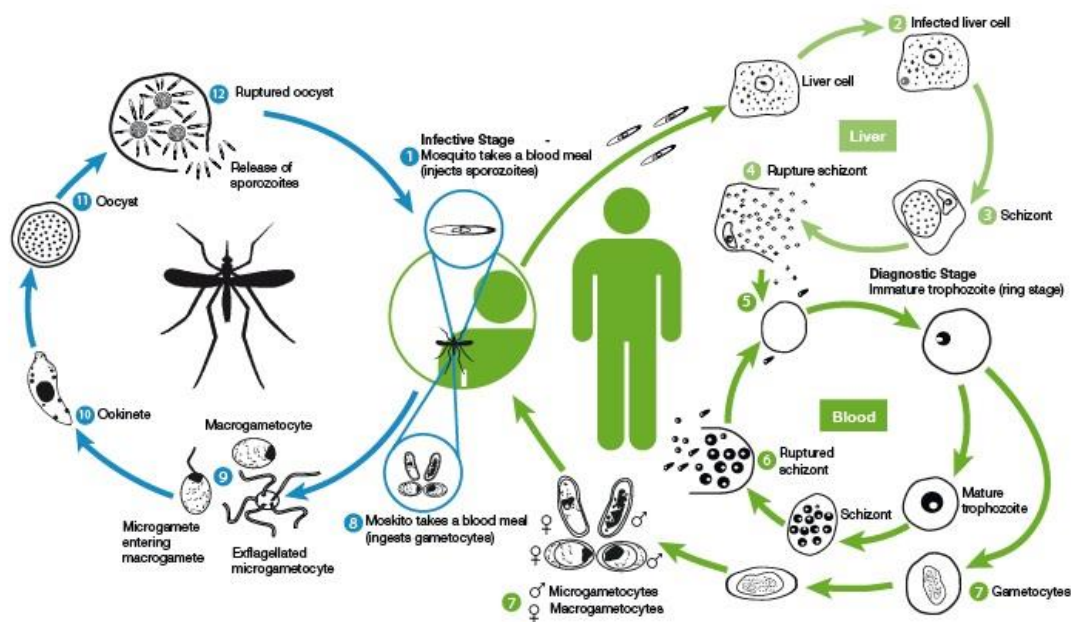
Malaria is caused by protozoan parasites of the genus *Plasmodium*, including *P. falciparum* and *P. vivax*. The parasite cycles between human and mosquito hosts with several stages which are shown in Figure 5. With their saliva, the mosquitoes inject infectious sporozoites into the human skin, from where they enter the human blood stream, invade the liver and then the red blood cells as merozoites, causing them to be destroyed. A transformation leads to gametocytes, which when ingested by another mosquito taking a blood meal from the infected human, can be transmitted to another human, thus completing the transmission

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<sup>19</sup> The term nexus originates from Latin and describes the act of binding or tying together (Sachs and Silk 1990).

cycle (Bomblies 2015). Symptoms of malaria include fever, chills, sweats, headache and in its progressed stage jaundice, bleeding disorders, shock, renal or liver failure, encephalopathy, coma and death (Tulchinsky and Varavikova 2014). Malaria is a central public health problem and one of the most prevalent vector-borne diseases globally (Carver et al. 2015). There are an estimated 225 million cases worldwide each year (Bomblies 2015, Tulchinsky and Varavikova 2014), resulting in 660,000 deaths – 90% of which hit African countries.

Malaria-transmitting *Anopheles* mosquitoes breed and spend their larval stages in and thus entirely depend on, standing aquatic environments such as riverbeds and valley bottoms (Dale and Knight 2008, Smith et al. 2013). Malaria has a long history of association with wetlands (Carver et al. 2015, Malan et al. 2009). The term malaria originates from Medieval Italian, where ‘mala aria’ meant ‘bad air’, a term used to describe so called marsh fever which individuals contracted when staying near swamps and marshlands (Ukorojie and Abowei 2012). In many parts of the world, wetlands used to be perceived as wastelands and sources of malaria (McCartney and Rebelo, 2015).



Source: [www.dpd-cdc.gov/dpdx](http://www.dpd-cdc.gov/dpdx)

**Figure 5: Infection cycle of malaria**

The ecology of the disease is closely associated with hydrological features such as the availability of water, flooding and water resources management, with other physical feature such as altitude and seasonality and with man-made features, behaviour and use (Johnson and Paull 2011, Omukunda et al. 2012). The mosquito species vary considerably in their water-ecological requirements, and this affects the disease ecology. According to Carver et al. (2015), *healthy wetlands* are characterized by intact wetland communities (including mosquitoes and a variety of invertebrates and vertebrates and their interaction) with large biodiversity and trophic structure that tend to minimize the dominance and production of

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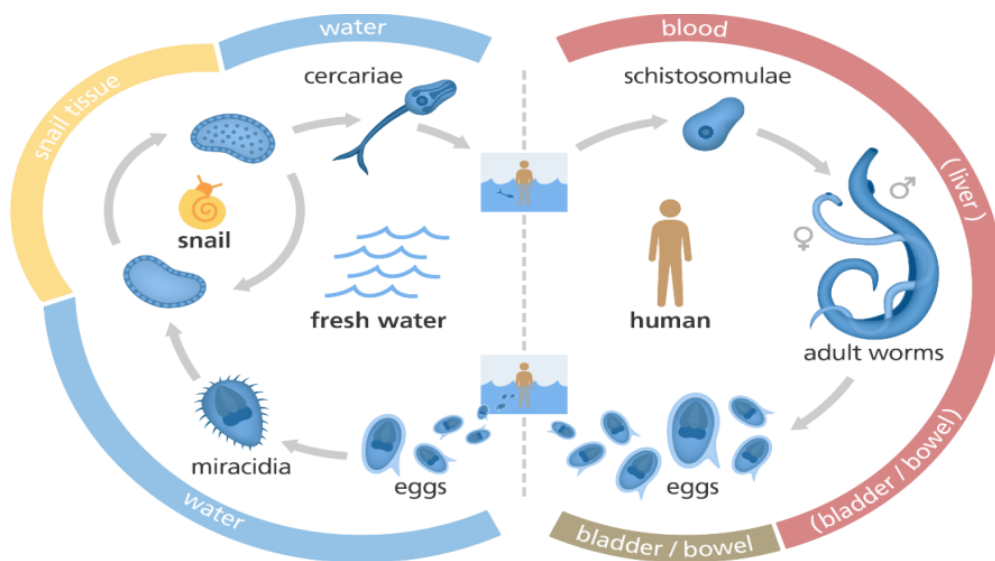
vector mosquito species and reservoir host species and naturally reduce the vector-borne disease risks to surrounding human and animal populations. Particularly in smaller and ecologically very vulnerable wetlands, however, anthropogenic disruptions, such as land use changes, water development and drainage projects, and other human modifications to the wetland, compromise natural ecological processes that regulate mosquito populations. Such activities can lead to increased exposure and transmission (Confalonieri et al. 2014, Malan et al. 2009, Patz et al. 2004). Several authors suggest that wetland rehabilitation and creation could inadvertently encourage the growth of *Anopheles* mosquito populations by a range of activities such as the alteration of vegetation and the hydraulic habitat and potentially resulting changes in the water quality (Cook and Speldewinde 2015, Malan et al. 2009).

#### **1.4.5.2 Schistosomiasis**

Schistosomiasis, also known as bilharzia, is a chronic, debilitating disease endemic in Sub-Saharan Africa caused by parasitic trematodes of the genus *Schistosoma* (Appleton and Madsen 2012, Gryseels et al. 2006). Schistosomiasis can lead to chronic ill-health and belongs to the most important of the water-based diseases with currently over about 200 million people being infected worldwide and 600 million people at risk of infection, and 200,000 deaths annually (Tulchinsky and Varavikova 2014). According to Gerba and Nichols (2015), in their life cycle, the ova of the parasitic flukes hatch into ciliated miracidia in the water, where they infect a certain species of snails (Figure 6). The *schistosomes* cycle between water-based snails and humans (Batzer and Boix 2016), and humans are getting infected when larval forms of the parasite, which are released by the snail intermediate hosts, penetrate the skin during contact with infested water. In the human organism, the cercariae migrate through various tissues, ending up as adults, mating in the liver and producing large numbers of eggs, some of which pass into the intestine or bladder. Via human excreta the *Schistosoma* eggs return into the water, infect the snail and develop into larvae, thus creating an infectious cycle.

Symptoms which go along with an infection include intestinal, hepatic and other symptoms such as diarrhoea and abdominal pain, enlarged liver, blood in faeces or urine, skin rashes, fevers, chills, cough, and muscle aches (Gerba and Nichols 2015, Tulchinsky and Varavikova 2014). The amount of body surface which is contacting water and cercariae can determine the potential exposure to schistosomiasis transmission (Michelson 1993). Schistosomiasis is endemic in 74 countries in Africa, South America, the Caribbean and Asia (Tulchinsky and Varavikova 2014). Infections with schistosomiasis can occur particularly in areas that lack adequate sanitation, with risk factors being bathing, swimming and playing in infested water, as well as occupational proximity (Appleton and Madsen 2012, Gerba and Nichols 2015, Huang and Manderson 1992, Resh 2010).

The ecological requirements of the snails determine the distribution of schistosomiasis. Standing freshwater providing certain aquatic plants is the snails' preferred habitat, especially in wetlands.



Source: [www.yourgenome.org](http://www.yourgenome.org)

**Figure 6: Infection cycle of schistosomiasis**

Current flow velocity, temperature and habitat permanence, on the other hand, limit snail occurrence (Appleton and Madsen 2012, Dale and Connelly 2012). The degradation or alteration of wetland systems can eventually accelerate the prevalence of schistosomiasis (Confalonieri et al. 2014, Malan et al. 2009). According to Gergel (2013), schistosomiasis is a 'sensitive ecological indicator disease' for monitoring ecosystem changes because its prevalence can change immediately following alterations to the surrounding water landscape.

In particular, inappropriate water management, lack of sanitation, reuse of untreated wastewater for irrigation as well as occupational proximity have been shown to increase the transmission risk of schistosomiasis. Surface irrigation systems that result in water stagnation and weed growth have been identified as a high risk factor, as they create favourable snail-breeding conditions. Within irrigated areas, over season, among sites and depending on local circumstances, the presence and density of snails differs (Boelee and Madsen 2006, Gerba and Nichols 2015, Utzinger and Tanner 2000).

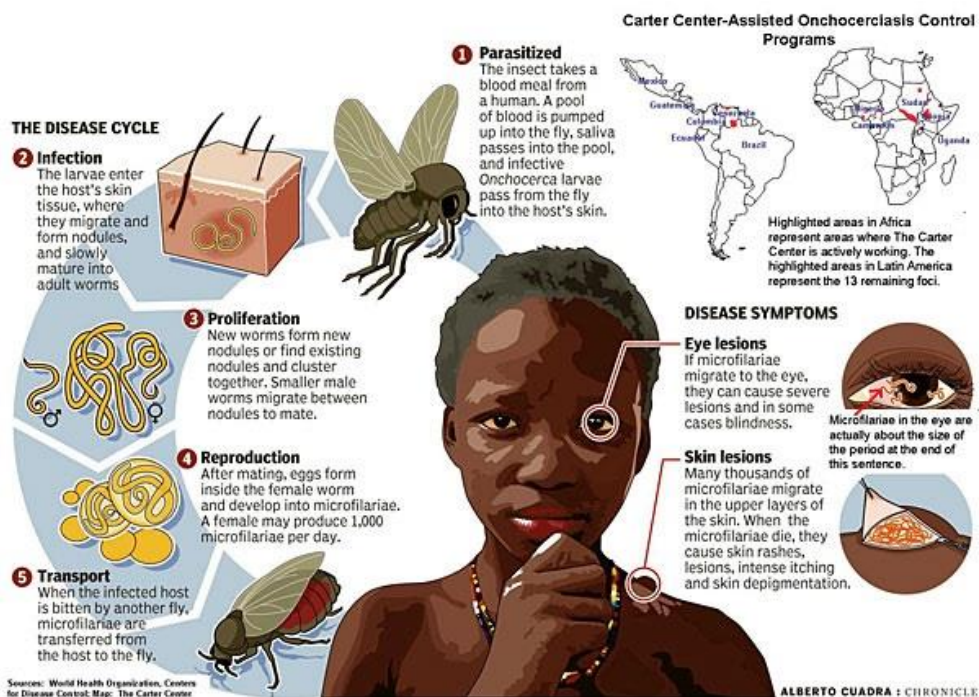
### 1.4.5.3 Onchocerciasis

Onchocerciasis is an eye and skin disease better known as 'river blindness'. It is caused by the parasitic filarial nematode *Onchocerca volvulus* and vectored by infected blackflies of the *Simulium damnosum* species complex (Resh 2010, Taylor et al. 2010). The infectious agent of the disease enters the skin in the larval stage during the vector's blood meal where it develops into an adult form (Bomblied 2015). In the human body, after mating, the female

adult worm can release embryonic larvae (microfilariae) that migrate in the tissue, form nodules and mature to adult worms (Figure 7).

The adult female produces thousands of larval worms in the human host that migrate into the eyes and upper layers of the skin, causing severe itching and lesions, rashes, and vision changes that can ultimately lead to permanent blindness (Hopkins and Boatin 2011). By blood meals from infected humans, other blackfly vectors can ingest filarial stages of the worm's life cycle and transmit the infection further (Bomblies 2015, Figure 7). Despite successful control intervention during the past thirty years, the disease is more spread than thought (Bomblies 2015, Hopkins and Boatin 2011). Today, over 120 million individuals, mostly in Africa, are at risk of onchocerciasis, and 18 million are infected (WHO 2017<sup>20</sup>).

Onchocerciasis occurs mainly in areas in Sub-Saharan Africa. The disease-transmitting blackflies breed in fast-flowing rivers and streams (Resh 2010). For that reason, the geographic distribution of onchocerciasis is determined by the distribution and suitability of local river systems (Zouré et al. 2014). Populations can be exposed to the transmission of onchocerciasis if they live permanently near the breeding sites, and if they spend a certain amount of time and frequency near the vectors (Hopkins and Boatin 2011, Zimmermann 2001).



Source: www.cdc.gov

**Figure 7: Infection cycle of onchocerciasis**

Generally, environmental modifications affect the cycle of blackflies and could therefore also affect the incidence of onchocerciasis (Confalonieri et al. 2014). Dams and degraded forests provide an ideal habitat for the vectors and facilitate exposure to onchocerciasis (Bomblies 2015, Prüss-Üstün and Corvalan 2006). There is barely any literature available on

<sup>20</sup> Further reading at <http://www.who.int/mediacentre/factsheets/fs095/en/>.

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onchocerciasis in wetlands. According to Dale and Knight (2008), it occurs widely but is little reported in connection with wetlands. However, as it is closely linked to rivers and streams, onchocerciasis is a relevant health threat when discussing water-related diseases in wetlands.

#### **1.4.5.4 Diarrhoeal diseases**

Diarrhoea is usually a symptom of an intestinal infection caused by a variety of bacterial, viral and parasitic organisms which can be transmitted by both waterborne and water-washed exposure pathways (Cook and Speldewinde 2015, Tulchinsky and Varavikova 2014). It is defined as the passage of three or more loose or liquid stools per day. Diarrhoeal diseases cause the secretion of fluids and dissolved salts into the gut with mild to severe or fatal complications. In developing countries, they account for half of all morbidity and a quarter of all mortality due to dehydration, especially in children. Infection can stem from the ingestion of contaminated water and food, and is closely linked to poor hygiene and inadequate sanitation (WHO 2014), potentially accelerated by the proximity to livestock and their waste. The risk of contracting diarrhoeal diseases is especially high where people are in close contact with contaminated water sources and where water supply management is poor (Tulchinsky and Varavikova 2014).

Poor surface water quality in wetlands may result from discharging contaminated effluent, wastewater or stormwater into source water, from inadequate waste and sanitation management, waterlogged environment and poor drainage (Anthonj et al. 2016<sup>21</sup>, Cook and Speldewinde 2015, Falkenberg 2016, Joseph and Jacob 2010). All of this contributes to the spread of diarrhoeal diseases, especially during and after flooding (Derne et al. 2015, Jenkins and Jupiter 2015). Fuhrmann et al. (2015) found high amounts of *E. coli*, as well as high concentrations of helminth eggs in an Ugandan wetland, indicating potential health risks stemming from faecal contamination. Masamba and Mazvimavi (2008), on the other hand, did not detect a high concentration of faecal coliforms and faecal streptococci in their research area within the Okavango Delta, characterized by multiple uses. This was explained to potentially result from the low runoff during the rainy season due to low rainfall, sandy soil with high infiltration rates and low slopes prevalent in that particular area. According to Cools et al. (2013), seasonal floods dilute the contaminated water, flush the stagnant water, thus improve water quality and potentially reduce pathogen load and thereby diarrhoea risk, also.

#### **1.4.5.5 Typhoid fever**

Typhoid fever is a bacterial disease which is caused by the two major serovars of pathogenic *Salmonella enterica*, namely *Typhi* which infects humans only and *Paratyphi*, which infects both humans and domestic animals (Bartram and Hunter 2015). Symptoms develop few

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<sup>21</sup> Parts of this chapter have been published.



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days after exposure, and differ very much in severity. Besides fever, they include the feeling of weakness, stomachaches, headaches, a loss of appetite, and in some cases, a rash of flat, rose-colored spots. Typhoid fever affects millions of people annually and is reported to cause 500,000 deaths per year (Tulchinsky and Varavikova 2014). The pathogen is transmitted through the ingestion of faecally contaminated water or food or through transmission by flies that transfer the bacteria.

The disease is closely linked to areas and living conditions with low standards of hygiene and inadequate water supply. Water and wetlands act as transport media of faecal pathogens and abiotic factors play a role in disease transmission. This association of typhoid fever and wetlands was evidenced by Fuhrmann et al. (2015), who found health-threatening amounts of *Salmonella spp.* in an Ugandan wetland.

#### **1.4.5.6 Trachoma**

Trachoma, an infectious eye disease caused by the bacterium *Chlamydia trachomatis*, is the leading cause of preventable blindness worldwide (Feasey et al. 2010). The organism is transmitted through contact with eye discharge of an infected individual, typically by use of household items such as handkerchiefs and washcloths. The bacterium can also be transmitted by flies that have landed on the eyes or nose of someone infected (Ngondi et al. 2007, Tulchinsky and Varavikova 2014). Usually, the first infection occurs in childhood. If not treated, after several reinfections, trachoma can cause major scarring in the inside of the eyelid, which might as a result turn inward and cause scratching of the cornea by the eyelashes. Besides being painful, this can lead to visual impairment, permanent corneal damage and irreversible blindness. Trachoma is associated with attributes of the physical and social environment and stands in close connection with poor personal and environmental hygiene and inadequate sanitation of human and animal waste (Clements et al. 2010, Hopkins et al. 2008, Montgomery et al. 2010, Schémann 2002). Furthermore, it has been linked to limited health service provision. Trachoma is endemic in 57 countries and has caused visual impairment in approximately 2.2 million people, and blindness in 1.2 million people respectively. It affects poor rural areas and mostly marginalized populations (Tulchinsky and Varavikova 2014) and occurs especially in rural Sub-Saharan Africa.

A report from Berthe and Kone (2008) found the risk of contracting trachoma in Malawian wetlands to be high where populations have only limited access to adequate water supply and sanitation.

#### **1.4.6 Health-related behaviour: A reference to prevention and health-seeking**

Health-related behaviour is powerful: healthy behaviour may determine the prevention, as well as risky behaviour may drive the exposure to and therefore transmission of infectious disease and therefore, theoretical approaches to health behaviour are adopted here. Gochman (1997) defines health behaviour as *'those personal attributes such as beliefs,*



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*expectations, motives, values, perceptions and other cognitive elements; personality characteristics, including affective and emotional states and traits; and overt behaviour patterns, actions and habits that relate to health maintenance [preventive health behaviour], to health restoration [illness behaviour] and to health improvement [sick-roles behaviour].'*

Health behaviour theories observe individual, interpersonal, organisational, community, societal, supranational or environmental factors shaping behaviour and behavioural change, with key elements including threat, fear, response efficacy, self-efficacy, barriers, benefits, subjective norms, attitudes, intentions, cues to action and reactance (Anthonj 2012, Curtis et al. 2009; 2011, The World Bank 2017<sup>22</sup>). When it comes to the elaboration of health risks and diseases associated with the use of the natural environment – in this study wetlands – and the role of health behaviour, the health belief model, the theory of planned behaviour and reasoned action and the social cognitive theory apply (Bartholomew et al. 2011, Renner 2008).

The psychological health belief model (Janz and Becker 1984) aims at explaining and predicting health behaviours by attributing a major role to the attitudes and beliefs of individuals. According to this theory, health protective behaviour is a result of the individual's perceived personal susceptibility to and the severity of the adverse health condition and the perceived benefits or barriers of taking preventive action (Fishbein & Guinan 1999). According to Bartholomew et al. (2011), the decision-making process is mainly triggered by internal and external factors.

According to the theory of planned behaviour, behaviour depends on one's intention to perform certain acts, with behaviour being influenced by the attitude, beliefs and values relating to the outcome of the behaviour, as well as being determined by subjective norms and beliefs, relating to general social norms. Moreover, the perceived behavioural control, which contains the individual's perceptions of their ability to perform behaviour plays a role. The intention to perform behaviour is determined by three conceptually independent constructs: attitude, subjective norm and perceived behavioural control. The theory can be applied in situations in which people are aware of the negative consequences of their behaviour (Ajzen 1991, Bartholomew et al. 2011).

The third theory which is relevant with regard to health-related behaviour is the social cognitive theory by Bandura (1998), an interpersonal theory which includes both the determinants of behaviour and the process of behaviour change, suggesting that human actions can be explained by the interaction of behaviour, personal and environmental determinants, referred to as reciprocal determinism. Behaviour is not driven by inner forces, but by external factors: Environmental factors include situational influences and environmental conditions in which behaviour is performed, such as social forces (norms), and structural influences (access to resources, policies) while personal factors include

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<sup>22</sup> Further reading at <https://siteresources.worldbank.org/EXTGOVACC/Resources/BehaviorChangeweb.pdf>.

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instincts, drivers and other motivational forces (Anthonj 2012). According to Bartholomew et al. (2011), outcome expectations, self-efficacy, behavioural capability, perceived behaviour of others and the environment are variables underlying behaviour and the process of behavioural change.

#### **1.4.6.1 Health-protective behaviour: A reference to water, sanitation and hygiene**

Although risk perceptions act as triggers for precautionary action (Wiedemann and Schütz 2005, Chapter 1.4.3), the engagement in preventive health behaviours is not merely determined by the awareness of objective health risks, but also mainly influenced by health beliefs and specific health cognitions (Renner et al. 2008). The same theories of health behaviour also apply to hygiene behaviour as demonstrated by Curtis et al (2009). Following social and evolutionary psychology and neuroscience, the authors mainly assign behaviour to three types of discrete but interacting causes. These are cognitive or executive control producing 'planned' behaviour which aims at preventing disease, achieving long-term health goals, beneficial supernatural objectives like a state of religious purity or 'good luck' and adequate socialization in healthy behaviour and good hygiene manners, e.g. as taught to children. Moreover, there is the reward system stimulating 'motivated' behaviour, with drivers of motivation being disgust, a factor which is related to status, social standing and affiliation in doing what everybody else would, comfort, nurture, education and care for children, and attraction, as well as fear regarding hygiene-related diseases. Besides, there is the automatic or reflexive control which is responsible for 'habitual' behaviour, learnt at an early age, automated and regularly triggered by a particular cue, with 'habit' being the most primitive psychological system involved. Curtis (2011) concluded that although setting-specific differences prevail, behavioural patterns are common.

All named psychological factors determining hygiene behaviour in development settings are also largely influenced by the environment. Physical factors include aspects such as the provision, access, availability and cost of water and hygiene, and the proximity and adequacy of sanitation, but also, behaviour may underly seasonal fluctuations. Social factors cover culture, lifestyle, beliefs, norms and traditions, sociodemographic and socioeconomic factors such as wealth, the social network and access to education and information. Biological barriers include poor environmental conditions and pollution, lack of water and sanitation, lack of drainage, lack of time and priorities to apply health-protective behaviour. All of these environmental factors can be changed or mediated, thus offering the possibility of changing behaviour. Generally, psychological and environmental factors are likely to determine hygiene behaviour (Curtis et al. 2009; 2011).

According to the Framework to Analyze Sanitation Behaviors to Design Effective Sanitation Programs (SaniFOAM) of the World Bank's Water and Sanitation Programme, sanitation behavioural determinants – all of which can be transferred to any other preventative health behaviour – include **F**ocus on **O**pportunity, **A**bility and **M**otivation. In this framework,

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opportunity includes institutional or structural factors that influence people's chances to perform a particular behaviour. Opportunities include perceptions on the availability services, social norms for health behaviour, sanctions and enforcement. Ability relates to the individual capabilities of performing a behaviour, which would entail health knowledge, awareness and perceived social support for acquiring and using a latrine, household roles and decision-making on expenditures, as well as perceived affordability. Motivation here includes each individual's desire and willingness to perform a behaviour, with drivers being beliefs, values and attitudes surrounding health behaviours, as well as emotional, physical and social drivers, competing household priorities and willingness to pay (Stedman 2014, The World Bank 2017<sup>23</sup>).

#### **1.4.6.2 Health-seeking behaviour. A reference to livelihoods**

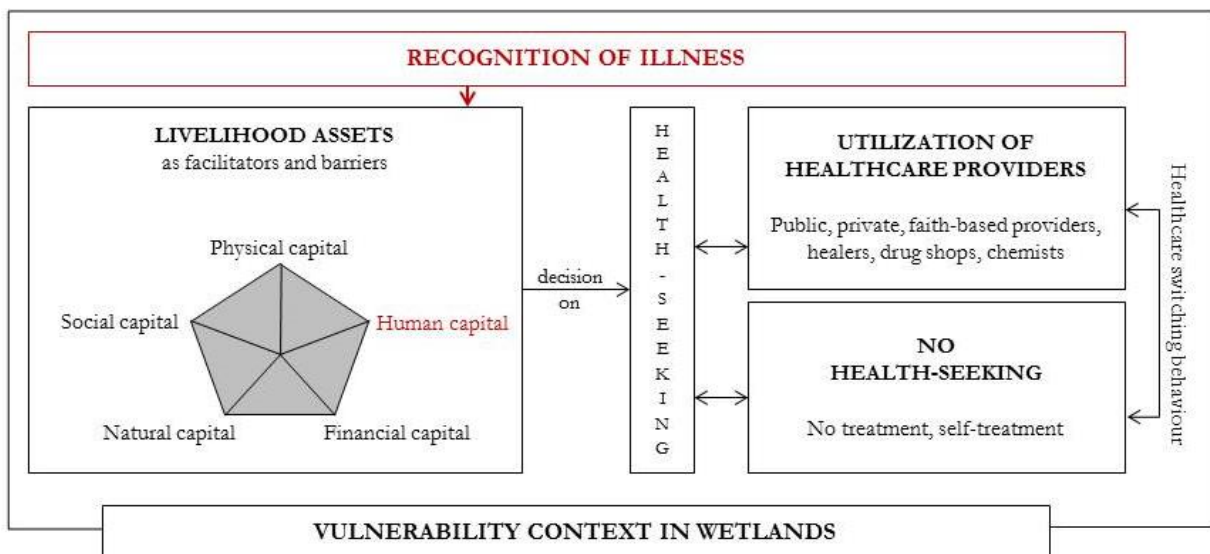
Health-seeking approaches usually focus on individuals from their first recognition of symptoms, applying pathway models that follow the sick person through different phases of formulating the illness, deciding on seeking care and actual health seeking until recovery. According to Ahmed et al. (2000), health-seeking behaviour is conceptualized as a 'sequence of remedial actions' taken to rectify 'perceived ill-health'. Obrist et al. (2007) took up the sustainable livelihoods approach (Chapter 1.4.2) and the livelihood assets with regard to access to health in order to investigate the interactions between actors at risk and healthcare providers. Then they integrated it into their *Health Access Livelihood Framework*. Access to healthcare services in resource-poor settings was linked to Penchansky and Thomas' (1981) five dimensions of access. These entail the availability of health services, such as drugs; the accessibility of services addressing the distance to health facilities and the availability of transport; the affordability of services in terms of admission fees, cost of medication and transport; the adequacy of services, as well as acceptability regarding people's perception and judgement of the quality of services also played a role. Generally, the degree of access to health services according to this theoretical complex relates to the interplay between the healthcare services and broader policies, institutions, organizations and processes governing the services and the abovementioned livelihood assets people can mobilize and combine in particular vulnerability context (Obrist et al. 2007). According to the same authors, access to health services is also governed by cultural norms, subjective preferences and medical traditions. They argue that recognizing illness and seeking treatment depends through a considerable extent on individual, community and societal access to livelihood assets. Based on Obrist et al.'s (2007), DFID's (2001) work and based on my preliminary considerations with regard to health-seeking behaviour in wetlands, a conceptual framework applicable to health-seeking behaviour in the Ewaso Narok Swamp has been developed (Figure 8). It considers the decision on seeking healthcare providers or

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<sup>23</sup> Further reading at <https://www.wsp.org/featureevents/features/sanifoam-framework-design-effective-sanitation-programs>

not after recognition of an illness against the background of livelihood assets in the vulnerability context of wetlands.

As suggested by Obrist et al. (2007), the ecosystem as such as the inhabitants' backbone of their livelihood (natural capital), farming activities and selling products from the wetlands helping gain income (financial capital), families provide support (social capital), infrastructure, roads and means such as bikes or vehicles enabling care-seeking (physical capital) and popular, traditional, and biomedical knowledge on diseases and disease transmission possibly preventing exposure (human capital).



Informed by Obrist et al. (2007)

**Figure 8: Health-seeking in a wetland context**

All these assets may determine the wetland users' health-related behaviour. Moreover, depending on severity of ill-health, on access to services and assets, multiple and switching healthcare utilization strategies may be developed.

All of these theories are relevant in terms of wetlands, health risks and disease exposure and applied to the Ewaso Narok Swamp.

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## 1.5 How to read this study: An introduction to the structure

In the further course of this thesis, the links of wetland use and health risk factors exposing to diseases are going to be thematised based on data from different levels and perspectives. Overall, the reader should keep the wetland setting described in Chapter 1.3.2, as well as the wetland user groups (Chapter 1.3.3) and the prevalent diseases (Chapter 1.3.4) in mind in order to have clear picture of the situation on the ground. The conceptual framework (Chapter 1.4) provided and the wetland-related diseases presented (Chapter 1.4.5) will be useful in order to have the numerous and different findings in the right context.

The general introduction is followed by the methodology used for the research and analysis. The Chapter 2 intends to explain in great detail every step taken in order to develop the tools used for sampling, data collection and analysis. Moreover, the process of triangulation is described, which played a central role in this work.

The three subsequent chapters can be considered as sub-studies (Chapters 3-5). They reflect the three objectives (Chapter 1.2, Table 1) of this thesis and build on one another, containing results, limited discussions and short conclusion. Those synopses aim at facilitating a better readability.

A literature-based systematic review on use-related disease exposure in Sub-Saharan African wetlands is provided in Chapter 3, which results in a theoretical framework displaying the most important links. Based on this framework, Chapter 4 presents a health risk assessment from the Ewaso Narok Swamp. It includes occupational and domestic wetland use, health-related behaviour and sociodemographic factors of the study population. The same variables that played a role in the theoretical part of this work are associated with self-reported symptoms and approximated disease models that mirror the diseases present in wetlands. Theory and risk assessment are then complemented by a health knowledge and risk perception study that addresses the same aspects as the review did, as shown in the Chapter 5. The perceptions are integrated into the theoretical framework and discussed against the risk assessment.

In the Chapter 6, theory is contrasted with risk perceptions and risk assessment. This joint discussion chapter synthesizes, triangulates and discusses used-related diseases, risk perceptions and behaviours in wetlands against each other. Moreover, it addresses the domestic and occupational domains, the potential of WASH in disease prevention in wetlands, the meaning of health-seeking behaviour in wetlands, the special case of pastoralists and semiarid wetland settings, health effects arising from the use of agrochemicals and suggestions on how to achieve a health-based wetland management, before discussing methodology and limitations.

The concluding Chapter 7 completes this work, taking up the most important lessons learnt and underlining their relevance on international policy agendas, as well as controversies.

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## **2 METHODOLOGY FOR RESEARCH AND ANALYSIS**

This chapter outlines and discusses the methodological approach that was followed for the collection and analysis of data. It describes how the researcher investigated aspects of individual, occupational, domestic and environmental spheres that relate to the exposure and risk of diseases in wetlands, guided by the theoretical and conceptual framework described in the previous chapter. After briefly justifying the research strategy and explaining the influence of an exploratory field trip, the chapter offers insights into the use of grounded theory in developing and shaping the data collection tools and the choice for a combination of qualitative and quantitative methods. A short listing and description of the data collection methods is provided and the different analytical tools and triangulation process delineated.

### **2.1 Conceptualization of the research: Introducing the study design**

In order to investigate health risks and disease exposure of the people using the Ewaso Narok Swamp in Kenya, the main focus was on different wetland user groups, including smallholder farmers, commercial farmers, pastoralists and service sector workers, and their households. Their perceptions and behaviours were addressed as central aspects into this study.

However, before this could be done, the first study phase was used in order to ground theory by identifying and examining a problem through an explorative and reflective process, rather than having clearly defined research hypothesis. A theoretical framework was needed to be developed in order to guide the choice of methodologies to be applied in the field, guaranteeing a sound and meaningful data collection in a so far under-researched research field. This theoretical framework was built based on the requirements of a multinational multidisciplinary research project that this PhD thesis was part of (Chapter 1.2), based on an exploratory field trip prior to the onset of data collection (Chapter 2.1.1, Photo 3) and a detailed systematic analytical literature review (Chapter 2.2, Chapter 3).

The information gathered during the first trip to East Africa led to the decision of addressing use-related health risks in wetlands, since several stakeholders confirmed the foregoing assumptions gained from studied literature and secondary data before the onset of the field phase: All were pointing to the phenomenon of in-migration and increased use of wetlands as a vivid on-going process in the region, affecting the local population and potentially increasing their exposure to disease risks. The drive for increased use of these vulnerable ecosystems linked to potential impact on human health was seen to be a consistent theme in nationally and locally important agendas and proclaimed targets of development. For all these reasons, the type of wetland use was considered to be a valuable aspect against which to further investigate health risks. This first phase of the PhD allowed for the complexity of the research questions to arise, be defined and delineated in dialogue with information

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coming from the field and available literature. The grounded theory derived formed the basis of the empirical methods chosen for this investigation (Chapter 2.3).

Based on this wide-ranging preparatory work, the second study phase covered a case study, with different empirical methods applied. In order to draw a very broad picture on the risks arising from wetland use and the related perceptions, a variety of different perspectives and views was supposed to inform the research. For this reason, a combination of quantitative and qualitative methods was adopted, targeted at different stakeholders: Since during the exploratory phase the previous assumption by the researcher was complemented by an emerging argument from various stakeholders, that people with occupational differences in wetlands may be exposed to water-related diseases in a different way, this insight was adopted in the study design. A case study has been defined as '*an intensive study of a single unit with an aim to generalize across a larger set of units*' (Gerring, 2004), which, for the Ewaso Narok Swamp means, that units would be considered to be (i) the Ewaso Narok Swamp and (ii) the different wetland user groups in the Ewaso Narok Swamp, representing accordingly a marsh in semiarid East Africa and the groups using such an ecosystem; depending on the generalization that one is willing to attempt. This study covered the nexus of health risks, perception and behaviour in the context of the use of the Ewaso Narok Swamp. Within this nexus, research examined four different groups in a cross-sectional study (Chapter 2.3.2) that addressed four different cohorts, namely smallholder farmers, commercial farmers, pastoralists and service sector workers, identified by random and snowball sampling. The study included household surveys (n=400) and observational assessments (n=397). The cohorts also were part of the qualitative part of the study (Chapter 2.3.3). Respondents of in-depth interviews (n=20) would be identified by anchor questions from the household survey. Moreover, key informants and experts working in the health, WASH, water, wetland, education or related sectors were interviewed (n=8) and feedback on all findings was received during a debriefing meeting. It served to present the preliminary results and discuss them with local chiefs, elders, and community health workers (n=30). Additional sources of information were very limited statistical official health data from the Rumuruti District Hospital (Chapter 1.3.4) and educational material from primary school books. All of these data sets were triangulated (Chapter 2.5 and 6.1).

### **2.1.1 An exploratory field trip in order to sharpen the research focus and design**

The direct contact of the investigator with its field and setting of research is crucial to adequately capture the context, the interactions between the individuals living and stakeholders working in the research area and processes in a structural, physical, cultural and societal dimensions (Völker 2012). This is especially true in a setting which much differs from the researchers' background regarding the named dimensions. In order to familiarize with the research area and the subjects under investigation, a first exploratory

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field phase took place from February to April 2014<sup>24</sup> and Uganda. It served to conduct a general socioeconomic and environmental mapping of people using wetlands. The trip aimed at gaining an impression on the livelihoods and daily routine of the people working in wetlands, an insight into different user groups, the infrastructure, water supply and sanitation, as well as their health situation. Representatives of district and higher level authorities, non-state actors and stakeholders that were responsible for wetland management, water supply and sanitation, environmental protection and health, were informally interviewed (Annex 2). This information gathering aimed at getting a broad picture and idea about those enrolled in wetland and health management and to learn about the specific activities going on in East Africa. Moreover, field trips to wetlands were conducted (Photo 3) that served to get a first overview on wetland use, which appeared to range from rice farming and crop cultivation using chemical fertilizers to livestock farming, mining, brick-making and grass harvesting. Also, the wetland water was extracted for domestic use. The inspection of a sanitation facility in a wetland revealed low quality and faecal contamination, lack of hygiene equipment and running water.

A trip to a health post near a wetland revealed that the most common disease among farmers in wetlands was malaria, seasonally changing in its incidence. Wetland farmers themselves mentioned to contract diarrhoeal diseases from the low quality irrigation water.

Representatives of the water users' organization mentioned that the incidence of malaria had reduced due to the conversion of natural wetlands into agricultural areas, transforming river networks and standing water into better managed canals with less papyrus, which minimized the mosquito populations. Informal talks with people using a water point by a wetland revealed that less than 60% do not boil or otherwise treat their water before drinking even though they supposed it hazardous due to low quality.

After 8 informal semi-structured interviews and two wetland field trips and the visit of two Nile Basin Initiative libraries in Entebbe and Kigali, a first overview of the activities in wetlands and healthcare, prevention of disease, water provision and sanitation in the region was achieved.

The interviewees and secondary data verified the relevance and indicated the importance of investigating water-related health risks arising from wetland use. The preliminary results of this exploratory phase stroke the researcher as highly relevant and worth examining in greater depth. The issues and questions to be included into the data collection tool were identified, broadened or narrowed down as necessary. In the course of this tour, the idea evolved of investigating different groups of wetland users from the highly diverse and manifold types of wetland use, which would be expected in Kenya also.

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<sup>24</sup> Originally, this present research was supposed to be conducted in Rwanda.





a. Rice farming in inland valley swamps.



b. Field trip in inland valley swamps.



c. Wetland community.



d. Testing of rice production in a wetland.



e. Using the wetland as a dumping ground.



f. Water point within a wetland (2014).

**Photo 3: Impressions of East African wetlands during the exploratory tour**

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## 2.2 A literature review grounding theory on use-related diseases in wetlands

Since little is known about the ramifications of wetland use on the exposure to and risk of contracting diseases, an exploratory study design was applied for suitably framing a theoretical concept as a basis for the subsequent empirical part of the study. The present work adopted *Grounded Theory* for exploring use-related health risks and diseases that the use of wetland may expose users to. *Grounded Theory* is based upon a research design for the development of subject-related context for a certain topic, as developed by Glaser and Strauss in the context of qualitative social research (1967; 2008, Corbin and Strauss 2008). Being a tool that discovers new ideas and relationships through a concrete set of procedures, while the focus is on the research topic and not on the scientific model or theory, it was seen as very useful. Following this approach, data was systematically collected and analysed; and based on both, theory was discovered, developed and confirmed. In a permanent dynamic dialogue with that data, information gathering, analysis and development of theory were closely and reciprocally connected (Anthonj 2012). A strict system was abandoned, rather was the process inductive, open and flexible in order to facilitate a portrait of the diverse social reality (Gatrell and Elliott 2009, Goldkuhl and Cronholm 2010, Strauss 1991). By this, *Grounded Theory* offered a high potential in approaching, capturing and understanding the reality (and in this case, the available literature in Chapter 3) with creativity, openness and association skills (Anthonj 2012, Strauss and Corbin 1996, Völker 2008).

According to Pfaffenbach (2005), data for grounding theory can be collected from empirical research as well as from the analysis of existing literature. Here, the observations and insights gathered during an exploratory field trip (Chapter 2.1.1, Annex 2) provided a first overview of issues and risk factors to be addressed with regard to wetland use.

Based on this prior knowledge, the literature review was intended to build a theoretical framework on wetland-use-related risk factors and water-related disease exposure arising from the use of wetlands (Bowling 2014). It identified articles from peer-reviewed journals and book chapters that (i) address water-related diseases in Sub-Saharan African wetlands and (ii) link those diseases to the use-related exposure. The WHO & Ramsar technical report on wetlands and human health (Horwitz et al. 2012) served as a starting point for approaching the topic. It presents a range of water-related diseases in wetlands and helped for pre-selecting a set of water-related diseases present in Sub-Saharan Africa which were included in the review according to their transmission pathways. Electronic literature databases were deployed for computer-based searches, including ScienceDirect, PubMed and Web of Science. Furthermore, electronic archives of relevant international organizations and research institutes were searched. The search within titles, abstracts and keywords included keyword combinations of wetlands, the major wetland uses, and water-related

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diseases. The review approach was adapted from previous work from Völker and Kistemann (2011).

The review aimed to shed light on selected water-related infectious diseases and elaborated risk factors associated with wetland use. It considered diseases that represent each of Bradley's categories of differing transmission pathways in detail: (i) waterborne diseases (typhoid fever, diarrhoeal diseases), (ii) water-washed (or water-scarce) diseases (trachoma, diarrhoeal diseases), (iii) water-based diseases (schistosomiasis) and (iv) vector-related diseases (malaria, onchocerciasis) (see also Chapter 1.4.5). All of those diseases were selected because of their relevance for Kenya: According to WHO (2014), diarrhoea is among major causes of death among children under five years in Kenya and therefore a relevant subject of investigation. Typhoid fever is common in Kenya, too, especially in urbanizing areas with poor access to safe water and improved sanitation (CDC 2014<sup>25</sup>). Trachoma is considered a public health threat in Kenya (WHO 2006a), which is why the disease was selected for representing water-washed disease transmission. According to WHO (2013), schistosomiasis is a neglected tropical disease (NTD) of special importance in Kenya and therefore a very relevant research topic. Onchocerciasis, also a NTD, has been addressed by the African Programme for Onchocerciasis Control (APOC) in many African countries. Even though it is present at low, hypo-endemic levels in Kenya the risk factors associated with this vector-related disease need to be studied in the context of wetlands. The WHO (2016) attributes one of the main causes of morbidity in children under 5 years in Kenya to malaria. This shows the relevance of the research topic.

The search included articles published between 2000 and 2016 and numerous studies were found (Table 5), some of which were more, others of which were less relevant to be included in the study. The titles of all articles identified were screened in order to identify potentially relevant studies for abstract review.

Of those identified, only publications on natural inland wetlands were considered. Studies on selected water-related infectious diseases in wetlands and with a major focus on Sub-Saharan Africa were included. Also, studies linking wetland and ecosystem use and the selected water-related diseases were included. Studies dealing with constructed wetlands and saltwater resources and water-related diseases other than the pre-selected ones were excluded, as well as pesticide- or animal-related health risks and diseases. All included documents were hand-searched for additional bibliographical references. The full decision procedure and inclusion and exclusion criteria of articles are shown in Figure 9. The final set of eligible texts was then subject to analysis and synthesis (Chapter 3). A wider range of references was included for the disease-specific explanations that do not refer to wetlands.

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<sup>25</sup> Further reading at <http://wwwnc.cdc.gov/travel/diseases/typhoid>.

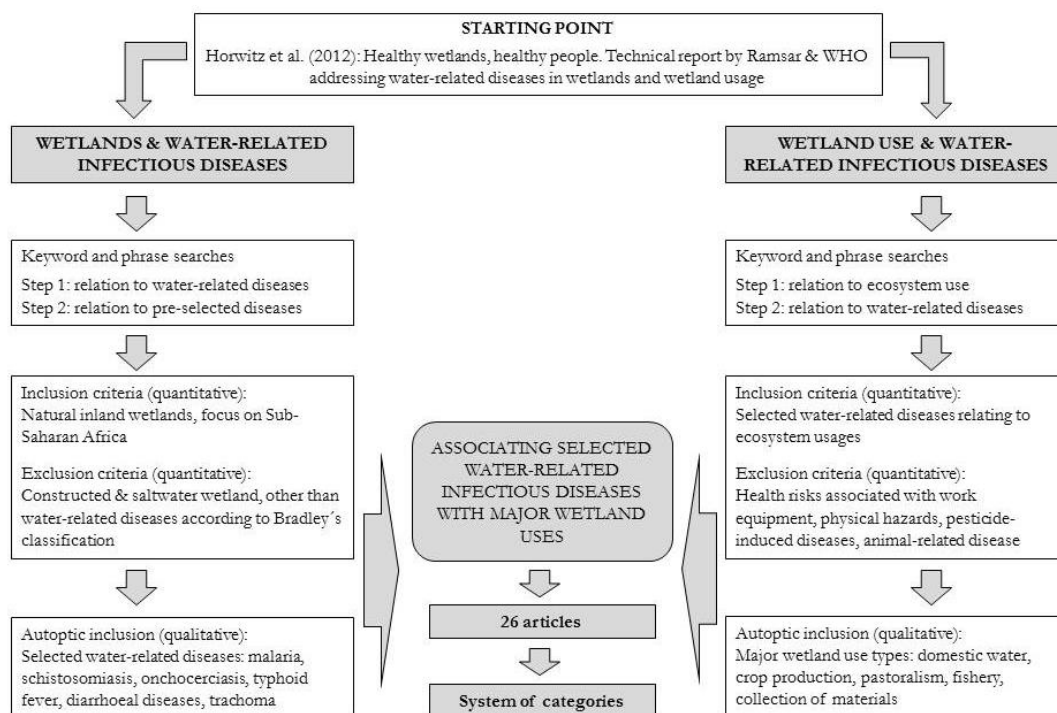
**Table 5: Numbers of scientific publications found for keyword and phrase searches**

Keyword combinations	ScienceDirect	PubMed	Web of Science
<b>I WETLANDS &amp; WATER-RELATED DISEASES</b>			
wetland + disease	6.144	363	676
wetland + water-related disease	4.662	21	3
wetland + malaria	734	55	110
wetland + diarrhoea (diarrhoea / diarrea)	479	3	11
wetland + schistosomiasis	185	42	44
wetland + bilharzia	44	44	3
wetland + typhoid fever	92	0	0
wetland + onchocerciasis	52	0	1
wetland + river blindness	121	0	1
wetland + trachoma	19	0	0
<b>II WETLAND USE &amp; WATER-RELATED DISEASES</b>			
wetland + use + disease	6.144	363	363
wetland + domestic water	7.305	281	742
wetland + drinking water	5.349	117	334
wetland + disease + domestic water	1.959	10	17
wetland + disease + agriculture	3.470	41	50
wetland + disease + livestock	1.554	17	25
wetland + disease + pastoralism	83	0	0
wetland + disease + fishery	1.457	4	11
wetland + disease + occupation	478	2	2
wetland + disease + building material	3.226	0	4

The keyword search refers to scientific publications published between 2000 and 2016.

Besides the peer-reviewed articles selected for this analysis, further grey literature, statistics and secondary data provided by public and private libraries, governmental and non-governmental offices and stakeholders were kept in mind and used for this thesis.

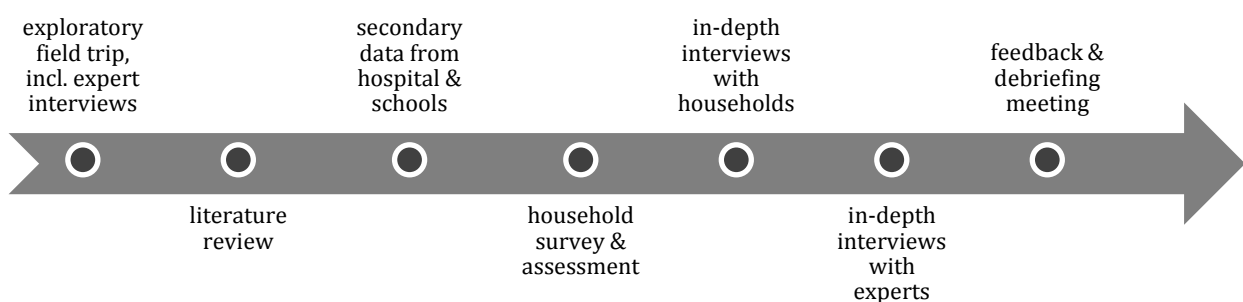
Based on the results of the systematic literature review (Chapter 3) and the insights of the exploratory tour (Annex 2, Chapter 2.1.1), research questions were developed, further concretized and the suitable research tools were identified and adjusted.



**Figure 9: Multi-step procedure to identify articles for the review on diseases in wetlands**

## 2.3 Empirical research: mixed methods for a social science perspective on health risks

Studying use-related diseases, self-reported symptoms, health-related behaviour and health risk perception in wetlands critically requires a holistic research approach. When designing this broad study, the researcher was confronted with a wide range of open questions and the challenge of deciding whether to apply a qualitative or quantitative approach. Both have advantages and disadvantages. While quantitative research tries to verify already formulated hypotheses by standardized statistical empirical methods, it might likely reduce the statements and reactions of the research participants to predefined categories and prevent the exploration of new findings (Anthonj 2012, 2015). On top of that, information without any relevance for the target population might be raised and important information may be neglected. Qualitative social research, an approach stemming from social and cultural anthropology, on the other hand, provides good opportunities to elaborate a topic openly and to sophisticatedly ascertain the social realities of the research participants by direct interaction (Bowling 2014, Mayring 2002). The data gathered can hardly be generalized since they only reflect subjective ideas, experiences and views. Following the epistemology of medical anthropology, which *'has so thoroughly grounded its contribution to the study of health and disease on a combination of qualitative (e.g. open-ended interviews) and quantitative (e.g. surveys and observational assessment) methods of investigation'* (Joralemon 2017), this research comprised a mixed-methods approach (Figure 10, Table 6). The different thematic issues, partly explorative in their nature, all of which were highly connected, and the complexity of the research, called for openness and flexibility in the approach. They also demanded a broad spectrum of information and various kinds of data from different levels and sources (Bowling 2014, Lamnek 2010).



**Figure 10: Research design and application of mixed methods**

Since, according to Blaikie (2009), *'the use of single methods is usually associated with narrow and perhaps one-off research topics. Such research provides limited opportunities for advancing knowledge. The use of a variety of methods should be seen as the norm'*, mixing different methods seemed an appropriate approach in order to adequately shed light to multiple angles of the problem in a very distinct topic, context, and study site. By combining multiple quantitative data collection with qualitative local knowledge and perceptions, cross-checking and triangulation of the results was facilitated, as others had previously



demonstrated (Anthonj et al. 2016, Aiello and Larson 2002, Few et al. 2013, Halvorson et al. 2011). Each method to be used was supposed to offer information (i.e. reviewed scientific literature, interview transcripts, statistical results from household surveys, printed material of health education from school books, health statistics) and analyzed both quantitatively and interpretively.

**Table 6: Overview of empirical methods used in the Ewaso Narok Swamp**

<b>EXPERTS in RWANDA and UGANDA</b>	
Exploratory field trip, Feb – April 2014	qualitative data
	informal in-depth interviews with experts (informal) (n=11)
	Health professionals: WHO Office Rwanda, district health officers, Access Project representative Environmental professionals: Rwanda Environment Management Authority (REMA), Water professionals: Protos Great Lakes Coordinator, USAID representative for WASH Agriculture / nutrition professionals: Welthungerhilfe, JICA, Protos Other professionals: Genocide Memorial AEGIS Trust
<b>TARGET POPULATION</b>	
Quantitative household study, Jan – March 2015	quantitative data
	Household survey (n=400)      Observational assessment (n=397)
	Wetland user groups      Wetland user groups
	<ul style="list-style-type: none"> <li>- Smallholder farmers (n=106)</li> <li>- Commercial farmers (n=95)</li> <li>- Pastoralists (n=99)</li> <li>- Service sector workers (n=100)</li> </ul>
	<ul style="list-style-type: none"> <li>- Smallholder farmers (n=104)</li> <li>- Commercial farmers (n=94)</li> <li>- Pastoralists (n=99)</li> <li>- Service sector workers (n=100)</li> </ul>
<b>TARGET POPULATION</b>	
Qualitative IDIs with household members, Jan – March 2015	qualitative data
	in-depth interviews (n=20)
	Smallholder farmers (n=5)      Pastoralists (n=5)
	<ul style="list-style-type: none"> <li>- Female, African location (sh1)</li> <li>- Female, African location (sh2)</li> <li>- Female, Milimani (sh3)</li> <li>- Female, Central (sh4)</li> <li>- Male, Milimani (sh5)</li> </ul>
	<ul style="list-style-type: none"> <li>- Female, Mathera Ignois (pa1)</li> <li>- Female, Mathera Nklois (pa2)</li> <li>- Male, Mathera Nklois (pa3)</li> <li>- Male, Mathera, Nklois (pa4)</li> <li>- Male, Mathera Nklois (pa5)</li> </ul>
	Commercial farmers (n=5)      Service service sector workers (n=5)
	<ul style="list-style-type: none"> <li>- Male, Mbogani Sosian (co1)</li> <li>- Female, Sosian Container (co2)</li> <li>- Female, Milimani (co3)</li> <li>- Male, Sosian Marura (co4)</li> <li>- Female, Marura Narok (co5)</li> </ul>
	<ul style="list-style-type: none"> <li>- Mpesa shop seller, Gatundia (se1)</li> <li>- Seller, Gatundia (se2)</li> <li>- Copyshop owner, Gatundia (se3)</li> <li>- Agrovet shop seller, Gatundia (se4)</li> <li>- Restaurant owner, Gatundia (se5)</li> </ul>
<b>EXPERTS in EWASO NAROK SWAMP, KENYA</b>	
Expert IDIs, Jan-March 2015	qualitative data
	in-depth interviews with experts (n=8)
	Health authorities: District Health Officer (DHO), Former Public Health Officer (PHO), Community Health Worker (CHW), Chemist, Herbalist Water authorities: Water Resources Management Authority (WRMA), Rumuruti Water and Sanitation Public sector institution: Manyatta Primary School
<b>EXPERTS in EWASO NAROK SWAMP, KENYA</b>	
Expert feedback, May 2016	qualitative data
	feedback / debriefing meeting (n=30)
	Chief, Sub-Chiefs, Water Resources Management Authority representatives Community health workers for the whole Ewaso Narok Swamp Representatives of the Farmers' Association and local elders from different villages in the study area

In order to obtaining information on local people's current perceptions and practices around wetland use, water, disease prevention and healthcare, and to capture their prevalent ideas and attitudes around these issues, the execution of a household survey

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(n=400) was chosen for quantitative data collection. The survey and incorporated observational household assessment (n=397) (Falkenberg 2016, Herbst 2006, Webb et al. 2006), were complemented by semi-structured in-depth interviews (n=20). The latter should produce deeper information going beyond pre-defined survey questions. They addressed the wetland users and experts (n=8). Some of the findings from the different data sources would be successfully triangulated, while others would be conflictive or inconsistent. In-depth interviewing helped to explain the contradictions or to strengthen the findings. Secondary statistics were analyzed and compared with primary results from the household survey and with secondary scientific literature from the region.

The overall duration of fieldwork was six months (February to April 2014, January to March 2015 and May 2016).

### **2.3.1 Ethical considerations: working with rather than studying target population**

Whenever empirical studies in biomedical research involve human individuals and address health-related issues, ethical standards need to be met with the highest imperative. It is crucial to assure that *the research protocol, the objectives and the methods used safeguard the dignity, rights, safety, and well-being of all actual or potential participants involved. This is in cognizance of the fact that the goals of research, should never be permitted to override the health, well-being, and care of research participants* (Mandate of the Ethics Review Committee, KU), neither prior to, during, or in the aftermath of a research. Ethics in research include the need to act in the interest of potential research participants and concerned communities, and having due regard for the requirements of relevant regulatory agencies and applicable laws, besides taking into account the interests and needs of the researchers. Ethical research requires having all research participants adequately informed before asking their definite voluntary consent (Annex 6). Such provides the platform for questions and feedback, as well as the possibility to withdraw from the participation in the study at any time, treating their personal information with confidentiality, privacy and anonymity in the course of data collection, having the potential benefits and burdens of research be distributed fairly among all groups and classes in society, being willing to change the study protocol before the onset of a study according to Ethics Committees' input and ethical considerations<sup>26</sup>. Ethical ways of empirical research include *working with* rather than *on studying* participants, which is why all the points mentioned above were respected throughout this study.

In order to ensure ethical and scientific standards, a detailed study protocol was submitted to two ethics research committees prior to the start of study, defended and slightly modified according to the committees' suggestions. Ethical approval had been granted by the Ethics Committee of the University of Bonn, Germany (Reference number 246/14) and by the

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<sup>26</sup> Mandate of the Ethics Review Committee at the Division of Research, Innovation and Outreach of the Kenyatta University, Nairobi. Further reading at <http://research.ku.ac.ke/index.php/en/mandate-ethics-review-committee>.

Ethics Review Committee at Kenyatta University, Nairobi, Kenya (Reference number: KU/R/COMM/51/411) (Annexes 7-8).

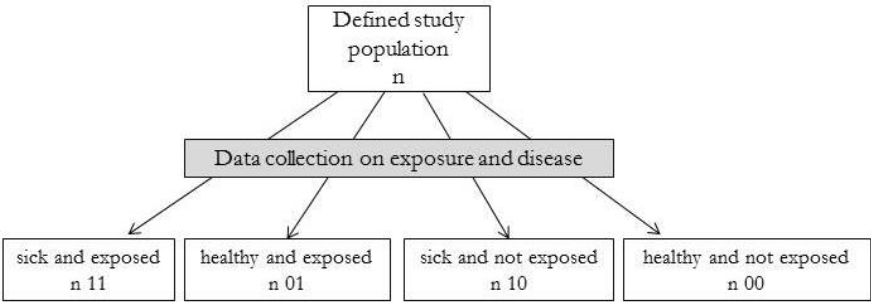
Besides ethical ways of preparing and conducting the research, high attention was also paid to the dissemination of the study results, which would include a debriefing event (Chapter 2.3.3.3) held in the research area and the dissemination of research reports containing preliminary results. This procedure would contribute to the sustainability of the research, assuming the participants and recipients would make the information available to their communities, thus facilitating a better understanding of the health implications in wetland ecosystems, on health-related risk behaviour and on the prevention of wetland-related health risks. The publications resulting from this research (Anthonj 2016, Anthonj et al. 2016) would be placed at the Water Resources Management Authority’s and at Kenyatta University’s disposal. Presentations held between 2013 and 2017 at conferences listed online at the GlobE Wetlands Project Homepage would be made available upon request.

**2.3.2 Quantitative part: cross-sectional study & observational cohort assessment**

The focus of the quantitative part of the study was to gather information on the target populations’ knowledge about health and diseases, on their wetland use and health-related behaviour in order to facilitate assessments of health risks in wetlands and in order to capture their respective risk perception. This was done by using a cross-sectional study approach applying standardized household surveys and observational assessment tools.

**2.3.2.1 A cross-sectional study design**

The identification and evaluation of disease risk factors was realized by an observational study approach with a cross-sectional design. Cross-sectional studies encompass a population sample from the target population at a specific point of time, thus representing a snapshot of the situation (Bowling 2014, Gordis 2008, Yeatts 2015). The medical condition (prevalence) and current or past exposure levels (exposure prevalence) of selected individuals are collected simultaneously. Since usually there can be a large time span between exposure and onset of disease, this study type is only limitedly suitable for proving causality of risk factors within analytical epidemiology and therefore rather an instrument of descriptive epidemiology.



Source: Kreienbrock and Schach 2005, Gordis 2008

**Figure 11: Design of a cross-sectional study**



This study approach is often adopted, facilitating not only the documentation of the current state, but also the generation of hypotheses. In the field of environmental epidemiology, cross-sectional study designs are the most common form of study (Kreienbrock and Schach 2005:76).

Ideally, a random sampling is done, dividing the study population into sick and healthy individuals, as well as exposed and not-exposed (Figure 11), best captured in a four-fold table:

**Table 7: Four-fold table for the calculation of odds ratios**

	Exposed (E = 1)	Not exposed (E = 0)	Total
Sick (S = 1)	n <sub>11</sub>	n <sub>10</sub>	n <sub>1•</sub> = n <sub>11</sub> + n <sub>10</sub>
Healthy (S = 0)	n <sub>01</sub>	n <sub>00</sub>	n <sub>0•</sub> = n <sub>01</sub> + n <sub>00</sub>
Total	n <sub>•0</sub> = n <sub>11</sub> + n <sub>01</sub>	n <sub>•0</sub> = n <sub>10</sub> + n <sub>00</sub>	n = n <sub>••</sub>

This table facilitates an estimation of prevalence and simultaneously the display of exposure level at the record date, which allows for calculating odds ratios, a measure of association between exposure and health outcome (Chapter 4.3-4.4; Yeatts 2015):

$$OR = \frac{n_{11} * n_{00}}{n_{10} * n_{01}}$$

The cross-sectional design was chosen because it allowed to (i) extrapolating the meaning of risk factors and preventative measures from representative random sample to target population, (ii) be conducted in a rather short study period which was rather little costly. It has been argued that cross-sectional studies do not capture the temporal dimension from exposure to risk factor to the onset of an adverse health effect, or the duration of a disease (Kreienbrock and Schach 2005). Moreover, such a study design usually does not capture well rare or short-lasting illnesses and due to these temporal or longitudinal deficiencies, the meaningfulness of results and the cause and effect relationship might be biased or even difficult to be established (Song and Chung 2010). However, if the exposure or disease is rare among the overall population, but rather widespread within a subpopulation or certain population (or user) group, a cross-sectional design can be highly beneficial (Kreienbrock and Schach 2005:78). Therefore, as the intention of this study was to assess use-related risk factors among different user groups, the cross-sectional design was seen as the best quantitative approach to be pursued.

**2.3.2.2 Sampling of target population: different cohorts or wetland user groups**

The study population lives in Ewaso Narok Swamp, a highland floodplain (Chapter 1.3.2, Map 2). As the study was intended to address health risks and health risk perceptions of people using the wetland, the study population was stratified into discrete groups, according to judgements of differential exposure (Winkler et al. 2010; Renn & Rohrmann 2005). Since

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the most common type of wetland use is agriculture, the study population would firstly include farmers working in the swamp. Proximity and physical contact to the water was used as an indicator of exposure to health risks and water-related infectious diseases. Therefore, two different kinds of farmers would be included: smallholder and commercial farmers (Chapter 1.3.3). Based on evidence from previous studies, farmers generally were rated at being exposed to high risk (Fuhrimann et al. 2014), and out of the two groups, the commercial farmers were assumedly being more exposed to potential risks due to their irrigation-intensive horticulture farming activities. Another group included in the study were pastoralists, living a semi-nomadic lifestyle in higher and drier areas, not exactly close, but directly linked to the swamp.

These three most prominent wetland user groups were identified prior to the start of the field research through informal interviews with various stakeholders during the exploratory trip in spring 2014 and a pre-test study phase in January 2015. Moreover, individuals not directly exposed to the wetland by use were included as the group of service sector workers in nearby Gatundia (=control group). In total, four different profile groups with different exposures would be included in the study:

- Smallholder farmers (sh): direct exposure by use
- Commercial farmers (co): high direct exposure by use, esp. irrigation activities
- Pastoralists (pa): limited exposure by use, distance to the swamp, agro-pastoralism
- Service sector workers (se): no direct exposure, workplace outside of wetland

A total of 400 households were addressed to be part of the survey. The user group approach was adopted as a basis for commensurate samples of 100 respondents per group.

In the Ewaso Narok Swamp, Local Chiefs (LC) hold black books and lists where every smallholder and commercial farmer in the area of command is registered. After making the LCs familiar with the planned study and after receiving their informed consent to work in the sub-locations under their command and to collaborate, they supported the researcher in the process of sampling and data collection. They provided all existing black books for the respective sub-locations of the Ewaso Narok Swamp and gave the researcher the permission to manually transfer all names to the computer. Out of the total farmers' population in the wetland, random sampling was done to extract a representative sample of each of the two groups. The statistical software SPSS was applied to compute the sample. As it was expected that not all selected individuals would be willing to participate in the study, a replacement list of 25% of each sample, namely 25 smallholders and 25 commercial farmers, was created. These were approached after exhaustion of the sample list. By this strategy, 106 smallholder farmers and 95 commercial farmers could be identified in the different villages in Rumuruti Ward. The sampled households were visited with a local elder, who assisted in identifying the targeted households.

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Additionally, snowball sampling was applied for the pastoral user group who lived in rather remote areas surrounding the swamp. They were identified with the help of the village elders, as they know all pastoralists in the area. Due to the low population density and the pastoralist's distinct occupation and lifestyle which require them to walk long distances and always be on the move, the only possible method to be applied was the snowball sampling by elders and pastoralists leading to the respondents. Despite it being a big challenge to recruit the requested sample of respondents, a total of 99 pastoralists could be won over to the participation in the research.

People working in the service sector as sellers, tradespeople, mechanics and motorbike taxi drivers were included as a fourth group. The 100 service sector workers lived in nearby Gatundia, a central area with better water supply and sanitation infrastructure. They were identified by strategic sampling in the central area of Gatundia. After systematic walks, an inventory of all shops (agroveter shops, supermarket, m-pesa shops, salons, and others) was made and based on this, every second shop or trader's place was approached for identifying respondents. Support was provided by elders from Gatundia in the identification process.

The samples chosen enabled a transferable and comparable research outcome. In this regard, 'representative' means that the composition of target groups needed to contain comparable factors. Furthermore, the size of the sub-samples or cohorts had to be in proportion to the whole sample and the number of samples needed to be chosen according to the possible outcome and evidence. In this study, the total sample of 400 persons for the survey was expected to be representative.

These four different cohorts or user groups were investigated both in terms of their health-related behaviour and their health risk perception. By definition, a cohort, deriving from the Latin word *cohors* which means military unit (Song and Chung 2010), is a '*group of people with defined characteristics who are followed up to determine incidence of, or mortality from, some specific disease, all causes of death, or some other outcome*' (Morabia 2004).

As the main exposure factor of interest was the contact to water in wetlands, the survey addressed nearly commensurate cohorts with suspected differences in the level of water contact in their occupational routines. The cross-sectional design allowed for studying and comparing the results relationship between different groups at a single point in time (Hennekens 1987). This approach facilitated the provision of a large array of information on the frequency of several self-reported symptoms and other health-related characteristics. Although in this cross-sectional study design cohorts were used, this was not a cross-sectional cohort study as described by Hudson et al. (2005).

### **2.3.2.3 The main data collection tool: a household survey**

Since it is a widely applied tool in social research, which can easily be used to capture both general information and knowledge on specified topics from a large population sample, a

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survey questionnaire was rated the best tool to obtain data in the wetland setting. Besides comparability of results and potential for statistical analyses, an advantage of such kind of data collection clearly lies in the very well-known data collection process – as well to officials, ethics committees or authorities in charge of deciding on whether to conduct research or not – as to the target population and enumerators that rather know surveys than qualitative research methods<sup>27</sup>. By including not only closed, but also open-ended questions and even observational assessments (Annex 3, Chapter 2.3.2.4), far more information than purely quantitative was included in this standardized questionnaire-based survey (Bowling 2014).

The survey applied aimed at gathering demographic, general occupational and socioeconomic household information, wetland utilization, occupational characteristics, as well as domestic water supply, sanitation and hygiene. Data on preventive measures regarding water-related infectious diseases were collected by asking the respondents on their main modes of protecting themselves against water-borne, water-based, water-washed and vector-related diseases. These variables were included as a basis and exploratory variables for the risk assessment of wetland users in the Ewaso Narok Swamp. Self-reporting of symptoms which the respondents had been suffering from during a one-month recall period, including abdominal complaints, fever, eye and skin conditions, were captured, with symptoms serving as proxies in assessing the potential disease risks in the wetland (Chapter 4.3 ff). This syndromic surveillance (Ziemann 2015) approach was chosen in order to provide disease information from a context where no traditional surveillance system could be applied (Paterson and Durrheim 2013). For all self-reported sickness episodes, the health-seeking behaviour was recorded by an event analysis (Githinji 2009).

Moreover, perceptions were investigated by gathering the respondents' general health knowledge, specific knowledge on water-borne, water-washed, water-based and vector-related diseases. A focus was on malaria, diarrhoeal diseases, typhoid fever, schistosomiasis, trachoma, corresponding to the literature review (Chapter 3). Due to a lack of knowledge among the wetland users and experts, onchocerciasis was excluded. Skin diseases and eye diseases were integrated into the perception study. The diseases' transmission pathways, risk factors related to wetland use, and perceptions on health-related behaviour were addressed. The metadata gathered from the household survey is listed in Table 8.

The tool was developed by the researcher based on her foregoing literature reviews and exploratory tour; adapted after a pre-test phase, which took place before the onset of the research. The water supply, sanitation and hygiene part included slightly modified questions designed by researcher Susanne Herbst, published and available in her PhD (Herbst 2006).

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<sup>27</sup> In most development context settings, research is primarily conducted by surveys, e.g. by demographic and health surveys from national statistics offices.

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**Table 8: Classification of variables from the household survey**

Variable category	Description
Wetland-use related factors	Occupation Type of wetland use Time and duration of use
Demographic & socioeconomic factors	Age and sex Duration of residence in in study area Household size and children Distance to Ewaso Narok Swamp and infrastructure Education level Ownership of selected household goods
Health-related and behavioural factors	Self-reported symptoms Event analysis of last sickness episode Health-seeking behaviour Preventive measures Water source and storage, sanitation, hygiene Knowledge and perceptions about selected diseases

Making use of this partly pre-designed research tool with formulated categories (i.e. water storage spots, water supply sources etc.) reduced the expenditure time and increased the efficiency. The questions were translated into Kiswahili and re-tested during the training of the enumerators, in order to make sure of its clarity and contextual fit. The reformulation of some questions was necessary in order to make them better understandable and translatable for the enumerators, as evolved during the pre-test in a wetland near Nairobi, two weeks prior to the start of the actual field research and household survey.

The survey was kept as short as possible and manageable to finish it within one hour or less. It was administered orally in English or Kiswahili and, where necessary, translated into other prominent languages among the respondents, namely Kikuyu, Masai, Samburu, and Turkana. The questionnaire paper sheets were filled by the researcher and trained enumerators (Chapter 2.3.3.4). The findings of the survey were geo-referenced through the collection of GPS points. After cleaning the data and plausibility checks, the answers were processed into SPSS®.

#### **2.3.2.4 Observational WASH assessment of households**

As previously indicated, an observational assessment of the same households was included in the survey questionnaire (Annex 3). It provided the opportunity to closely observe household conditions and practices regarding one of the most crucial preconditions for the prevention of diseases: the domestic water, sanitation and hygiene (WASH) situation. The domestic WASH conditions were assessed by data obtained during observational spot checks<sup>28</sup> (Herbst 2006, Falkenberg 2016, Table 9).

Indicator spots for this observational assessment included: drinking water storage, coverage and signs of pollution; type of sanitation facility and location of the same; personal hygiene

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<sup>28</sup> Parts of this chapter have been published (Anthonj et al. 2016).

and visible signs of dirt on hands, clothes and body. Structured spot observations could be employed in the households according to a prepared checklist based upon previous work from Falkenberg (2016), Herbst (2006), Herbst et al. (2008) and Webb et al. (2006).

The checklist (Annex 3) was used to create comparability between results from different households, ranging from positive (+1), to neutral (0) and to negative (-1) scores.

The observational assessment was conducted once for every household after asking for permission to have a look at the storage containers and sanitation facilities. Lists and assessments were never disclosed to the study participants and information was only filled in the respective checklists after the end of a household visit to not make them feel uncomfortable or observed.

**Table 9: Criteria for the observational WASH assessment**

	Negative score (-1)	Neutral score (0)	Positive score (+1)
Water	water storage container uncovered, with visible signs of pollution	water storage container not covered, but no visible signs of pollution	water storage container is covered, no visible signs of pollution
Sanitation	no sanitation facility on the premises	unimproved* sanitation facility on the premises	improved* sanitation facility on the premises
Personal hygiene**	several visible signs of dirt on clothes, hands, and body	few visible signs of dirt on clothes, hands or body	neat appearance, no signs of dirt on clothes, hands or body

\*Improved sanitation is defined as one that hygienically separates human excreta from human contact and includes flush toilet, pit latrine with slab, connection to septic system and others. Unimproved sanitation includes buckets, shared sanitation and others (WHO/UNICEF JMP, 2015).  
 \*\*Personal hygiene was assessed based on a general range defined according to the discretion of the researcher.

The drinking water storage container was assessed according to the hazard analysis critical control point (HACCP) concept for water storage in the house (Herbst 2006, WHO 2004). The evaluation of the cleanliness of the storage container and water in terms of visible pollution was included as a proxy for water quality.

The type of sanitation facility was evaluated based on the WHO/UNICEF JMP (2015), which distinguishes between ‘improved’ sanitation that hygienically separates human excreta from human contact and includes flush toilet, pit latrine with slab, connection to septic system and others compared to ‘unimproved’ sanitation that includes buckets, shared sanitation, open defecation and others. The level of personal hygiene was rated according to the physical appearance of the household head and related to visible signs of dirt on hands, clothes, or body serving as a proxy for hygiene measures. It was assessed based on a general range defined according to the discretion of the researcher.

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### **2.3.2.5 Counting assets to estimate the socioeconomic status of households**

In the study setting, as in other economically deprived areas, addressing wealth or income is a problematic issue (Filmer and Pritchett 2001, Oakes and Rossi 2003). Talking about money puts respondents into an uncomfortable situation, especially if their income is low. Given the sociocultural background of the principal investigator coupled with the assumption that Europeans are generally very rich and based on prior experience in similar settings, questions about money were decided to be excluded from the survey for courtesy and ethical reasons. Many studies relating to health risks, perception and behaviour, however, found socioeconomic status (SES) to significantly matter for individuals, families, communities (Beogo et al. 2014, Danso-Appiah et al. 2010, Das and Ravindran 2010, Penchansky and Thomas 1981, Shayo et al. 2015). In this study, SES was relevant to be associated with health knowledge and risk perception, self-reported symptoms and health-seeking behaviour. Thus, socioeconomic status was estimated without gathering income data (which might not be comparable anyways since possession might matter more than cash money) and approximated by using the availability of durable goods as an indicator. An SES index, which has been demonstrated to be consistent with expenditure and income measures (KDHS 2014, Rutstein and Johnson 2004), served for the household's long-term standard of living, based on the possession of different asset items, including car, motorcycle, bicycle, mobile phone, radio, TV, refrigerator, running water, sanitation. As has been shown in other studies, such indices are robust to the assets included and produce internally coherent results predicting information on wealth- and expenditure-related behaviour that can easily be compared between groups in similar settings (Filmer and Pritchett 2001, Fuhrmann et al. 2016). Other studies also included items such as computer, electricity, type of dwelling and floor, possession of land or others (Fuhrmann et al. 2016, KDHS 2014, Rutstein and Johnson 2004).

### **2.3.2.6 Data mining: secondary data from District Hospital and school books**

Additional sources of information included secondary data gathered from the Rumuruti District Hospital on hospital admissions between December 2013 and December 2014 (Chapter 1.3.4). Numbers of admission for patients suffering from malaria (clinical and confirmed), amoebiasis, typhoid fever, gastroenteritis (G/E), gastritis, conjunctivitis, candidiasis, pneumonia, upper respiratory tract infections (URTI), respiratory tract infections (RTI), tonsillitis, bronchitis and sexually transmitted infections (STI) were manually copied from handwritten hospital black books and descriptively analyzed, before being used for triangulation with the study results of self-reported diseases.

Moreover, WASH-, health- and disease-related educational material from primary school books for science classes 1 to 8 was collected from primary schools around Rumuruti, in order to place the communities' level of knowledge in the context of risk perception and health-related behaviour. These data were also used for triangulation.

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### **2.3.3 Qualitative part: in-depth interviews with users, experts & feedback meeting**

Social interactions, behaviours, and perceptions that occur within groups and communities can best be captured by anthropological studies, as had been conducted in small, rural (and often remote) societies since the early 1900s. By living with and participating in such societies over long periods of time, by documenting their social structures and belief systems, researchers such as anthropologists Bronislaw Malinowski<sup>29</sup> and Alfred Redcliffe-Brown<sup>30</sup> are known as the pioneers of qualitative social research (Reeves et al. 2008). Approaches as described by both researchers were applied in this study.

In-depth and deep-ground information on living and working in the Ewaso Narok Swamp, about certain health-related exposures and risks, about individual perceptions, experiences, knowledge and experience approaches with regard to the transmission of certain diseases in wetlands, occupational differences, high risk groups, setting-specific particularities and health behavioural patterns were conducted with wetland users and experts. Also, a feedback meeting on the preliminary results of data collection and analysis was carried out.

#### **2.3.3.1 In-depth interviews with wetland users**

In-depth interviews were designed to provide a platform for subjective perceptions and explanations by the wetland users. Out of the 400 survey respondents, key informants for in-depth interviews were identified based on anchor questions from the survey questionnaire. 20 individuals that equally represented the four different groups (n=5 for each cohort) were revisited for semi-structured interviews between February and March 2015 with a trained female public health research assistant (Chapter 2.3.3.4). The interviews had the objective to gather information on top of the survey questions, not restricting participants to predefined responses and allowing for probing as well (Bowling 2014). The questions raised followed an interview guide developed prior to the study (Annex 4, partly adopted from Githinji 2009). Direct feedback and clarification of research questions was possible by the conversation-like atmosphere during the thematic interview situation, as well as 'deeper digging'. This facilitated very detailed information which would have been impossible using standardized interviews (Corbin and Strauss 2008, Mayring 2002).

The substance of the answers given was verified by triangulation with quantitative findings and literature reviews. The question guide was changed and adapted according to the outcomes evolving during the research process. The interviews were conducted in English or Kiswahili and where necessary, also in Kikuyu, Masai, Samburu or Turkana with the help of a translator. The answers were then directly translated into English, in order to give the possibility for further questions as well as clarification and to prevent misunderstandings.

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<sup>29</sup> Bronislaw Malinowski travelled to Papua New Guinea in 1914 in order to conduct fieldwork and participant observation in the Trobriand Islands.

<sup>30</sup> Alfred Redcliffe-Brown travelled to the Andaman Islands in 1906 and to Western Australia in order to conduct fieldwork.



Each interview took between 30 to 120 minutes. The interviews were audio-recorded upon people's agreement, and where they did not, extensive notes were taken to include non- and extra verbal communications as well. The interviews took place in a convenient, trustful and relaxed atmosphere in the interviewees' well-known atmosphere in their households, work places or any other suggested place<sup>31</sup>. All interviews were conducted after obtaining an informed consent both for the survey and the in-depth interviews by each participant.



a. In-depth interview with a Samburu pastoralist in his homestead.



b. Open-air in-depth interview with a farmer, attracting a lot of attention.



c. Post-in-depth interview lunch in a smallholder farmer's household.



d. Souvenir photo from the interview, requested by the interviewee (2015).

**Photo 4: Impressions of in-depth interviews with wetland users**

At the end of each in-depth interview, a small gift was offered to each household as an appreciation of their time and willingness to be part of this research project (Bowling 2014). The gift constituted of a bag with some basic essentials for a household (sugar, tea, maize flour, soap) which constituted basically a symbolic and well-received gesture of gratitude, recommended by the local authorities.

**2.3.3.2 Qualitative in-depth interviews with experts**

Based on the information gathered during the household survey, observational assessment and in-depth interviews with the people using wetlands, experts to contribute to the

<sup>31</sup> There was absolute privacy and discretion between the researcher and the interviewee.

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research topic by their specific background and profession by means of in-depth expert interviews were identified between January and March 2015. The experts chosen (n=8) were a supplementary source of information in addition to the target group of interest (Table 6). Important information was collected during these interviews with different stakeholders working in the field of water, sanitation, health, wetland management or environmental management. Interviewees mostly consisted of representatives of the health sector (district health officer, community health worker, chemist, herbalist etc.), the water (Water Resources Management Authority) and sanitation sectors (Rumuruti Water & Sanitation), as well as the educational sector (teachers and caretakers in elementary schools). Compared to the in-depth interviews with the target population, those with experts were more distinct for the different interviewees, more focused and less explorative. The interviews were conducted as open interviews regarding the unique tasks and jobs of the interviewees, their unique functions and experiences. They served to get deeper ground information and expert information addressing specifics on health risks and risky behaviour in wetlands, on wetland management activities, as well as on suggested best practice and successful intervention in terms of disease control, potential 'solutions' or reduction to disease transmission. In this situation, the experts acted as providers of context knowledge (Anthonj 2012, Bogner and Menz 2005, Bowling 2014, see Chapter 2.3.3.2).

After having had some time had already spent in the research area around Rumuruti, having become 'well-known' within the communities by being visible and participating in local activities and by this, building trust, it was a relatively easy task to approach and win experts over partaking in the study. Several offices were visited more than once for networking, which also helped in terms of gathering data. All experts were interviewed either in their offices and workplaces<sup>32</sup> or other quiet and private atmosphere and had the possibility to speak openly without being restricted to certain responses or expectations. The semi-structured interviews, taking 30 to 75 minutes, enabled the researcher to obtain a great deal of useful information and to add on and triangulate the findings gathered before.

### **2.3.3.3 Debriefing meeting**

After the completion of data collection and preliminary analysis of the data gathered during the main field research phase in spring 2015, a debriefing event was organized by the researcher in collaboration with the Water Resources Management Authority. It took place in the WRMA main boardroom on 11<sup>th</sup> May 2016 (Photo 5).

This meeting aimed at making the gathered information available to the communities by delivering preliminary research reports to the local chiefs, elders and community health workers. Also, it opened a platform for receiving feedback on the same during and after a verbal and illustrated presentation delivered by the researcher and simultaneously translated into Kiswahili by a previously briefed and trained Community Health Worker.

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<sup>32</sup> In the Rumuruti District Hospital, WRMA, Manyatta Primary School, Rumuruti Water and Sanitation.



a. Presentation of preliminary findings; b. participants of the debriefing event at the Water Resources Management Authority in Rumuruti, 2016.

**Photo 5: The feedback and debriefing event at WRMA**

Representatives of the government were invited, as well as all CHW working in the Ewaso Narok Swamp, and all contact persons who were part of the research in 2015, representing all major tribes in the wetland. The presentation formed the basis of a better understanding of the health implications in wetland ecosystems, on health-related risk behaviour and on the preventive measures of such wetland-related health risks. The audience followed the invitation of asking questions, giving comments, sharing ideas, criticism, and recommendations on the way forward, as well as making use of directly exchanging views at cross-sectional levels.

**2.3.3.4 The role of enumerators and field assistants within this PhD project**

The teaming up with a GlobE project colleague from the agronomy group and the support of a team of enumerators and research assistants made the empirical data collection of this PhD study efficient. The health survey and observational WASH assessment (Annex 3) presented in the preceding chapters were integrated into a combined survey on wetland utilization, crop and livestock production and human health.

For the conduct of the combined household survey, a total of six enumerators were thoroughly selected based on their prior experience in data collection (e.g. within the National Demography and Health Survey) and their performance in personal interviews. Their scientific backgrounds varied widely, although all were students of the Kenyatta University, who had finalized their Bachelors courses already. One had a background in public health, one in biotechnology, two were economists, and two were agronomists. All of them were fluent in both English and Kiswahili, and one additional local language, of which Masai prove very useful.

In order to guarantee a common sense and understanding on the research survey questionnaire tool among the enumerators, a one week training was conducted at the National Museums of Kenya in Nairobi in January 2015. All of the selected six enumerators



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were trained, which was of extraordinary importance given the extensive agronomy and health content of the tool. The participation in the training was an obligatory precondition for being selected as a field enumerator.



a. Training on the conduct of the survey; b. discussions on the survey tool in Nairobi, 2015.

**Photo 6: Training of enumerators and field assistants at the National Museums of Kenya**

The training, conducted in English, contained basics of requirements for scientific data collection, ethics of research and guidelines for behaviour and patience during interviews, the desired approach, an overall presentation of the research project, explaining the research's purpose, an introduction into the research topics and explanation of the questions asked and their context, a training on conducting the observational assessment and role plays of interview situations and test. A focus was set on the right wording, on translation from English to Kiswahili, and the retranslation into English (Bowling 2014). The enumerators were induced to practice the survey questioning aloud orally and openly to their fellow trainees rather than having the respondents fill their survey questionnaire themselves. Besides practicing, the training also intended to give room for the expression of personal opinion of the respondents during the interview situation, even beyond the strict boundaries of the survey questions. These activities, above all, also promoted team building.

A pre-test of the questionnaire was included in the training phase, as well as joint cleaning and correction of the filled paper surveys. Both the simulation of field research and the direct feedback on filled questionnaires was needed in order to well prepare the team and in order to assess each enumerator's ability to conduct the survey. And it was very useful in terms of training the research tool in a wetland setting near Nairobi. Within this phase, the survey tool was still slightly modified according to its practicability and comprehensibility in the field. The participation in the training was not payed. For the conduct of the pre-test, as well as for the actual survey in the Ewaso Narok Swamp, fixed salaries and per diems were paid on a weekly basis.

Over the entire period of the survey, interviewers were retrained, received direct feedback on their filled paper questionnaires that were discussed in a feedback discussion round and checked by the researcher overnight.



a. Working under extreme conditions in the Kenyan heat; b. getting around in the surroundings of the swamp in 2015.

**Photo 7: Collecting data in the Ewaso Narok Swamp**

For the qualitative part of the study, a female biotechnology student who had been involved as an enumerator in this study was exclusively occupied for assisting the researcher in conducting in-depth interviews. She had been identified with the support of the researcher Dr. Sophie Githinji from KEMRI Wellcome Trust according to her wide-ranging experience in conducting surveys and in-depth interviews in the field of public health. She was trained in-depth on the interview guides (Annexes 4-5) by the researcher before the onset of the qualitative interviews and a pre-test was carried out. This assistant would accompany the researcher to every in-depth interview, ready to translate into Kiswahili where needed, which was necessary in three out of 20 interviews with the target population. She would also support the researcher in clarifying the meaning of questions, if the respondents had difficulties in answering. For two interviews with respondents from the Masai tribe who were not able to speak neither English nor Kiswahili, one female enumerator, who is a Masai herself, accompanied the researcher and the research assistant.

The research assistant also supported the researcher in the transcription of the audio-recorded interviews, and helped in retranslating spoken and recorded Kiswahili parts into English. Another research assistant from Kenyatta University, a female public health student, rechecked both the transcripts and the translations back in Nairobi after the finalization of the data collection.

The handling of problems and challenges during data collection was a central aspect that was directly discussed every evening after completing the data collection. Discussions covered any uncertainties regarding data collection, approaching of households, and challenges faced during the day. Being aware of the challenge of underreporting problems in Kenya, the researcher sent the signal that talking about any challenge and problem is crucial in the course of a research. She encouraged everyone in the team to report as early as possible in case anything went other than planned or desired<sup>33</sup>.

<sup>33</sup> At the end of the data collection, each team member received a certificate containing information on the subject of the survey, the training, as well as personal references.

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## 2.4 Analytical methods

The quantitative and qualitative empirical data covering issues related to risk perception, behaviour, WASH and risk were analyzed by different methods. These included descriptive and analytical statistical methods, principal component analyses, univariate and multivariate models, qualitative thematic content analyses, all of which aimed at meeting the study's three objectives:

The identification of water-related infectious diseases that can be present in wetlands and associate them with different uses. Data for this objective were obtained from an analytical literature review on use-related risk factors and disease exposure.

The second objective of this study was to assess disease risks among wetland users and link it to their health-related behaviour. Therefore, domestic, occupational and socioeconomic factors that could pose a risk for disease transmission were to be analyzed by linking them to self-reported symptoms. The data consisted of household survey findings, an observational assessment and in-depth interviews.

The third objective was to estimate the level of health knowledge and health risk perception of wetland users and the differences between different groups. Data were gathered through a household survey and in-depth interviews. The analytical tools applied are being presented in the following.

### 2.4.1 Analyzing quantitative data on WASH, risk assessment and perception

All data from the household survey and the observational spot check were cleaned, proved for plausibility and entered into an IBM SPSS® 22 Statistics programme database. Throughout the analysis and writing, data were first descriptively analyzed before statistically analyzing them. The analytical methods of quantitative data included minima, maxima, interquartile range, means, medians and 95% confidence intervals (CI), pearson's chi-squared test and phi coefficients for correlation analyses and significances (Kreienbrock & Schach 2005). All of these measures were calculated with IBM SPSS® 22 Statistics.

Kruskal-Wallis H tests were carried out to detect differences in the WASH conditions and the health risk perceptions between the wetland user groups. They apply to two or more groups of an independent variable and their association with a dependent variable and are considered the suitable nonparametric alternative to the one-way ANOVA, and an extension of the Mann-Whitney U test. The Kruskal-Wallis H test was run because the dependent variable was ordinal, the independent variable consisted of two or more categorical, independent groups, and because the observations included were independent. Since the Kruskal-Wallis H test could not reveal which of the independent variables statistically significantly differed from each other, additional post hoc tests were done.

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In order to measure the level of association between exposure and outcome in terms of health risks, odds ratios (OR) were calculated (see also Chapter 2.3.2). OR serve to assess the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure (Szumilas 2010:227, Giesecke 2002, Beaglehole et al. 1993, Bowling 2014). In this study, OR served to determine whether particular exposures were risk factors associated with the self-reported symptoms abdominal complaints, fever, skin and eye diseases. They facilitated a comparison of the magnitude of various risk factors<sup>34</sup>.

OR were calculated using generalized linear regression models and included self-reported symptoms (abdominal complaints, fever, eye conditions, skin irritations) as the dependent variables (binary coded). Independent variables used in the regression models were household characteristics, WASH conditions, occupational wetland use and exposure groups etc. and of binary, and ordinal and numeric level. A 95% confidence interval (CI) was used to estimate the precision of the OR, with a large CI indicating a low level and a small CI indicating a high level of precision. A 95% CI not including the value 1 indicated statistical significance (significance level set at  $p$ -value  $\leq 0.05$ ).

The choice of independent variables in the process of model building was performed in two steps. Initial predictors were chosen à priori based on literature (review chapter 3) and plausibility. Subsequently, univariate regression models for all available variables were computed in order to determine the strength of association between the outcome variables (symptoms) and any one of the parameters investigated in this study (Hosmer and Lemeshow 2013), first forming four-fold tables as described in Chapter 2.3.2.1. Following Githinji's approach (2009), variables were considered for integration into the multivariate analyses if their univariate test had a  $p$ -value  $\leq 0.25$ . According to Hosmer and Lemeshow (2013), the traditional use of the  $p$ -value  $\leq 0.05$  often fails to identify variables known to be important and a selection relying solely on statistical significance has been denied by many authors. Moreover, knowledge and explicit assumptions on causal relationships stemming from observations in the field or based on published literature (Githinji 2009) determined the inclusion or exclusion of variables into the multivariate analyses.

$$Y = b_1 \times x_1 + b_2 \times x_2 (\dots) + E$$

The five final multivariate regression models (models 1-5: diarrhoea, malaria, typhoid fever, trachoma, skin disease) with the respective dependent variables (abdominal complaints, fever, eye condition and skin irritation) included three to five independent variables.

The univariate and multivariate models were performed using the statistical computing software RStudio®. The tables and charts visualizing the quantitative findings were created

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<sup>34</sup> OR = 1 Exposure does not affect odds of outcome; OR > 1 exposure associated with higher odds of outcome; OR < 1 exposure associated with lower odds of outcome.

with Microsoft Excel® 2010. In order to prove the transparency of results, the analytical procedures are provided in syntax form in the digital annex of this thesis.

### 2.4.2 Estimating the socioeconomic status of households by analyzing assets

In order to estimate the socioeconomic status of households in the Ewaso Narok Swamp, the SES index using household asset data was generated via a principal components analysis (PCA) to reduce the data (compare Filmer & Pritchett 2001, KDHS 2014, Table 10). Categorical variables were transformed into separate dichotomous indicators, used to produce a common factor score for each household. SES categories were obtained by deriving weights from the first principal component and dividing the same into tertiles.

**Table 10: Proxying socioeconomic status by an asset-based Principal Component Analysis**

Item included in PCA	1 <sup>st</sup> component*	Weight	Additionally: proxy on
Radio	.751	1	Access to information
running water	.677	2	WASH*, reduced time for water collection
mobile phone	.631	3	Access to information
Bicycle	.621	4	Transport means, greater mobility
TV	.498	5	Access to information
Sanitation	.128	6	WASH***, reduced contact to contamination
Motorcycle	.093	7	Transport means, greater mobility
Car	-.016	8	Transport means, greater mobility
Refrigerator	-.101	9	Electricity, WASH

\* Extraction method: Principal Component Analysis. Rotation method: Oblimin with Kaiser Normalization. a. Rotation converged in 9 iterations.

\*\* Limited information on WASH, since not improved water source is measured, but running water on plot or nearby regardless of water quality

\*\*\* Only the sanitation facilitated that are classified as improved by the WHO / UNICEF JMP are included.

This was done because according to Filmer and Pritchett (2001), the first principal component is the linear combination of all variables that has maximum variance, so it accounts for as much variation in the data as possible and captures the largest amount of information that is common to all of the variables.

From this procedure, three categories of socioeconomic status evolved, namely high, medium and low status, based on the given population. The respective SES category was assigned to each respondent's household.

### 2.4.3 Aggregating and analyzing qualitative data

The qualitative data gathered during in-depth interviews with the target population, expert interviews and the debriefing and feedback meeting was subject to detailed analysis. The audio-recorded files were transcribed by use of the software easytranscript® in order to put the communications into writing (Bowling 2014). For the transcription of the interviews, the easy transcript system as suggested by Dresing and Pehl (2011: 18) was used. It includes statements, breaks, stresses important points, notes, emotional and non-verbal expressions and possible interruptions. In the course of transcription, a language cross-check was done



by the research assistant for those interviews that contained Kiswahili. The researcher then smoothed the language and corrected the transcripts in collaboration with her assistant. The same was done for the notes. In order to prevent misinterpretation of any protocols, these were controlled by comparison with the original transcript, the rehearing of the original audio record and the discussion with the assistant.

According to Mayring (2002), qualitative statements made by humans call for a thorough interpretation, considering the hermeneutic perception, that creations by humans are always connected with subjective intentions. This requires an exact and appropriate description of the statements and experiences shared by the individuals who are part of any research. The reproduction of such subjective views is closely linked to the risk of losing or neglecting information, which is why the aggregation and analysis needs the same high priority as the data collection. To capture well the data and their interpretation, the transcripts and notes were then analyzed using ATLAS.ti7® software, a programme for analysis of qualitative empirical data. To get the massive amount of conversation material and statements into a manageable order, a first organisation of the text pieces took place by sorting passages of the text to key words that would capture similar aspects and make patterns visible. First, open coding was done, facilitating the search for differences, similarities and action patterns to build thematic categories and getting an overview of the overall data. Then, theoretical coding, considering the foreknowledge when choosing to sort text passages into groups of codes, was applied to generally structure the data (Corbin and Strauss 2008). Categories were predefined in a minimal way in order to ensure methodological transparency and to prevent misinterpretation.

**Table 11: Overview of qualitative metadata from the Ewaso Narok Swamp**

Main theme	Code	Subcode	Number of quotes
Health-related benefits provided by wetlands			21
Perceptions on health risks	Disease causes	Health risks	33
		Common diseases	9
		Malaria	16
		Diarrhoeal diseases	8
		Schistosomiasis	8
		Eye conditions	5
		Skin diseases	17
		Occupational health risks	12
		Other troubles	26
		Health-related knowledge	
Health-related behaviour	Aspects related to water, sanitation and hygiene		20
		Preventive measures	47
		Burden of disease	41
		Health-seeking	8
			29
<b>Sum of quotes used for analysis</b>			<b>311</b>

The categorization was based on main themes in the qualitative results that were addressed by the interviewees (Akter and Ali 2014, Lawrence et al. 2016), displayed in the Table 11.

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Selective coding helped to connect different categories and validate the interlinkages between them, allowing for the disclosure of structural patterns (Bowling 2014, Lamnek 2010). As a massive amount of qualitative material was collected in the Ewaso Narok Swamp, only the most important passages were considered and the outcomes were generalized, while the differences among the interviews were detected.

Pertinent and representative quotes were integrated in the results and discussions sections of the two empirical chapters of this work (Chapters 4-5). Furthermore, classified qualitative data were visualized by creating Sankey and Chord diagrams (Figures 13 and 34-36) with Microsoft Excel® and the softwares D3®, delimited.io® and Tableau®. Those diagrams combine health risk perceptions linked to water, sanitation and hygiene and other aspects. The system of codes, categories and classifications were included as appendices, as well as all original transcripts and notes and an overview of relevant statements.

## **2.5 Triangulating data from different research methods**

A major methodological and analytical pillar, which was omnipresent when preparing and conducting, when analyzing and putting this research into writing, was the triangulation. This is a method which serves to analyze a phenomenon by combining different methods, applied to overcome the challenge of representativity of qualitative data (Flick 2015). Denzin (2009) established the idea of triangulation in 1978 and distinguished four different kinds:

- Data triangulation which includes and applies data from different sources and levels on the same research topic;
- Investigator triangulation which employs different persons for the collection and analysis of the data;
- Theory triangulation which analyzes the research topic by the application of different theories or hypotheses;
- Methodological triangulation which applies different methods.

For this research, all of these approaches were used: (i) Both quantitative and qualitative original and secondary data were used, gathered from literature, a household survey, from an observational assessment, from open-ended questions in the survey questionnaire, from in-depth interviews, key informant and expert interviews, from a feedback meeting and from official authorities (Chapters 2.2-2.5). (ii) The researcher was supported in the collection and transcription of the data by her trained research assistant, with whom she also discussed about the results right after each interview conducted. (iii) Numerous theories were applied for this study (Chapter 1.4), such as the sustainable livelihood approach, theories of assessing health impacts, on health risk perception and health-related behaviour and on water-related disease transmission. (iv) Last but not least, a variety of methods were applied (Chapter 2.3), ranging from an explorative field trip to grounding

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theory of reviewing literature, to a cross-sectional study approach and observational assessment, to semi-structured interviews, applying descriptive and analytical statistics, univariate and multivariate models, to qualitative thematic analyses. Moreover, further possibilities for triangulation were created:

- Users versus uses: By not only sampling different wetland users groups (Chapter 1.3.3), but also probing for different wetland uses in the survey, another dimension of triangulation was included in the study. It aimed at facilitating to cover more aspects on top of the four groups, not pre-judging the characteristics and occupational features of the members of the groups, thereby making cross-checking and plausibility possible.
- Quantitative versus qualitative: By gathering data on the same topics by both quantitative (Chapter 2.3.2) and qualitative methods (Chapter 2.3.3), not only the validation and verification of data could be achieved. Also, deeper insights and detailed information on very specific ramifications brought up by the interviewees could be shed light on.
- Theory versus practice: Water-related infectious disease prevalence and exposure as evidenced by previous publications (Chapter 3) would not in any way have been possible to be detected by the researcher whatsoever. Neither means, nor know-how, nor medical staff would have been available to detect diseases. Triangulating theory with practice by approximating the diseases by self-reporting of symptoms (Chapter 4) facilitated an assessment of disease risks in the area.
- Theory versus perception: The triangulation of data on health risk perception with the theoretical framework by comparing both approaches and the conclusions the researcher gave the possibility of gathering insights into the level of health knowledge concerning selected diseases (Chapter 5). This would then be discussed against health-related behaviours.

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### **3 CONTRACTING INFECTIOUS DISEASES IN WETLANDS. A QUESTION OF USE?**

Wetlands play multiple roles in disease relationships (Cook and Speldewinde 2015, Johnson and Paull 2011, Parkes and Horwitz 2009). Human exposure to pathogens in such settings can be categorized according to exposure through the service provided, e.g. drinking contaminated wetland water, and, where services are eroded, the conditions giving rise to exposure, e.g. mosquito habitats favoured by modification of the wetland (Horwitz and Roiko 2015) and the variable risks arising according to the season (Hongo and Masikini 2003, Horwitz and Finlayson 2011, Neogi et al. 2014). Following these concepts, one can easily hypothesize that people using wetlands for different purposes might be at different risk of contracting diseases. Despite the often extensive use of wetlands, the available literature on their comprehensive ramifications on human health and their interactions with disease transmission is not very broad, case studies are lacking (Finlayson et al. 2015, Horwitz et al. 2012) and little is known about disease prevalence in wetlands (Dale and Knight 2008).

#### **3.1 Approaching wetland-use related infectious diseases by reviewing literature**

As was described in the methodological chapters (1.4.4. and 1.4.5), out of each of Bradley's categories of differing transmission pathways the ones of special relevance in wetlands and for wetland users in Sub-Saharan Africa, including malaria, onchocerciasis, diarrhoeal diseases, schistosomiasis, typhoid fever, and trachoma, were included into the literature review (Table 12). They are presented in detail in the following in relation to their wetland use-related risk factors. This comprehensive overview on available research in the field is intended to give a literature-based evaluation on risk factors linked to the different wetland uses and aims at filling the knowledge gap on use-related diseases.

A total of 26 documents fulfilled all primary criteria to be included in the review (Table 13). 16 texts from Sub-Saharan African countries were included, namely Tanzania (n=4), Uganda (n=3), Mali, Senegal and South Africa (n=2 each); Ethiopia; Kenya and Nigeria (n=1 each). These 16 publications covered various types of studies, such as cross-sectional studies (n=6), out of which two were cross-sectional combined with qualitative data. Five studies were reviews. Moreover, longitudinal studies (n=2), a qualitative study, a multi-criteria analysis study, one comparative study on spatial distribution and one field study including parasite collection were part of this review. The papers investigated different types of wetlands, such as floodplains (n=4), river deltas and basins (n=2 each) located in rural areas. Moreover, four of the studies targeting wetlands were conducted in swamps.

**Table 12: Compilation of water-related infectious diseases with relevance in wetlands**

Disease	Organism type	Disease agent	Transmission pathway	Symptoms	Link to wetlands	Epidemiological relevance
Malaria	Protozoa	Plasmodium spp. Plasmodium falciparum	Malaria-transmitting <i>Anopheles</i> mosquitoes breed and spend their larval stages in standing waters such as riverbeds and valley bottoms.	Fever, chills, sweats, headache and in progressed stage jaundice, bleeding disorders, shock, renal or liver failure, encephalopathy death.	The ecology of malaria is closely associated with hydrological features (availability of water, flooding, water resources management).	Malaria is a central public health problem, 225 million cases worldwide each year. 660,000 deaths – 90% in African countries.
Schistosomiasis (Bilharzia)	Trematode	Schistosoma spp.	Intermediate snails living in or spending part of life cycle in water.	Intestinal, hepatic and other symptoms, diarrhoea, abdominal pain, enlarged liver, blood in faeces or urine, skin rashes, fevers, chills, cough, muscle aches, chronic ill-health.	Standing freshwater with certain aquatic plants is the snails' preferred habitat. The degradation or alteration of wetland systems, inappropriate water management, lack of sanitation, reuse of untreated wastewater for irrigation increase the risk of schistosomiasis.	There over 200 million people being infected with schistosomiasis worldwide, 600 million people at risk of infection, and 200,000 deaths annually, esp. in Africa.
Onchocerciasis (River blindness)	Nematode	Ochocerca volvulus	Onchocerciasis-transmitting blackflies ( <i>Simulium damnosum</i> ) breed in fast-flowing rivers and streams.	Severe itching and lesions of the skin and eyes, rashes, and vision changes that can ultimately lead to permanent blindness.	Populations can be exposed to onchocerciasis if they live permanently or stay near suitable river systems, the vectors' preferred breeding sites.	Despite successful control intervention, over 120 million individuals in (esp. Africa) are at risk of onchocerciasis, 18 million infected.
Diarrhoea	Bacteria, viruses, parasites	Escherichia coli and many others	Pathogen is ingested by the intake of contaminated water or food, lack of water for hygiene, inadequate sanitation.	Three or more loose stools per day, secretion of fluids and dissolved salts into the gut, mild to severe or fatal complications, dehydration, malnutrition.	Poor surface water quality in wetlands resulting from discharging wastewater, inadequate sanitation management, waterlogged environment and poor drainage increase the risk of diarrhoeal diseases, esp. during and after flooding.	In developing countries, diarrhoeal diseases account for half of all morbidity and a quarter of all mortality especially in children.
Typhoid fever	Bacteria	Salmonella spp.	The pathogen is transmitted through the ingestion of faecally contaminated water or food or by flies.	Fever, feeling of weakness, stomach aches, headaches, a loss of appetite, and in some cases, a rash of flat, rose-colored spots.	Water and wetlands act as transport media of faecal pathogens and abiotic factors play a role in disease transmission.	Typhoid fever affects millions of people annually and is reported to cause 500,000 deaths per year.
Trachoma	Bacteria	Chlamydia trachomatis	Person to person contact through contact with eye discharge of an infected individual, flies, lack of water for hygiene.	Scratching of the cornea by the eyelashes, pain, visual impairment, permanent corneal damage and irreversible blindness.	Trachoma is associated with attributes of the physical and social environment and is closely connected with poor hygiene and inadequate sanitation, all of which is likely present in wetlands.	Trachoma has caused visual impairment in 2.2 million, and blindness in 1.2 million people in poor rural areas and marginalized populations in Sub-Saharan Africa.

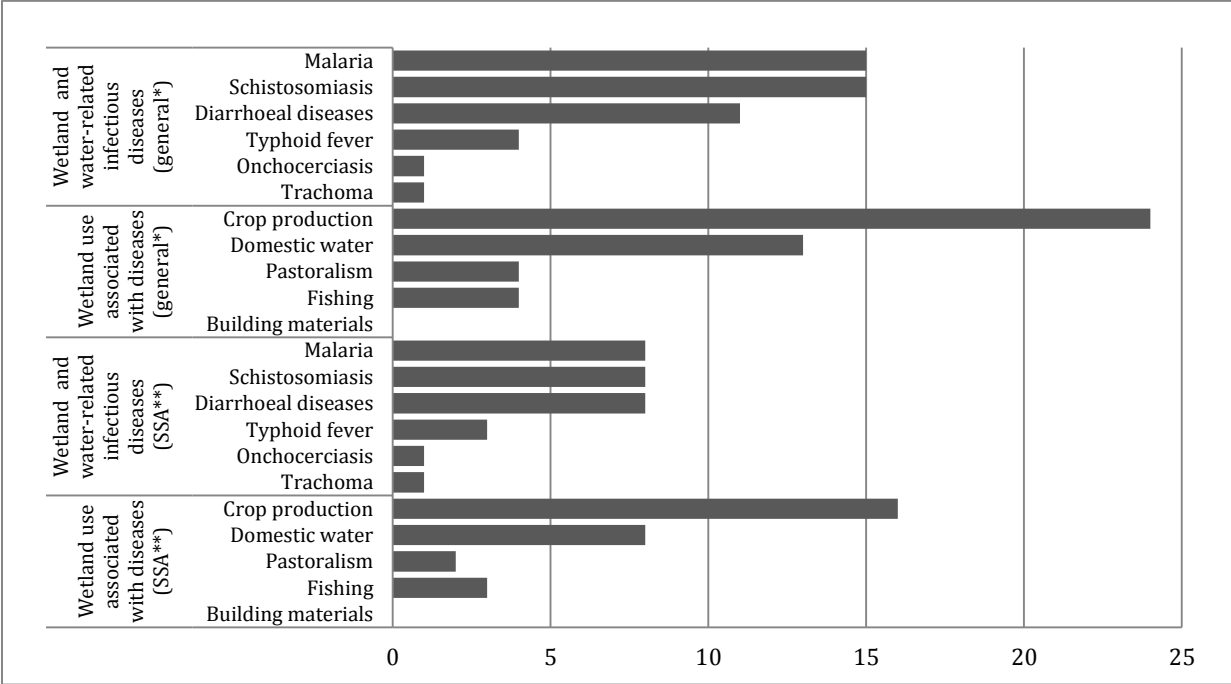
\*Summary of Chapter 1.4.5. Sources: Appleton and Madsen 2012, Dale and Connelly 2012, Dale and Knight 2008, Malan et al. 2009, Prothero 2000.

Out of the studies conducted in swamps, three referred to an urban swamp in Uganda (all conducted by the same authors in the same study area), and one to a swamp rural Kenya. The remaining four publications from SSA would not disclose detailed information on the freshwater wetland settings.

Ten publications, all of which were reviews or book chapters, particularly from a recently published book by Finlayson et al. (2015) did not refer to a certain country or specific type of wetland. Instead, they generally covered natural freshwater wetlands and one manipulated natural wetland.

A wide range of disciplines were represented, including physical sciences such as environmental and conservation science, (wetland) ecology, limnology, geography, engineering, biology, climatology, food and agricultural science, fishery, parasitology, natural resource and water management, and humanities and social sciences (public health, epidemiology, psychology, sociology, development studies), with most texts straddling more than one discipline or field.

The results of the literature review showed that the water-related infectious diseases that have mostly been addressed in the context of wetlands are malaria and schistosomiasis (n=15 each), followed by diarrhoeal diseases (n=11), typhoid fever (n=4), onchocerciasis and trachoma (n=1 each, see also Figure 12 and Table 14). Generally, the wetland uses were associated with those selected diseases, above all, crop production (n=24), domestic water (n=13), pastoralism and fishing (n=4 each).



\* General refers to all publications reviewed, regardless of the geographical setting (n=26).

\*\* SSA refers to the publications that include studies from Sub-Saharan Africa only (n=16).

**Figure 12: Results of the literature review on use-related infectious diseases in wetlands**

**Table 13: Description of included studies on use-related infectious diseases in wetlands**

No	Setting	Wetland	Type of study	Discipline	Focus	Author
<b>SSA</b>						
1	Ethiopia	South Bench, natural wetland	Cross-sectional & qualitative	Agriculture & Natural Resource Management	Wetland cultivation has socio-economic impacts for those falling ill.	Mulatu et al., 2015
2	Kenya	Swamp, highland vs lowland	Spatial distribution	Public Health, Climatology, Zoology, Insectology	Swamp cultivation increases the vector habitats, thus malaria transmission.	Omukunda et al., 2012
3	Mali	Natural freshwater wetland	Review	Environmental Science, Limnology, Public Health	Sanitation practices in wetlands cause different health threats.	Berthe & Kone, 2008
4	Mali	Inner Niger Delta	Multi-criteria analysis study	Environmental Science & Policy, Limnology	Sanitation is considered a major health risk factor in wetlands.	Cools et al., 2013
5	Nigeria	Inner Niger Delta	Review	Biology, Fishery & Aquatic Sciences	Malaria and onchocerciasis are occupational risks of fishermen in swamps.	Ukoroiye & Abowe, 2012
6	Senegal	Senegal River Basin	Longitudinal study	Parasitology, Veterinary Medicine, Public Health	In wetlands, dams and irrigated agriculture affect schistosomiasis risk.	DeClerq et al., 2000
7	Senegal	Senegal River Basin	Review	Geography	People in tropical wetlands are exposed to a range of health hazards.	Prothero, 2000
8	South Africa	Natural freshwater wetland	Review	Ecology, Public Health	Wetlands host schistosomiasis hosts, depend on hydrological regime.	Appleton & Madsen, 2012
9	South Africa	Natural freshwater wetland	Review	Wetland Ecology, Zoology, Conservation Sciences	Wetland changes encourage malaria and schistosomiasis transmission.	Malan et al., 2009
10	Tanzania	Kilombero Valley	Qualitative study	Public Health	Insights into knowledge and perception of wetland farmers of malaria.	Obrist et al., 2010
11	Tanzania	Kilombero Valley	Longitudinal study	Public Health	Living in temporary settlements in wetlands does not increase malaria risk.	Hetzel et al., 2008
12	Tanzania	Kilombero Valley	Parasite distribution	Public Health & Epidemiology	Schistosomiasis can be prevalent in wetlands and man-made habitats.	Utzing & Tanner, 2000
13	Tanzania	Kilombero Valley	Cross-sectional study	Water Management & Public Health	WASH conditions in temporary wetland settlements cause diseases in farmers.	Veltins, 2014
14	Uganda***	Swamp - urban	Cross-sectional study	Epidemiology & Public Health, Environ. Managem.	Wastewaters in wetlands pose considerable health threats.	Fuhrmann et al., 2015
15	Uganda***	Swamp - urban	Cross-sectional study	Epidemiology & Public Health, Environ. Managem.	Different wetland-related infections arise for different exposure groups.	Fuhrmann et al., 2016a
16	Uganda***	Swamp - urban	Cross-sectional study	Epidemiology & Public Health, Environ. Managem.	Gastrointestinal diseases differ among different exposure groups in wetlands.	Fuhrmann et al., 2016b
<b>GLOBAL</b>						
17	unspecified	Natural freshwater wetland	Review	Public Health, Limnology	Some wetland invertebrates cause diseases, esp. schistosomiasis and malaria.	Batzer & Boix, 2016
18	unspecified	Natural freshwater wetland	Review	Biological & Environmental Sciences, Limnology	The occurrence of mosquito-borne diseases is linked to 'health' of a wetland.	Carver et al., 2015
19	unspecified	Natural freshwater wetland	Review	Public Health, Natural Resources Management	Public health perspectives on water systems and ecology in wetlands.	Cook & Speldewinde, 2015
20	unspecified	Manipulated natural wetland	Review	Environmental Sciences, Agriculture, Ecology	Research addresses health sensitive wetland management for disease control.	Dale & Connelly, 2012
21	unspecified	Natural freshwater wetland	Review	Environmental Sciences, Ecology	Wetlands pose benefits and threats. Integrated wetland management is needed.	Dale & Knight, 2008
22	unspecified	Natural freshwater wetland	Review	Public Health, Biological & Environmental Science	Wetlands are known sites of exposure to waterborne infectious diseases.	Derne et al., 2015
23	unspecified	Natural freshwater wetland	Review	Biological Sciences, Natural Sciences, Limnology	Proposal of a strategy for comprehensive assessment of wetlands and health.	Horwitz & Finlayson, 2011
24	unspecified	Natural freshwater wetland	Review	Freshwater Biology, Ecology	The ecology and emergence of diseases is closely associated with fresh waters.	Johnson & Paull, 2011
25	unspecified	Natural freshwater wetland	Review	Public Health & Limnology	Both natural and human-made water bodies in wetlands host disease vectors.	Resh, 2010
26	unspecified	Natural freshwater wetland	Review	Public Health, Food & Agricultural Sciences	Environmental and health interactions in wetlands require broad approaches.	Zimmermann, 2001

\* All 26 included publications have a focus on wetlands.

\*\* The studies with a regional focus on Sub-Saharan Africa are sorted by country names.

\*\*\* These three papers all refer to the same study area in Uganda.

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When considering only those publications from SSA wetlands, the diseases addressed touch upon malaria, schistosomiasis and diarrhoeal diseases (n=8 each), typhoid fever (n=3), onchocerciasis and trachoma (one each).

These diseases were mainly linked to crop production (n=16) and domestic water (n=8). Fewer addressed fishing (n=3) or pastoralism (n=2) in SSA wetlands. Using wetlands for the collection of building materials was not associated with the risk of contracting diseases; neither in general, nor in SSA in particular.

### **3.2 Linking wetland uses to wetland-related infectious diseases**

While reflecting on the transmission of water-related diseases, both the particular geographic, topographic, ecological settings along with climatic factors, altitude and vegetation in wetlands need to be considered, while human behavioural patterns play a major role, too (Appleton 1983). For generations, wetlands and their socioeconomic potentials have been used in Sub-Saharan Africa (Dixon and Wood 2003). The extent of use varies significantly between different regions and socioeconomic groups, with a strong tendency to increased use and exploitation, differing between regions and socioeconomic groups. The most common uses as found in Sub-Saharan Africa are: extraction of water for domestic use (including drinking water), crop production, pastoralism, fishery and collection of building materials (Dixon and Wood 2003, Isunju et al. 2016, McCartney and Rebelo 2015, Rebelo et al. 2010, Sakané et al. 2011).

This review revealed that the associations between wetland use and water-related infectious disease exposure mostly described in the literature (Table 14) refer to agricultural crop production and malaria (n=12 in total, n=6 in SSA). Moreover, agricultural crop production was associated with schistosomiasis (n=13 in total, n=8 in SSA) and with diarrhoeal diseases (n=8 in total, n=5 in SSA). Besides crop production, domestic water and related risks were thematised in the context of wetlands, mostly associated with diarrhoeal diseases (n=9 in total, n=6 in SSA), schistosomiasis (n=6 in total, n=3 in SSA) and malaria (n=6 in total, n=4 in SSA). Less associations were described regarding pastoralism with malaria (n=2 in SSA), diarrhoeal diseases (n=1 in total, none in SSA) and schistosomiasis (n=1 in total, none from SSA). Fishery also was not widely addressed in association with diseases in wetlands and limited to schistosomiasis (n=3 in total, n=2 in SSA), malaria (n=2 in SSA) and onchocerciasis (n=1 in SSA).

Mostly linked to any sort of wetland use were malaria (crop production > domestic water > pastoralism, fishery) and schistosomiasis (crop production > domestic water > fishery > pastoralism), followed by diarrhoeal diseases (domestic water > crop production > pastoralism). Neither typhoid fever (domestic water > crop production), nor onchocerciasis (crop production > fishery) or trachoma (domestic water) were much dealt with.



Besides, some associations were not established at all, including crop production with trachoma; domestic water with onchocerciasis; pastoralism with onchocerciasis or trachoma; fishery with typhoid fever, diarrhoeal diseases or trachoma; and the collection of building materials with any of these diseases.

**Table 14: Water-related infectious disease exposure arising from wetland use**

Setting	Malaria				Onchocerciasis				Typhoid fever				Diarrhoeal disease				Trachoma				Schistosomiasis				Author
	Domestic water	Crop production	Pastoralism	Fishery	Domestic water	Crop production	Pastoralism	Fishery	Domestic water	Crop production	Pastoralism	Fishery	Domestic water	Crop production	Pastoralism	Fishery	Domestic water	Crop production	Pastoralism	Fishery	Domestic water	Crop production	Pastoralism	Fishery	
<b>SSA</b>																									
Ethiopia									x					x											Mulatu et al., 2015
Kenya		x																							Omukunda et al., 2012
Mali	x												x				x					x			Berthe & Kone, 2008
Mali	x												x								x	x			Cools et al., 2013
Nigeria		x		x		x		x																	Ukoroiye & Abowei, 2012
Senegal																						x			DeClerq et al., 2000
Senegal	x	x	x	x					x				x								x		x		Prothero, 2000
South Africa																					x	x		x	Appleton & Madsen, 2012
South Africa	x	x	x																		x	x			Malan et al., 2009
Tanzania		x																							Obrist et al., 2010
Tanzania		x																							Hetzl et al., 2008
Tanzania																						x			Utzingler & Tanner, 2000
Tanzania													x	x											Veltins, 2014
Uganda***									x				x	x											Fuhrmann et al., 2015
Uganda***																						x			Fuhrmann et al., 2016a
Uganda***													x	x											Fuhrmann et al., 2016b
<b>GLOBAL</b>																									
unspecified	x																				x				Batzer & Boix, 2016
unspecified		x																							Carver et al., 2015
unspecified		x											x	x											Cook & Speldewinde, 2015
unspecified																						x			Dale & Connelly, 2012
unspecified		x																							Dale & Knight, 2008
unspecified									x				x	x	x						x	x		x	Derne et al., 2015
unspecified		x											x	x								x			Horwitz & Finlayson, 2011
unspecified																							x		Johnson & Paull, 2011
unspecified	x	x																			x	x			Resh, 2010
unspecified		x				x																x			Zimmermann, 2001

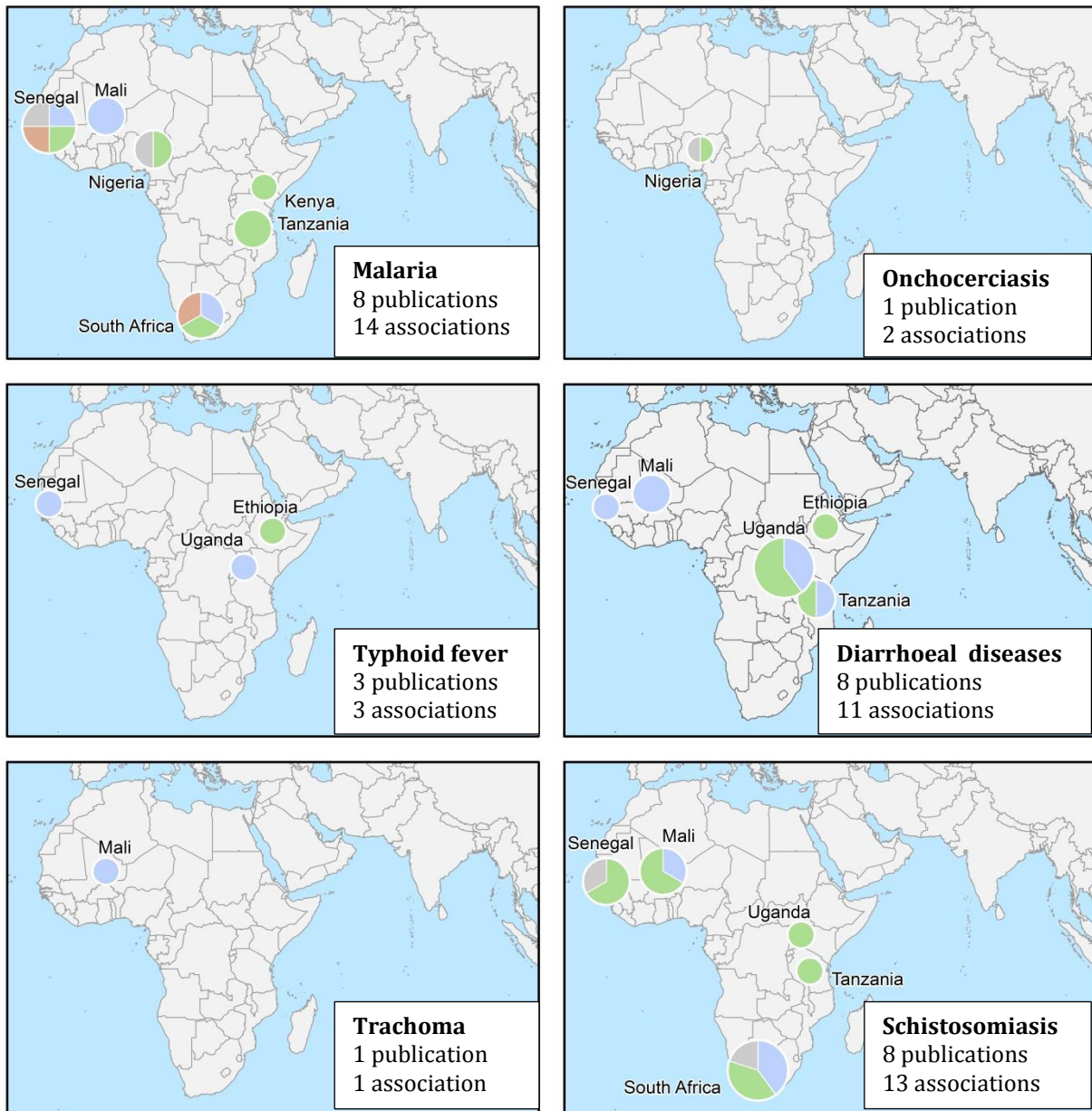
\* All included 26 publications have a focus on wetlands.

\*\* The studies with a regional focus on Sub-Saharan Africa are sorted by country names.

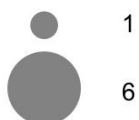
\*\*\* These three papers all refer to the same study area in Uganda

A regional stratification of these associations (Map 3) shows that different diseases were linked to different uses in different countries within SSA. Malaria, for example, was linked with all four uses identified in the literature review in Senegal, but only with crop production in Tanzania and only with domestic water in Mali, diarrhoeal diseases in Senegal, South Africa and Mali were only associated with domestic water, or with crop production in Ethiopia, whereas in Uganda and Tanzania they were related to both of these uses, and in Kenya to domestic water and pastoralism. Schistosomiasis was linked to domestic water, crop production and fishery in South Africa, but only to two of these uses in Senegal and Mali, and even only to one Tanzania and Uganda. Typhoid fever was in Senegal and Uganda associated with domestic water, in Ethiopia with crop production only. Onchocerciasis was

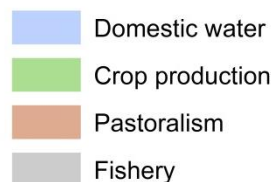
linked to fishery and crop production in Nigeria exclusively, and trachoma to domestic water in Mali.



**Number of associations between use and disease**



**Wetland use**



Data sources:  
 Review by Carmen Anthonj, 2017  
 GIS data from United Nations Environment Programme (UNEP)  
 IHPH, GeoHealth Centre, Bonn, 2017

The material on this map does not imply the expression of any opinion concerning the legal status of any country, territory or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

\* These maps are based on the review of n=16 publications from Sub-Saharan Africa.

**Map 3: Spatial distribution of use-related infectious disease exposure in wetlands**

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Each out of these activities in wetlands is differently linked to water contact and water-related transmission pathways that entail different health risks (Derne et al. 2015). Depending on the type of use and occupational characteristics, on the time and duration spent in wetlands, depending on the physical contact to water and thereby to pathogens and vectors, wetland users may be exposed to different risk factors associated with the previously named water-related infectious diseases. The ramifications are presented for each of the uses in a detailed way (Figure 13).

### **3.2.1 Domestic water**

Most wetlands serve as important sources of drinking and domestic water for rural communities, especially in the dry season and in locations where alternative sources are scarce (Cunningham 2015, McCartney and Rebelo 2015, Rebelo et al. 2010, Skov 2015). Where central water treatment facilities are unavailable and domestic household water treatment is absent, the health implications of water depend entirely on the natural purifying processes within the wetland. These have their limits, and if exceeded by extensive pollution from livestock, wild animals, and, certainly, human activities, wetland water quality is likely to decline. Using the wetland water for domestic purposes then may expose people to numerous water-related infectious diseases (Derne et al. 2015, McCartney and Rebelo 2015).

In wetlands, the absence of safe water supplies and sanitation – the reality for a high share of wetland communities - contributes to the spread of diarrhoeal diseases, especially in rural areas (Derne et al. 2015, Veltins 2014). Evidence from Mali showed that where wetlands provide the main drinking water source, the prevalence of diarrhoeal diseases is high (Berthe and Kone 2008). The ingestion of untreated wetland water is known to be a health risk factor due to a possible intake of pathogens causing diarrhoea and other waterborne diseases such as typhoid fever (Cools et al. 2013, Derne et al. 2015, Fuhrmann et al. 2015, Mulatu et al. 2015, Prothero 2000, Veltins 2014).

Mosquito densities tend to be far higher in settlements and other human-made habitats, probably because of reduced predation and competition compared to natural water bodies (Resh 2010). Therefore, storing water under unsafe conditions outside the house, in such ecosystems, e.g. in barrels and pots, creates mosquito breeding habitats (Batzer and Boix 2016, Prothero 2000). This can lead to an increased risk of contracting malaria. The same is true for small amounts of standing water, e.g. in car tires, that provide breeding habitats for vectors. Fetching water from wetland water bodies, rivers or streams can expose wetland water users to malaria (Cools et al. 2013) and onchocerciasis (Hopkins and Boatman 2011).

The use of wetland water for personal and domestic hygiene is linked to several diseases, too, including diarrhoea (Derne et al. 2015). By direct contact with infested water, e.g. while swimming, bathing or while washing clothes or utensils, people can contract schistosomiasis

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(Boelee and Madsen 2006, Derne et al. 2015, Resh 2010). This is especially the case where large population groups live near wetlands into which faeces containing *S. mansoni* eggs are washed due to unsafe sanitation practices, particularly during the rainy season (Appleton and Madsen 2012, DeClerq et al. 2000, Resh 2010, Zimmermann 2001). In times of drought, when water availability is reduced and people use the wetland for extraction of drinking water while concurrently watering their livestock in the same water source, wetlands may function as transmission foci of schistosomiasis as well (Johnson and Paull 2011). In dry wetland areas that provide only limited access to adequate water supply, sanitation and hygiene, trachoma can be prevalent (Berthe and Kone 2008). Especially where humans live in high proximity to livestock that attract the disease transmitting flies, the risk of contracting trachoma is high (Anchang et al. 2014).

### **3.2.2 Crop production**

Crop production is the main land use type as well as the main economic activity among rural communities, significantly contributing to food security in wetlands (Cunningham 2015, McCartney and Rebelo 2015, Nabahungu and Visser 2011). Agricultural use is steadily intensifying as the population in Sub-Saharan African countries is growing and economic development takes place (Dixon and Wood 2003, Rebelo et al. 2010). Subsistence crop production of maize, beans, millet and rice is most common in the drier wetland fringes or during the dry season, and rice is mainly cultivated in the floodplains or during the rainy season. The cultivation of locally marketable cash crops, mainly horticultures such as tomatoes and cabbage, is increasing. Their cultivation requires irrigation and drainage (Sakané et al. 2011).

During crop production in wetlands farmers are in direct contact with water and exposed to water resources potentially contaminated or infested with pathogens (Cook and Speldewinde 2015, Cools et al. 2013, Horwitz and Finlayson 2011, Mulatu et al. 2015, Zimmermann 2001). The most common disease transmission mechanisms in agriculture include vector-related and water-based transmission (Anchang et al. 2014).

Malaria has often been linked with agricultural practices. The modifications of wetlands and hydrological changes in the course of agricultural development in wetlands, in particular the creation of irrigation systems, small dams and rice cultivation areas, have been described as influencing and potentially increasing malaria risk (Carver et al. 2015, Dale and Knight 2008, Prothero 2000, Shayo et al. 2015, Ukoroije and Abowei 2012). By such man-made creation of breeding sites suitable for malaria-carrying mosquitoes, the disease emerged at localities where it did not previously exist (Resh 2010). Omukunda et al. (2012) found a high proportion of potential and positive breeding sites in cultivated swamps in Western Kenya. The authors suggested wetland agriculture to be favourable for malaria transmission. Hetzel et al. (2008), on the other hand, when investigating malaria risk of farmers living in temporary shelters during flooding in the Kilombero floodplains in Tanzania, did not find an

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increased transmission risk. This was reasoned by the 98% usage of mosquito nets among the farmers living in such sites, preventing the transmission of malaria. In general, when compared to sites distant from water bodies, farming in wetlands near breeding sites of water-related insect vectors can cause a higher risk of contracting malaria (Obrist et al. 2010) and onchocerciasis near rivers or streams (Hopkins and Boatman 2011, Hopkins et al. 2008).

Agricultural cultivation has also been linked to the diarrhoeal diseases and intestinal parasitic infections (Fuhrimann et al. 2015, Fuhrimann et al. 2016a; 2016b, Falkenberg 2016), both through ingestion and due to contact with contaminated water. In an urban wastewater channel and wetland, the authors found the risk of diarrhoea acquisition to differ between different exposure groups including slum dwellers, drainage workers, farmers, with the latter being exposed the most. In temporary settlements in the Tanzanian Kilombero floodplains, a higher prevalence of diarrhoeal diseases in farmers staying in their fields overnight was evidenced compared to those in the villages (Veltins 2014).

Manure which is traditionally applied to fields as fertilizer is a risk factor that besides diarrhoeal diseases can also cause typhoid fever (Anchang et al., 2014). Mulatu et al. (2015) linked the occurrence of typhoid fever and diarrhoea mainly to decreased water quality resulting from wetland degradation due to cultivation.

Direct contact to infested wetland water may expose farmers to the risk of contracting schistosomiasis, as the parasites spend part of their lifecycle in water (Anchang et al. 2014, Appleton and Madsen 2012, Hopkins et al. 2008). The implementation of water projects in wetland agriculture, first and foremost irrigation systems and dams, lead to an expansion of the habitats of intermediate host snails, favouring new potential transmission sites for schistosomiasis as shown in a study by De Clercq et al. (2000) and others (Boelee and Madsen 2006, Cole 2006, Cools et al. 2013, Johnson and Paull 2011, Prothero 2000, Resh 2010, Steinmann et al. 2006, Utzinger and Tanner 2000). From an ecological perspective, irrigation dams and reservoirs typically have stable water levels that are stagnant or extremely slow moving and thereby form the ideal habitat for the snail hosts for intestinal schistosomiasis (Appleton and Madsen 2012).

### **3.2.3 Pastoralism**

Pastoralism and livestock grazing is the second most important land use type after crop production for wetland inhabitants in Sub-Saharan Africa. Cattle, goats, camels and other ruminants are grazed year-round on the dry fringes of both valleys and floodplains and in the centre of seasonal floodplains during the dry season (Berthe and Kone 2008, Rebelo et al. 2010, Sakané et al. 2011). In semiarid Sub-Saharan African regions, pastoralism is associated with a semi-nomadic lifestyle (Hongo and Masikini 2003).

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Pastoralists' adaptation to such drought-prone, water-scare and remote environments and their physical proximity to their livestock makes them face a different spectrum of health problems compared to non-pastoralist populations (Sumaye et al. 2013). Usually, pastoralist communities live farther away from wetlands than other users with limited access to water which has implications on their health (Patz and Confalonieri 2005).

Pastoralism and livestock is linked to direct contact with environmental pathogens and infected animals causing numerous diseases (Prothero 2000). When herding and watering their livestock in wetlands, the pastoralists put themselves at risk of contracting diseases related to insect vectors such as malaria (Shayo et al. 2015, Wielgosz et al. 2012) and onchocerciasis (Hopkins and Boatman 2011). Generally, proximity to animals that attract the insect vectors can be a risk factor to both diseases in wetlands (Resh 2010). Livestock is known to play a role as an alternative blood-meal source for vector populations as shown by Wielgosz et al. (2012). The presence of livestock might either reduce malaria transmission to humans, in the case that vectors prefer livestock meals, or enhance it, in the case that mosquito populations multiply due to the increased food source (Mutero et al. 1999). Additionally, the possession of livestock might create 'man-made malaria' in homesteads, since livestock hoof prints might create breeding habitats for disease vectors (Malan et al. 2009, Prothero 2000).

Untreated or unsafely disposed of livestock waste not only can cause water pollution, but also result in adverse health effects for pastoralists who ingest livestock-contaminated water (Johnson and Paull 2011). This faecal-oral transmission due to close proximity to the animals, as well as poor manure management, increases the risk of diarrhoeal diseases (Anchang et al. 2014).

The main water source of pastoralists is usually wetland water, which they share with their livestock. Particularly in dry areas, this might leave them with less water available for domestic purposes and might be associated with less hygienic environments and increased water-washed diseases such as trachoma (Clements et al. 2010, Ngondi et al. 2007). Trachoma is closely connected with aridity, distance from water source and nomadic livelihoods in close proximity to livestock that attract flies which spread the disease, all of which characterize pastoralism (Anchang et al. 2014, Berthe and Kone 2008). Disease prevalence in pastoralists differs from settled populations with a profile that is directed toward livestock-related diseases (Patz and Confalonieri 2005).

#### **3.2.4 Fishery**

Fish and fishery products are also important ecosystem services derived from inland waters (Berthe and Kone 2008). Fishery is undertaken to varying extents in wetlands. Whereas it is widespread in some wetlands, in others fishery is not practiced at all. According to the Millennium Ecosystem Assessment (2005a) wetland fishery is of particular importance in

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developing countries, and sometimes the primary source of animal protein to which rural communities have access (Roos et al. 2006). Traditionally, fishing was very important as a source of subsistence and income in Sub-Saharan floodplains, swamps and lakes, e.g. in the Tanzanian Kilombero floodplains (Rebelo et al. 2010).

Health risk factors linked to fishing are the direct physical contact to water sources, exposing the individuals who fish to schistosomiasis (Appleton and Madsen 2012, Boelee and Madsen 2006, Derne et al. 2015, Hopkins et al. 2008, Prothero 2000). Diseases associated with fishing in environments such as wetlands that provide good breeding grounds for female *Anopheles* mosquitoes and *Simulium* flies include malaria and onchocerciasis (Gergel 2013, Hopkins and Boatin 2011, Hopkins et al. 2008, Prothero 2000, Ukoroije and Abowei 2012).

### **3.2.5 Collection of building materials**

The natural materials for thatching and construction of housing such as reeds, clay, and wood, are another vital service wetlands provide. Such products are of importance particularly to poorer parts of the society (Cunningham 2015, Dixon and Wood 2003). Sakané et al. (2011) argue that factors driving people to use these products include the households' distance to the wetland and the affiliation to certain groups to use wetland products (also as medicine).

The literature on wetland use and diseases does not address collecting building material to be a risk factor associated with diseases whatsoever. However, one can assume that the collection of building materials near such ecosystems is linked with disease contraction, even though not explicitly mentioned. Since the proximity to water sources is associated with the risk of contracting onchocerciasis (Gergel 2013, Hopkins and Boatin 2011) and malaria (Gergel 2013), the collection of building materials may be linked to the two diseases to a certain extent, as well.

### 3.3 Synopsis: Associations between use-related risk factors and infectious diseases

Ongoing population growth is accompanied by higher density of populations living in closer proximity to wetlands, and consequently increasing contamination of wetlands (Appleton and Madsen 2012). The anthropogenic alteration, destruction and restoration (Malan et al. 2009), as well as human and livestock pollution of wetlands, drive the presence and proliferation of pathogens in wetlands (Zimmermann 2001), whilst human behaviour determines the users' exposure to these pathogens, as well as the risk of contracting diseases. Most of the diseases addressed in this review are very sensitive to the degradation of wetlands and to ecological, hydrological, seasonal and land use changes (Gergel 2013, Horwitz and Roiko 2015, Neogi et al. 2014). At the same time, changes to the ecosystem can pose secondary threats by limiting the provision of ecosystem services (Carver et al. 2015, Derne et al. 2015). Overall and as a consequence of these ramifications, wetlands play a role as transmission sites for waterborne and water-based diseases, as breeding sites for mosquito vectors and as sites of water-washed diseases.

This review shows that depending on the type of use, people in wetlands are exposed to different risk factors and water-related infectious diseases. It establishes connections of selected diseases with different transmission pathways that are linked to specific risk factors. All of these have been integrated into a detailed conceptual framework which clarifies the complexity of the relationships (Figure 13), illustrated in Map 4.

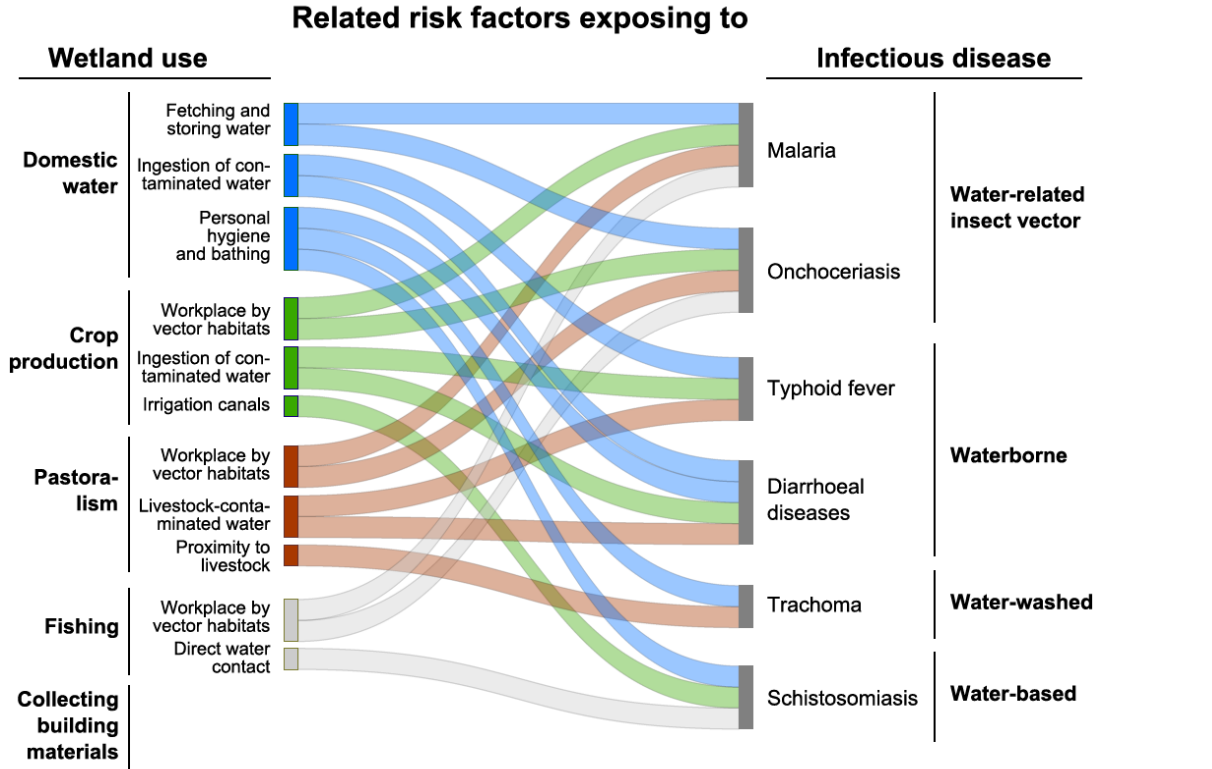
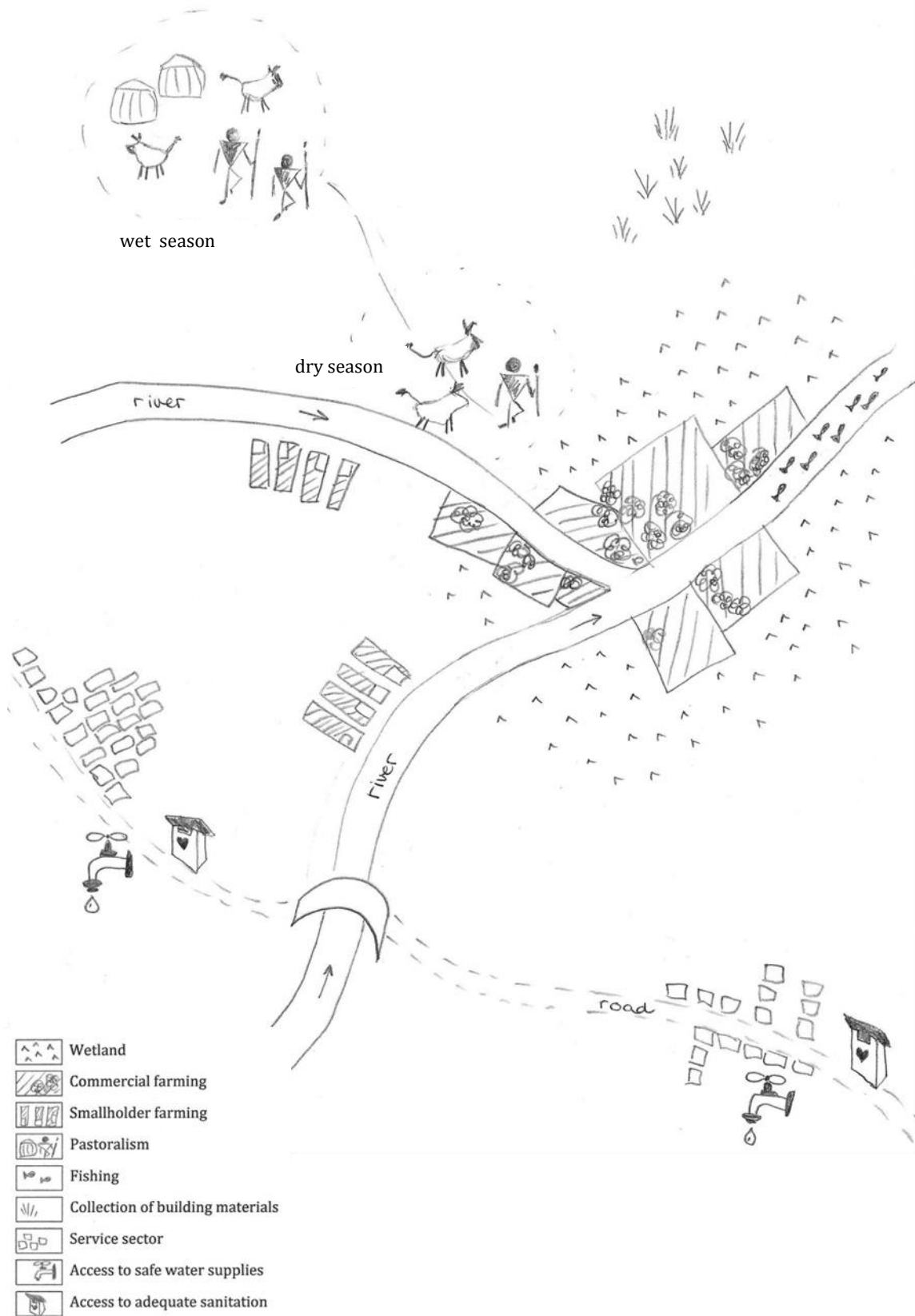


Figure 13: Framework of potential wetland-use-related infectious disease exposure





**Map 4: Idealized wetland in East Africa, displaying the most common uses and risk factors**

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The framework on wetland use and disease exposure provides a first attempt to conceptualize a range of complex interactions related to wetland uses and infectious diseases. The compilation shows that all selected diseases have been previously addressed in the context of wetland use, both on a global level and with a focus on SSA (Figure 12), thereby underlining their public health relevance in such ecosystems. While some diseases such as malaria (Hetzl et al. 2008, Malan et al. 2009, Omukunda et al. 2012), schistosomiasis (Appleton and Madsen 2012, DeClerq et al. 2000, Fuhrimann et al. 2016a) and diarrhoeal diseases (Fuhrimann et al. 2015; 2016b, Mulatu et al. 2015, Veltins 2014), receive more attention, others were only marginally mentioned, such as onchocerciasis (Ukoroije and Abowei 2012) or trachoma (Berthe and Kone 2008). Both of the latter are neglected tropical diseases with relatively low prevalence rates that are generally underreported (WHO 2015b). When looking at wetland uses and their relation to diseases in SSA (Figure 2 & 3), the same is true. While there is vast literature available that either discusses the role of crop production in wetlands (Fuhrimann et al. 2016a; 2016b, Hetzel et al. 2008, Mulatu et al. 2015), or the use of wetland water as a risk factor for the contraction of diseases (Cools et al. 2013, Veltins 2014), far less has been published on pastoralism (Malan et al. 2009, Prothero 2000) and fishing (Ukoroije and Abowei 2012) and water-related health risk factors in wetlands. Publications on the collection of natural materials from wetlands relating to disease transmission could not be identified.

Generally the literature available on use-related disease risks is very scattered, limited and varying significantly in its details, which is why the review refers to articles from a broad field of disciplines that only partly address the issue, marginally at that and not in a detailed way. The resulting list of risk factors does not claim to be exhaustive and could be extended by additional literature on further wetland uses and diseases.

The geospatial distribution of investigations relating wetland uses to diseases (Map 3; Figure 13) reveals that several case studies were conducted in East Africa (with particular focus on the Tanzanian Kilombero Valley and the Ugandan Nakuvibo wetland), in West Africa (Senegal and Mali), and in South Africa. The type of use and disease addressed differs according to the region and according to the type of wetland. Large parts of Southern Africa did not provide any studies at all, just like no studies were available from Central Africa. Large wetlands such as the Okavango Delta or the Congo River Floodplains remained underreported, and so did the Kenyan Ewaso Narok Swamp. This, however, does not mean that the use-related risk factors may be neglected. Although 16 references might not be sufficient in order to draw general conclusions on the exposure to use-related diseases in other SSA wetlands, the framework might be of some relevance in those wetlands that are unhealthily and unsustainably used for the listed purposes, and that lack adequate water, sanitation and sewerage infrastructure.

The framework on use-related disease exposure in wetlands visualizes that domestic water use and crop production can be linked to malaria, onchocerciasis, typhoid fever, diarrhoeal

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diseases, trachoma and schistosomiasis, representing all four transmission pathways as defined by Bradley (1974). Based on the available literature of the past 16 years, pastoralism can be associated with all infectious diseases but schistosomiasis. Fishing has been related to malaria, onchocerciasis and schistosomiasis, but not to typhoid fever, diarrhoeal diseases and trachoma. Some risk factors are well researched and understood, such as irrigation schemes favouring schistosomiasis prevalence (Appleton and Madsen 2012, DeClerq et al. 2000, Utzinger and Tanner 2000). For others, including the proximity of pastoralists to their livestock and the associated risk of contracting trachoma (Berthe and Kone 2008), only limited research has been carried out so far.

This asymmetrical reporting might indicate that via the more direct uses, where wetland users interfere more intensively and get into closer physical contact with water, the exposure level to water-related diseases might be higher. More indirect wetland uses such as pastoralism might imply fewer health risks, as might be the case for the collection of building materials, where very little interference with water might be expected. This assumption ends when considering the wetland use for fishing that would also logically entail close water contact.

Although it is difficult to generalize any sort of conceptual model of risk factors, exposure and transmission pathways of water-related infectious diseases, as they are linked to the site-specific hydrological, ecological, geographical and climatic conditions and are highly region- and population-specific, the review corroborates the assumption that the risk of contracting diseases in Sub-Saharan African wetlands is in any case a question of use.

However, in order to fully determine the actual health risks that arise from the use of wetlands, not only the actual form of use plays a role. It is essential to consider the wetland users' specific occupational and domestic situation. Water and wetland use and the entailed vulnerabilities to acquiring diseases can furthermore be influenced by health-risk perception, health-related knowledge and education, as well as socio-economic status, lifestyles, cultural aspects, traditions and beliefs (Cools et al. 2013, Dale and Knight 2008, Dunn et al. 2011, Michelson 1993).

In order to close this knowledge gap, the theoretical framework on wetland use-related infectious disease exposure that resulted from this review (Figure 13) needs to be filled with life in the following chapters. A detailed investigation of the named implications is required and will be presented in the form of a risk assessment of smallholder farmers, commercial farmers, pastoralists and service sector workers using the Ewaso Narok Swamp, Kenya (Chapter 1.3.3).

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## **4 HEALTH RISK ASSESSMENT IN THE EWASO NAROK SWAMP**

The analytical review on use-related health risks and on the contraction of diseases in wetlands (Chapter 3) clearly described how wetlands provide aquatic environments with optimal conditions for the survival or proliferation of certain bacteria, protozoa, viruses and helminths, as well as their hosts, reservoirs and vectors, some of which can cause diseases (Anthonj et al. 2016, Cools et al. 2013, Derne et al. 2015). The ones mostly associated with wetlands include diarrhoea and typhoid fever (faecal-oral route), schistosomiasis (skin contact), and malaria (vectors) (Appleton 1983, Cools et al. 2013, Derne et al. 2015, Horwitz et al. 2012, Malan et al. 2009, Zimmermann 2001). According to current literature, transmission occurs by the ingestion of contaminated water or through skin and mucous membrane surfaces by direct contact with water which is infested with pathogens. The lack of adequate water for personal hygiene, especially in close proximity to livestock; and, to a certain extent, vectors in water environments, can contribute to disease transmission. Transmission can take place both in domestic and occupational environments. This chapter evaluates, whether the grounded theory reflects the reality of health risks and disease exposure in the Ewaso Narok Swamp. Occupational uses of the ecosystem (Chapter 4.1.1), as well as the situation of domestic water, sanitation and hygiene (Chapter 4.1.2) in the wetland are described by presenting findings of the observational assessment (n=397) (Chapter 2.3.2.4) and the household survey (n=400) (Chapter 2.3.2.3) Moreover, the self-reported disease burden of the people in the wetland is assessed by presenting selected self-reported symptoms probed by checklists, including abdominal conditions, fever, skin irritation and eye condition (Chapter 4.2), before health-related measures and behaviours are associated (Chapter 4.3-4.4). All findings are presented per se, as well as stratified by groups. Based on these data, health risk assessments covering domestic WASH-related and occupational use-related risk factors for the named symptoms are computed with univariate and multivariate models.

### **4.1 Assessing domestic WASH, wetland uses and other risk factors**

#### **4.1.1 Wetland use and occupational routines in the Ewaso Narok Swamp**

The wetland users (n=300) reported a range of different uses (Table15). Using the wetland for crop production (78%) and in order to satisfy domestic water needs (74%) were most prominent. Moreover, livestock grazing (56%) was done in the swamp, irrigation water extracted (55%), housing material (52%) and medicinal plants collected (4%), and fishing activities were conducted (4%). The commercial farmers, besides crop production, used the water resources provided by the wetland for irrigation mainly (90%) and for domestic purposes (80%). Compared to the other groups, they collected more medicinal plants and did more fishing. The smallholder farmers, in contrast, used the swamp less and did less irrigation activities (59%) and domestic water (62%). Both groups of farmers would graze

livestock and animals in the wetland, indicating that they do not solely rely on crops, but also on livestock. The pastoralists, besides almost entirely using the wetland area for grazing their livestock (98%), used the water for domestic purposes (82%), collected more building materials than any other group (60%) and also medicinal plants (3%). More than one third of the pastoralists used the swamp for crop production, with half carrying out irrigation activities. This points to the lifestyle of pastoralists as not exclusively nomadic livestock keepers, but partly also sedentary agro-pastoralists maintaining their livelihoods with a combination of livestock and crops.

**Table 15: Type, time and duration of wetland use, stratified by user groups**

	Smallholder farmers (n=106)		Commercial farmers (n=95)		Pastoralists (n=99)		Total (n=300)	
	n	%	n	%	n	%	n	%
<i>Type of wetland use</i>								
Crop production	106	100.0	95	100.0	34	34.3	235	78.3
Irrigation water	63	59.4	85	89.5	17	17.2	165	55.0
Livestock grazing	30	28.3	40	42.1	97	98.0	167	55.7
Water for domestic use	66	62.3	76	80.0	81	81.8	223	74.3
Housing material	50	47.2	46	48.4	59	59.6	155	51.7
Medicinal plants	1	0.9	7	7.4	3	3.0	11	3.7
Fishing	4	3.8	9	9.5	0	0.0	13	4.3
<i>Time of use</i>								
Morning	74	91.4	60	82.2	52	80.0	186	84.9
Afternoon	7	8.6	13	17.8	13	20.0	33	15.1
<i>Start of wetland use</i>								
Start before 1975	17	16.0	1	1.1	3	3.0	21	7.0
Start after 1975 until 1995	38	35.8	30	31.6	27	27.3	95	31.7
Start after 1996	51	48.1	64	67.4	69	69.7	184	61.3

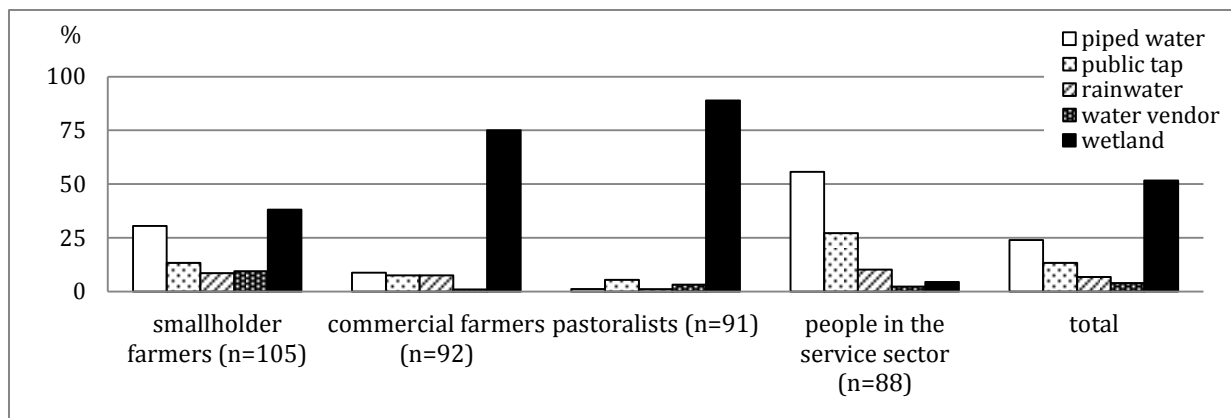
The substantial majority of all respondents, regardless of the group membership, mainly used the swamp in the morning (85%). Out of the survey respondents, almost two thirds started to use the wetland less than 20 years, reflecting the immense in-migration within the last decades.

#### **4.1.2 The situation of water, sanitation and hygiene in the Ewaso Narok Swamp**

Overall out of the people interviewed in the Ewaso Narok Swamp who shared information on their main drinking source during the household survey (n=376), more than half (56%) used so-called unsafe water sources (WHO/UNICEF JMP 2015) as their main source of drinking water, consisting of surface wetland water (52%) and water from a vendor (4%). The remaining share of people used improved water sources, including piped water (24%), water from public taps (13%) and harvested rainwater (7%) (Anthonj et al. 2016<sup>35</sup>; Figure 14<sup>36</sup>; Table 16).

<sup>35</sup> Parts of this chapter have been published.

<sup>36</sup> Wetland water refers to surface water from Ewaso Narok Swamp which is being fetched for drinking. Piped water, public taps and rainwater are classified as improved sources of drinking water, while water from vendors and surface water from wetlands are unimproved sources (WHO / UNICEF JMP 2015).



**Figure 14: Main drinking water source [%] by user groups in the Ewaso Narok Swamp**

The four user groups differed in terms of the water sources that they drew their drinking water from. The most striking result is that that the pastoralists almost exclusively used the wetland as their main water source (89%), followed by public taps (6%), water from vendors (3%), piped water and rainwater (1% each), which made an overall of 92% of the pastoralists using unsafe sources. The commercial farmers also had a large share of households mainly using wetland water (75%) for drinking, way less used improved sources (25%). This strongly contrasts the water sources of service sector workers, out of which only 7% used unsafe sources (5% wetland water, 2% water vendor). The majority of people in this occupational field made use of piped water (56%) or public taps (27%), few used harvested rainwater (10%). Out of the group of the smallholder farmers, half used unimproved and half use improved sources.

**Table 16: Domestic water, sanitation and hygiene, stratified by user groups**

	Smallholder farmers (n=105)		Commercial farmers (n=92)		Pastoralists (n=91)		Service sector workers (n=88)		Total (n=376)	
	n	%	n	%	n	%	n	%	n	%
<i>Water sources</i>										
Improved drinking water	55	52.2	22	23.9	<b>8</b>	<b>8.8</b>	<b>82</b>	<b>93.2</b>	167	44.4
Unimproved drinking water	50	47.8	70	76.1	<b>83</b>	<b>91.2</b>	<b>6</b>	<b>6.8</b>	209	55.6
Bathing in surface water	50	47.2	64	67.4	90	90.9	12	12	216	54.0
<i>Water supply, previous month</i>										
Same as usual	62	58.5	45	47.4	54	54.5	<b>71</b>	<b>71.0</b>	232	58.0
Discontinuous	<b>22</b>	<b>20.8</b>	11	11.6	7	7.1	16	16.0	56	14.0
Too little	13	12.3	10	10.5	<b>14</b>	<b>14.1</b>	6	6.0	43	10.8
Dirtier than usual	9	8.5	<b>29</b>	<b>30.5</b>	<b>24</b>	<b>24.2</b>	7	7.0	69	17.3

\*The outliers are printed in bold.

Regardless of the type of water source, the supply in the preceding month was recorded also. Overall, the supply was rated the same as usual by more than half of the people (58%), with the remaining share of respondents recalling it dirtier than usual (17%), discontinuous (14%) or too little (11%). Whereas the service sector workers out of all groups report the most stable supply, commercial farmers and pastoralists were faced with increased

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contamination and water shortage. Smallholder farmers faced discontinuity in their supplies, despite of two thirds of the group recalling the supply as same as usual.

Out of all respondents, more than half (54%) used surface wetland and river water as main sources for bathing, and here again, differences between groups became visible. While the vast majority of pastoralists (91%) primarily bathed in the river or wetland, only few (12%) of the service sector workers did.

In terms of water source and quality, several aspects were mentioned by the experts as challenging. Besides the dependency of wetland users on unsafe water sources and surface water and the subsequent increased risk of acquiring diseases, which are aspects that had been thematised by the users themselves, difficulties with presumed safe sources were addressed:

*'We have two different sources of water. The water from Nyahururu depends in its quality. Normally, water quality assessment is being done in Rumuruti.'* (former DHO<sup>37</sup>)

However, that water, according to the WRMA representative and the community health worker, is dirty and comes untreated, even additionally contaminated by the sewerage treatment plant that discharges into the river and wetland. The chemist interviewed, in contrast, described the water quality to have improved generally since, according to her, piped water was put up. This aspect, whoever, was not a satisfying indicator for safe water for the community health worker:

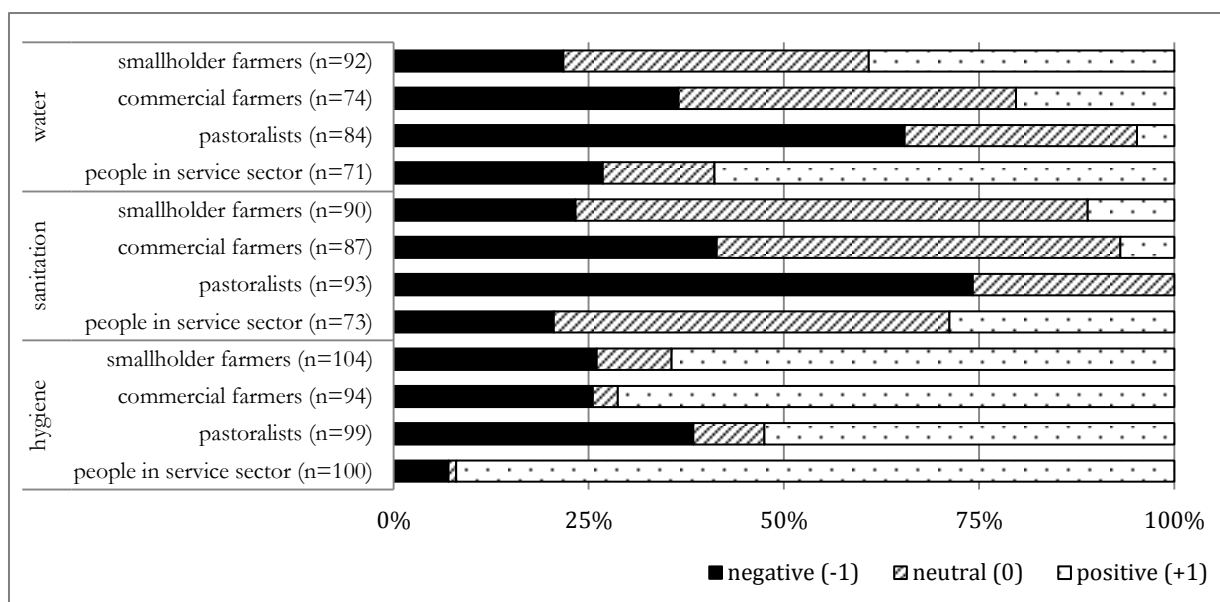
*'Some people have taps, but they don't have water because the bill was very high, they don't have money to pay those bills. The water is out or it has already cut off, so many people are relying on our river here.'* (CHW)

The observational household assessment (n=397) of the water storage, sanitation and personal hygiene conditions of different user groups in the Ewaso Narok Swamp revealed general trends (Figure 15, Photo 8).

Water storage conditions were scored rather negative in the households. Especially the pastoralists had their water stored in polluted and uncovered containers (median: negative; negative scores: 66%; neutral scores: 30%). The commercial farmers' water storage conditions were largely scored as negative, too, but were slightly better (median: neutral; negative scores: 37%; neutral scores: 43%). The smallholder farmers' water storage was scored as neutral or rather positive (median: neutral; neutral scores: 39%) with 39% having adequate water storage. However, 22% of them had their water storage containers uncovered. The respondents from the service sector showed the most positive results in terms of water storage (median: positive; positive scores: 59%). The water storage score was significantly associated with the group membership ( $p < 0.001$ ), with a moderate strength ( $\Phi = 0.493$ ).

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<sup>37</sup> The acronyms used here refer to the experts interviewed, They are listed in the Table 6 in Chapter 2.



**Figure 15: Observational assessment of domestic WASH conditions [%] in the Ewaso Narok Swamp by user groups**

All groups' sanitation situation was scored as neutral or negative, having either no or unimproved sanitation facilities in their homes or homesteads. The pastoralists' sanitation was mostly inadequate (median: negative), 74% of them had no sanitation facilities on their premises. Sanitation was scored as negative or neutral among the commercial farmers (median: neutral; neutral scores: 52%; negative scores: 41%) and the smallholder farmers (median: neutral; neutral scores: 66%; negative scores: 23%). People working in the service sector achieved the best scores (median: neutral; neutral scores: 51%; positive scores: 29%). The sanitation score was significantly associated with the group membership ( $p < 0.001$ ), with a moderate strength ( $\Phi = 0.506$ ).

The hygiene condition was scored generally rather positive among the user groups. The pastoralists had the lowest scores (median: positive; positive scores: 53%; negative scores: 38%), followed by the smallholder farmers (median: positive; positive scores: 64%), exceeded by the commercial farmers (median: positive; positive scores: 71%) and the people working in the service sector (median: positive; positive scores: 92%). The personal hygiene score was significantly associated with the group membership ( $p < 0.001$ ); however this association was weak ( $\Phi = 0.325$ ).

The water storage, sanitation and hygiene scores were significantly associated: the water score was associated with the sanitation score with a moderate strength ( $\Phi = 0.506$ ). The association of the water score with the hygiene score was weak ( $\Phi = 0.232$ ), as well as the association of the sanitation score with the hygiene score ( $\Phi = 0.330$ ). All associations were highly significant ( $p < 0.001$ ). The added WASH scores and resulting overall WASH situations of the different user groups' households ( $n = 309$ ) in the Ewaso Narok Swamp varied greatly.





a. Children fetching water from the river; b. woman washing clothes and utensils in standing water, which she also fetches for domestic purposes; c. sanitation facility without flush, paper, or handwashing option; d. sanitation facility of a pastoral homestead; e. water tank at the Rumuruti district hospital with information on safe water; f. uncovered water barrel (2015, 2016).

**Photo 8: Impressions of the WASH options in the Ewaso Narok Swamp**

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The people working in the service sector had the best WASH situation of all groups, followed in descending order by the smallholder farmers, the commercial farmers and the pastoralists. Groups differed significantly in their WASH situations (Kruskal-Wallis H test,  $p < 0.001$ ).

#### 4.1.3 Health-related and protective behaviour in the Ewaso Narok Swamp

Numerous health-protective measures against water-related diseases were proactively being applied by the people around the Ewaso Narok Swamp (Table 17). The most frequently reported measures included some sort of water treatment. According to the household survey, about 80% of all respondents mentioned to boil their water before drinking in order to improve its quality. This was being done because

*'...in the wetland, there is stagnant water which has insects inside that cause disease. If one doesn't boil the water it gives problems. [It] is dirty and when we use it without treating or boiling, there will be problems for health and diseases.'* (co4)

*'It is important to use clean and treated water. The piped water is harmful, one needs to boil it before drinking.'* (se5)

*'You can either treat the water or boil the water.'* (pa1)

*'We clean the water, we use a sieve. The water settles but it does not make any difference because when you sieve the germs are still in the water.'* (pa5)

In order to improve the drinking water quality, another measure on top of those set out by the study respondents was described by the DHO, the CHW and in detail, by the chemist:

*'Those who can afford use chemicals to make that water clean and bacteria-free. There is that stuff, which is normally used by the water and sewage company, it is called water guard. You can buy it from the shop and the supermarkets as liquid in bottles for 20 bop [KSH]. So you pour 20ml to the 20 litres of water in the jericin [water container], you wait for 10 minutes, you stir well. And then you may wait for it to settle and then after 30 minutes, they say from the label, that it's good to be consumed. (...) But not so many people use it since they cannot afford. (...) A person who buys water possibly doesn't have money to treat.'* (Chemist)

Overall, 45% made use of other water treatment measures, such as filtering and 15% claimed to regularly clean their water storage. Given the amount of health-related risks associated with water in wetlands, the share of people using safe water was quite low. According to one interviewee from an in-depth interview,

*'The people get their drinking water from the river and they don't treat it. They don't know the meaning of clean water. They just drink it like this. (...) They know it is dirty.'* (co2)

In terms of protective measures related to sanitation, the situation seems less positive, as only 12% of the respondents mentioned frequent cleaning of their facility. Personal hygiene appeared to be a measure taken quite serious in the wetland when considering the observational assessment (Chapter 2.3.2.4) which revealed that 70% of the respondents



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were in a state of neat physical and hygienic appearance. According to one interviewee of the in-depth interview,

*'...the majority of the people do hygiene measures.'* (sh2)

*'The people wash their face completely, that's everything.'* (pa5)

However, only 14% claimed to frequently wash their hands after using a sanitation facility for health reasons and only 11% would regularly wash their hands with soap for the sake of not contracting diseases. 18% would regularly take baths in order to protect their health. In terms of food-related protective measures, 26% reported to cook their food before eating in order to prevent themselves from getting sick, and 16% would usually wash their food before consumption.

28% of the respondents interviewed reported to have and use bed nets in their households in order to protect themselves from mosquito-borne diseases:

*'Like against malaria you use nets. The majority of people use nets because there are so many mosquitoes around.'* (se1)

*'We are using mosquito nets. I bought mine at 300 bop [KSH]. This is not expensive.'* (sh1)

On top of that and with the same purpose, 14% tried to avoid stagnant water near the home in order to prevent breeding grounds for mosquitoes. Another measure mentioned to be adopted was the wearing of protective gears (gloves, gumboots etc.) as to not get ill during fieldwork. Moreover, milk is taken in order to prevent adverse health effects from inhaling the pesticides.

*'I use protective gears and apply the chemicals only with a pump. When I am done, I take milk. It kills the negative effect of the chemicals.'* (sh1)

*'We protect ourselves against the chemical contamination if money is there. And then, eggs and milk help to neutralize the chemicals in the body. Also, we force you to vomit to get the poison out of our body.'* (co4)

Moreover, the target population would use medicinal plants or prescribed medicine to maintain their bodies in a healthy state and make sure to not become ill.

*'To prevent ourselves from getting sick, we take medicinal herbs.'* (pa5)

*'For everything that they do, they [the pastoralists] use medicinal herbs in their cooking. They use a lot of herbs so they are actually more educated in terms of the protection more than the people who are not pastoralist. When a normal person who is not a pastoralist takes meat from a dead animal they would die as opposed to a pastoralist who will not get affected because they live so much in the wild and they have extensive knowledge on the herbs. And also their bodies are strong.'* (co3)

*'We use medicinal plants as cure and even for prevention.'* (pa2)

*'Even against malaria there are very bitter herbs, they are strong. If you continue using that, you cannot be infected. We even use it as prevention. See I stayed 5 years taking plants. The day I stopped I was affected by malaria. So it is important.'* (sh3)

Despite the health benefits of herbal medicine, one should be cautious in using them, as stated by a pastoralist interviewed in-depth. One should be aware of which herb to take and be careful in whose advice to trust.

*'Sometimes you may pick the wrong plant for your eyes and you end causing more damage or even blindness.'* (pa3)

*'Herbalists are commen.'* (sh3)

**Table 17: Preventive measures applied by respondents, stratified by user groups**

		Smallholder farmers (n=106)		Commercial farmers (n=95)		Pastoralists (n=99)		Service sector workers (n=100)		Total (n=400)		
		n	%	n	%	n	%	n	%	n	%	
<i>Type of measures</i>												
Water	Boiling water	68	74.7	74	<b>87.1</b>	43	<b>69.4</b>	79	84.0	264	79.5	
	Water treatment	43	47.3	41	<b>48.2</b>	23	<b>37.1</b>	43	45.7	150	45.2	
	Filtering water	3	3.3	9	10.6	13	21.0	8	8.5	33	9.9	
	Cleaning water storage	16	17.6	11	12.9	6	9.7	17	18.1	50	15.1	
Sanitation	Cleaning latrine	13	<b>14.3</b>	11	12.9	2	<b>3.2</b>	13	13.8	39	11.7	
	Handwashing latrine	26	28.6	14	16.5	4	6.5	3	3.2	47	14.2	
	Handwashing soap	15	16.5	8	9.4	3	4.8	10	10.6	36	10.8	
	Frequent bathing	20	22.0	16	18.8	7	11.3	17	18.1	60	18.1	
Food	Washing food	23	25.3	13	15.3	3	4.8	15	16.0	54	16.3	
	Cooking food	38	41.8	15	17.6	10	16.1	24	25.5	87	26.2	
General	Mosquito bed net	20	22.0	33	38.8	12	<b>19.4</b>	47	<b>50.0</b>	112	33.7	
	Prevent stagnant water	9	9.9	10	11.8	4	6.5	23	24.5	46	13.9	
	Protective gears	26	<b>28.6</b>	18	21.2	4	6.5	4	<b>4.3</b>	52	15.7	
	Traditional medicine	4	4.4	4	4.7	13	<b>21.0</b>	0	<b>0.0</b>	21	6.3	
	Prescribed medicine	2	2.2	2	2.4	5	8.1	1	1.1	10	3.0	

\*The outliers are printed in bold.

The share of people applying protective health measures widely differed among different groups in the Ewaso Narok Swamp. When stratifying the results from the household survey and assessment by user groups, particular patterns became visible. Overall, there was the tendency of people working in the service sector applying health-protective measures most, whereas the pastoralists apply them least. This generalization, however, oversimplifies the situation by large. Although the most striking discrepancy was in the use of improved water sources (93% among service sector workers versus 8% among pastoralists), personal hygiene (92% versus 53% among pastoralists), followed by use of improved sanitation (29% of the service sector workers versus 5% among pastoralists), the type of measures applied otherwise differed widely between the groups: people in the service sector and commercial farmers would rather boil and treat water, whereas pastoralists would rather filter it. Any group would undertake more measures with regard to sanitation than the pastoralists. This reflects their widespread lack of possessing a facility at all and their practice of open defecation. Personal hygiene, handwashing and bath-taking was less frequently reported by the pastoralists as well, which, given the great distance of their homesteads to water sources and their unsafe water storage, is not quite surprising, since water seems to be rather scarce. This could also explain the limited washing of food before

consumption when compared to other groups. In terms of mosquito nets, the pastoralists as well as the smallholder farmers use least and they also least prevent stagnant water near their home as a matter of preventive measure and again, the service sector workers would have the best preventive health behaviour. Regarding protective gears, obviously, the farmers would use way more during their work (24% of commercial versus 19% of the smallholder farmers), which is due to occupational characteristics of working in and with the water during agricultural activities as compared to the other two groups. Out of all groups, the pastoralists would by far use more traditional medicines in order to prevent diseases (21% compared to 4-5% among farmers and none among service sector workers).

**Table 18: Reasons for not applying preventive measures, stratified by user groups**

Reasons	Smallholder farmers (n=15/106)		Commercial farmers (n=10/95)		Pastoralists (n=37/99)		Service sector workers (n=6/100)		Total (n=68/400)	
	n	%	n	%	n	%	n	%	n	%
Lack of necessity	6	5.7	4	4.2	<b>14</b>	<b>14.1</b>	3	3.0	27	6.8
Lack of interest	3	2.8	2	2.1	<b>13</b>	<b>13.1</b>	0	0.0	18	4.5
Lack of knowledge	2	1.9	1	1.1	4	4.0	0	0.0	7	1.8
Lack of money	2	1.9	0	0	3	3.0	1	1.0	6	1.5
Limited infrastructure	1	0.9	2	2.1	1	1.0	0	0.0	4	1.0
Other priorities	1	0.9	1	1.1	1	1.0	1	1.0	4	1.0
Lack of effect	0	0.0	0	0.0	1	1.0	1	1.0	2	0.5

\* This table only includes the respondents that do not apply any preventive measures whatsoever, thus referring to a total of n=68, only.

Those respondents not applying any preventive health measures (n=68 in total) named several reasons (Table 18), including and sorted by the frequency of being mentioned: the lack of necessity, interest, knowledge, limited financial means and infrastructure. During the in-depth interviews, however, especially the lack of money was underlined as the main factor holding the people back from applying preventive health measures:

*'Most of the people do not have gumboots to protect themselves against diseases. Also, mosquito nets are not very common. They cost about 400 KSH, which is expensive for the people. People take unsafe water (...), because clean water from the government is very expensive, it is not affordable to the people.'* (sh4)

*'The people fetch river water, but might not treat it because they don't have money. They know it might be harmful to their bodies. They are suffering because they are not able. It is not because they are ignoring but because they are not able to put up taps.'* (CHW)

*'Of course the people will prefer to go to the dam [to fetch water] if they cannot afford to buy safe water, they go for the priorities. You don't have food, you have got more than three kids, you need water. While water is a few meters there they would prefer to go and collect water there at the dam and save the 15 bob [KSH] for tomatoes and for vegetables.'* (Chemist)

*'People are not being well as far as health is concerned, because of their economic status. There are diseases that can be prevented, but it requires some investments.'* (former PHO)

According to the former Public Health Officer who participated in this study, the limited health education among the people was one determinant factor for the low use of measures:

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*'Something I observe that the body and therefore personal hygiene if not taken care of and this is linked to health education. Because if you use an unprotected source, you expect that water not to be safe so you need to boil the water, wash your hands, after visiting the toilet. Many people don't do that. What I have seen is that education is the best solution for the problems that we are facing. (...) Also, somebody will find it difficult, just because of lack of understanding, to go more than 2kms to fetch water to sprinkle on the floor [for domestic hygiene]. If it consumes so much time to fetch water why should one waste it on the floor. But if somebody is well educated, he or she will understand the reason and will not find it difficult.'* (former PHO)

Besides, a perceived lack of effect of protective health measures would induce the people to not apply any. The pastoral group stood out in terms of lack of interest.

*'The people get their drinking water from the river. And then they don't treat it. They don't know the meaning of clean water. They just drink it like this. They don't treat the water. They know it is dirty. They just take.'* (co2)

## **4.2 Assessing the disease risks by approximation with self-reported symptoms**

In order to assess disease risks in the wetland, the respondents were requested to report symptoms which they had suffered from during a reference period of four weeks in February 2015 (=period prevalence). The self-reported burden of symptoms was strikingly high in the Ewaso Narok Swamp: out of all 400 individuals interviewed, 385 reported 1,421 symptoms, corresponding to 96 % suffering from ill-health and only 4% not reporting any condition (mean 3.55 symptoms / individual).

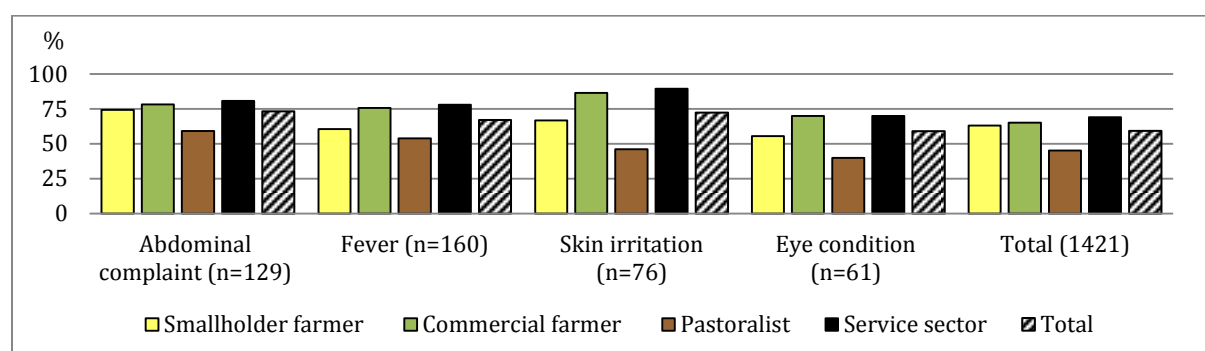
Flu occurred most often and among more than two thirds of all respondents (71%), and headache was very frequent as well (63%). Many respondents mentioned nausea (41%), fever (40%), and fatigue (38%). Abdominal complaints were prevalent among one third of all respondents (32%) during the four-week reference period, and so were, skin irritations (19%) and eye conditions (15%). Out of these preliminary 9 categories, 4 were considered to be analyzed in more detail. These included abdominal complaints, fever, skin irritations and eye conditions (Table 19). These were chosen since they were supposed to serve as proxies for diarrhoeal diseases, typhoid fever, malaria, and trachoma, reflecting different water-related disease pathways, all of which are real health threats in wetlands (Chapter 1.4.5). Whereas all four groups reported a similar prevalence of fever for the recall period, differences could be observed regarding the other symptoms and conditions: abdominal complaints were mostly reported by smallholder farmers (37%), skin irritation especially by smallholder (20%) and commercial farmers (24%) and eye conditions particularly by commercial farmers (19%) and pastoralists (20%). The pastoralists reported less abdominal complaints and skin irritations than any other group.

**Table 19: Self-reported symptoms in 4 weeks in February 2015, stratified by user groups**

	Smallholder farmers (n=106)		Commercial farmers (n=95)		Pastoralists (n=99)		Service sector workers (n=100)		Total (n=400)	
	n	%	n	%	n	%	n	%	n	%
<i>Self-reported symptoms</i>										
Abdominal complaints	<b>39</b>	<b>36.8</b>	31	32.6	27	27.3	32	32.0	129	32.3
Fever	42	39.6	38	40.0	39	39.4	41	41.0	160	40.0
Skin irritation	<b>21</b>	<b>19.8</b>	<b>23</b>	<b>24.2</b>	13	13.1	19	19.0	76	19.0
Eye condition	<b>20</b>	<b>18.9</b>	10	10.5	<b>20</b>	<b>20.2</b>	11	11.0	61	15.3

\*The outliers are printed in bold.

Everybody who had reported symptoms during the reference period was asked to state whether or not they had sought healthcare during this time. Out of the total of 1,421 symptoms reported, the health-seeking behaviour could be detected for all but nine reported symptoms. For about 60% (n=851 symptoms), healthcare was sought, while no provider was consulted for 561 symptoms (40%) (Figure 16). The utilization of healthcare differed according to the symptoms. Those suffering from abdominal complaints and skin irritations were most likely to seek healthcare (74% each). About two thirds of all respondents affected by fever (67%) made use of a healthcare provider. Half of those reporting eye conditions (52%) sought some kind of provider in the reference period. Differences became apparent between different groups.



**Figure 16: Health-seeking behaviour during last self-reported symptoms in February 2015, stratified by user groups [%]**

Overall, the service sector workers made most use of service providers (69%) and the pastoralists sought healthcare least often (45%). Regardless of the type of symptoms, the ones least likely to consult healthcare providers were the pastoralists and this pattern pervaded throughout all categories of symptoms. Mostly, service sector workers (fever, abdominal complaint, skin irritation) were the group that sought care more than others, in terms of eye conditions to the same degree as commercial farmers (70%). Not only the decision whether or not to seek healthcare differed according to the self-reported symptom and user group, but also the type of healthcare provision. In the Ewaso Narok Swamp, for those who decided to make use of a service provider, a public health facility (72%) was the most common without exception. Less sought care from private facilities (16%), chemists

(9%), and very few from faith-based providers such as the Catholic church or healers (3%) or non-governmental health providers<sup>38</sup> (1%).

*'Most people go to the hospital when they seek healthcare.'* (sh2)

*'Depending on the health condition, the people who are sick go to hospitals or clinic.'* (sh4)

The choices differed according to the symptoms (Table 20): While as for fever, chemists, faith-based and non-governmental providers had an equally low meaning in terms of seeking behaviour, chemists became important to help treating eye conditions (13% compared to 16% treated by private facilities). Faith-based providers were a bit more important for the inhabitants of the Ewaso Narok Swamp that were troubled with skin irritations (5% compared to 7% treated by chemists).

The choice of care provider also differed according to different user groups (Table 21, Photo 9). Although the vast majority of smallholder farmers (75%), commercial farmers (60%), pastoralists (66%) and service sector workers (84%) went to public facilities for healthcare, the percentages differed much between the groups. For all four groups, private facilities were the second leading choice, although, as well as for the public services, the share of the group making use varied very much (25% among commercial farmers at most versus 10% of service sector workers).

**Table 20: Health-seeking behaviour, stratified by symptoms [%]**

	Abdominal complaint (n=95)	Fever (n=107)	Skin irritation (n=56)	Eye condition (n=32)	Total (n=851)
<i>Healthcare provider</i>					
Public health facility	65.3	78.5	71.4	65.6	72.2
Private health facility	20.0	17.8	16.1	15.6	15.7
Chemist	10.5	1.9	7.1	12.5	8.5
Faith-based health provider	3.2	1.9	5.4	3.1	3.0
Non-governmental provider	1.1	0.0	0.0	3.1	0.7

**Table 21: Choice of healthcare provider, stratified by groups [%]**

	Smallholder farmers	Commercial farmers	Pastoralists	Service sector workers
<i>Healthcare provider</i>				
Public health facility	74.9	48.3	66.2	83.6
Private health facility	14.5	24.6	13.4	9.5
Chemist	8.0	11.4	12.1	6.8
Faith-based health provider	1.5	3.8	7.6	0.0
Non-governmental provider	1.1	0.0	0.6	0.0

For the pastoralists, private health facilities and chemists were almost equally important providers (13% versus 12%, respectively) and faith-based providers and healers were more important (8%) than for others (2% among smallholder farmers and 0% among service sector workers). Non-governmental providers played a very limited role in the wetland.

<sup>38</sup> Non-governmental providers in the Ewaso Narok Swamp include organizations such as the African Medical and Research Foundation (AMREF), which provides care in remote settings and for marginalized communities.





a. A traditional healer presenting his herbal medicines.



b. Medicinal plants offered at the market in Rumuruti.



c. A chemist / pharmacy in Gatundia.



e. Plant used for treatment of malaria in the Ewaso Narok Swamp (2015, 2016).

CITIZEN SERVICE DELIVERY CHARTER				
PHARMACY SERVICE		REQUIREMENTS	DEPARTMENT	
COMMON DRUGS	PAYMENT	PRESCRIPTION	CHARGES (KSHS)	
			WAITING TIME	
• ANTIBIOTICS	"	"	20-30	5-10 MINUTES
• SPECIAL DRUGS	"	"	50-150	"
• ANTI-TB DRUGS	"	"	FREE	"
• DEWORMERS	"	"	FREE	"
• UNDER 5 YEARS	"	"	FREE	"

**USILIFE HAPA.**  
**HUDUMA BORA NI HAKI YAKO**

d. Health services offered at the Rumuruti district hospital.

**Photo 9: Healthcare options in the Ewaso Narok Swamp**

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When stratifying the results by provider, very small-scale and detailed information become visible. While the ratio of different groups using public health facilities for self-reported symptoms is rather balanced (32% of smallholder farmers versus 30% of service sector workers, 21% of commercial farmers, and 17% of pastoralists) the differences are bigger when considering the other service providers utilized in the Ewaso Narok Swamp. For those using chemists when suffering from any symptoms (n=79), the proportional distribution is about the same (30% of commercial farmers at most versus 19% of service sector workers at lowest). The ratio of groups using private facilities for self-reported symptoms (n=132) is unbalanced with 39% accounted for by commercial farmers compared to much lower shares among smallholder farmers (29%), pastoralists and service sector workers (16% each).

The use of faith-based providers during self-reported symptoms (n=24) was even more uneven. Whereas half of all respondents that seek care from such providers (50%) are pastoralists, only 33% of commercial farmers and 17% of smallholder farmers use faith-based providers. Not a single service sector worker reported to do so. Non-governmental health providers were sought by very few respondents (n=4), out of which three were smallholder farmers and one was a pastoralist. Commercial farmers and service sector workers claimed to not have used these providers at all. Not seeking healthcare providers in the Ewaso Narok Swamp had multiple causes.

The most common reason was the self-treatment of respondents (55%), either with herbs or milk (29%) or with medicine and drugs (26%).

*'If you don't have money you take medicinal plants. You can take it even as prevention for your body. Also herbalists are common. The plants are here, like those big trees.'* (sh3)

One third of those reporting symptoms but not seeking providers saw no need, as they assessed their health good enough to continue without any treatment. Some of the respondents claimed to be limited by financial barriers (8%) of care-seeking, or by the physical distance to or inaccessibility of healthcare facilities (1%). Thus, instead of remaining completely untreated, the people would apply medicinal plants as an alternative self-healthcare option:

*'A big challenge is that the hospitals are so far away. The only hospital is here in Rumuruti, and again, if you don't have the means for the transport, you have a problem.'* (co4)

*'If people cannot go to the hospital, if they don't have money, they take herbals. There are so many hardships here; many people don't have money here.'* (se1)

*'Another problem is when we get sick we do not have easy access to the hospital apart from Rumuruti, which is very far. So we treat the people with medicinal herbs.'* (pa3)

*'When the people fall sick, from typhoid or so, they just go to the hospital in Rumuruti. It is far. Very far. Not everybody can afford to go. So many take herbs from the bush.'* (co2)

Just like the choice of the type of care provider, the reasons for not seeking any healthcare providers are associated with and differ according to the type of self-reported symptom

(Table 22). While for some self-reported symptoms, seeking care was not considered very necessary by a large percentage of respondents (42% for eye conditions, 37% for skin irritation), likely because the adverse health effect was not too big or because the situation was not considered severe, for others the situation was different. Not consulting healthcare providers in such cases did not imply to forego being treated. Treatment, however, was done by the individuals themselves. Self-treatment played a vital role for those reporting fever (75% in total, same shares of self-treatment with pharmaceutical medicine and medicinal herbs) and abdominal complaints (68%, consisting of 35% herbal and 33% pharmaceutical medicine).

*'You can cure stomachaches and even malaria and headaches. When you feel you are weak, you help yourself, you get those herbs from the bush.'* (co2)

*'I had used a certain herb. I can't tell you [the name in English] but I'll tell you, this one acts as Erythromycin, it's so bitter. You just pick the leaves and then you mash them, you crush them and then you add some water just cold water, give teaspoon in the morning and afternoon and then in the evening. [You use it] mostly [for] malaria. For abdominal disorders; you find that this one [showing another plant] also acts the same, it does the same same work, this one. (...) I was shown by my grandmother, you see my grandmother was herbalist so she showed me this, this one, I can't tell its name but most of the times, we do this the leaves, the leaves not the roots but the leaves, dry them, crush them.'* (co1)

*'When people are ill they take medicinal herbs. Like this one is for the stomach, if your stomach has pain, you remove the skin of this one then you boil 10 minutes then chew. The leaves and the back. You can take it both for prevention and cure.'* (pa3)

On an average, the lack of means prevented 8% of the respondents from seeking care. The numbers, however, differed according to the symptoms which may reflect also the priority setting and severity of a health condition.

**Table 22: Reasons for not seeking healthcare, stratified by symptoms [%]**

	Abdominal complaint (n=34)	Fever (n=53)	Skin irritation (n=19)	Eye condition (n=26)	Total (n=561)
<i>Reasons</i>					
Self-treatment with medicine	32.4	28.3	26.3	7.7	26.1
Self-treatment with herbs / milk	35.3	37.7	36.8	23.1	29.1
No necessity	23.5	28.3	36.8	42.3	36.0
No money	8.8	5.7	0.0	23.1	7.5
Distance to facility	0.0	0.0	0.0	3.8	1.3

**Table 23: Reasons for not seeking healthcare, stratified by user groups [%]**

	Smallholder farmers	Commercial farmers	Pastoralists	Service sector workers
<i>Reason</i>				
Self-treatment with medicine	34.0	34.0	13.0	<b>48.0</b>
Self-treatment with herbs / milk	11.0	8.0	<b>67.0</b>	4.0
No necessity	47.0	45.0	12.0	47.0
No money	8.0	11.0	5.0	1.0
Distance to facility	0.0	2.0	3.0	0.0

\*The outliers are printed in bold.

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Whereas 23% of those not seeking care when troubled with eye conditions due to financial constraints, only 9% mentioned this reason in terms of abdominal complaints. None would mention money as representing an insurmountable hurdle for care-seeking when suffering from skin irritations.

When comparing the different user groups in terms of their reasons for not seeking care providers, greatest differences became visible (Table 23). Although the smallholder and commercial farmers had relatively similar reasons not to seek care (47% versus 45% seeing no necessity in seeking healthcare, 34% using pharmaceutical medicine in both groups, 11% and 8% using medicinal herbs, 8% and 11% being hindered by financial barriers and 0% of smallholders versus 2% of commercial farmers hindered by distance), the differences compared to the service sector workers and pastoralists were tremendous. For the service sector workers, pharmaceutical medicine was the major alternative to seeking healthcare and thereby played the most important role compared to any other group (48% compared to 34% of the farmers and 13% of the pastoralists), while distance to facilities or money were no barriers. The pastoralists, on the other hand, attached the greatest importance to herbal medicine and milk to treat symptoms when not seeking care providers (67% compared to 11% or less among all other groups).

*'People who would like doing herbal medication are Samburu and Turkana [pastoral tribes], the other tribes would rather got to the hospital than use medicinal herbs.'* (co3)

*'The Samburu and the Masai [pastoral tribes] do not like going to the hospital, they like using medicinal plants.'* (pa3)

*'We [referring to pastoralists in general] give them [people who are ill] what we call herbal clinic. Every tree here, like that one, you cut the stem and remove its bark, put in some water and it changes the color, you remove and drink it. For malaria, for example, we have got another herb our old parents know.'* (pa4)

*'We have medicinal plants and we have livestock so we slaughter one or two and we mix it with herbs and then we take and feel better. We make a soup, or we can use the blood and the milk. The farmers do not know these medicinal plants, sometimes they ask us. Some pastoralists even go to the market in town to sell these plants, but the farmers there who live there do not know about these plants. Only the livestock keepers who live at the centers in town actually buy them.'* (pa5)

In some cases, the effectiveness of medical attention was rated as ineffective, not sufficient or even useless, which is why people shifted from having sought healthcare at health facilities to self-treatment with herbs:

*'Even this typhoid that we are getting even if it is treated [by healthcare providers] we don't get healed, so we take medicinal herbs.'* (sh3)

Not only would they apply for themselves when suffering from ill-health, but also would they feed them to their ill livestock:

*'Livestock also gets ill.'* (pa3)

*'We use medicinal herbs to cure the sick livestock.'* (pa5)

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Overall, the pastoralists considered few self-reported symptoms as unnecessary to be treated (12% compared to 45% and above among other groups).

The stratification by reason for not seeking healthcare allows for display of the ratio of reasons differing between different groups, even very small-scale. It reveals patterns that describe smallholder and commercial farmers as rather similar in terms of their reasons for not seeking care, and service sector workers (herbal medicine, money, distance) and pastoralists (herbal medicine, no necessity, distance) as extremes. Out of all symptoms self-treated with pharmaceuticals, the ratio is about equal between smallholder farmers (31%) and service sector workers (30%), whereas the commercial farmers, in comparison, use slightly less (25%). The pastoralists make up the group that least self-treats with pharmaceuticals (14%). However, they are most active in using herbal medicine (80% compared to 11% among smallholders or less among others).

Stating that symptoms were not necessary to be treated was most common among smallholder farmers (36%). Commercial farmers (28%) and service sector workers (26%) also assessed their symptoms as not severe enough to be treated, while this reason was less common among pastoralists (11%). While the ratio of those that had money as barrier for care seeking was relatively even between most groups (38% at most among commercial farmers versus 27% at least among pastoralists), only 3% of service sector workers mentioned this. Distance prevented few from seeking care (n=8), mostly pastoralists.

Several experts interviewed expressed their concerns about the limited health-seeking in the Ewaso Narok Swamp. The community health worker described the priority setting among people who struggle with financial constraints in detail, which often is to the disadvantage of them seeking care.

*'The people are suffering from diseases but they don't have any money to go to the hospital and to get treatment. At a facility you pay 50 bob [KSH]. That is for administration. Then after that it will depend on the disease. Being told to go to the laboratory that is where things become bad, since they are charging very much. So people might not be going to a health facility. It is not because they are not sick. People are sick but they don't go to hospital because they don't have money. They have to set priority. If you need food, you prefer to buy some unga [maize flour] and rely on the free traditional medicines from the bush.'* (CHW)

Moreover, limited health education was made responsible for not seeking healthcare, as described in the following:

*'If you are not educated you do not realize a disease, you may not notice. Here I believe ignorance is a major cause of this high mortality rate of children because if diseases occur, you find that the parents cannot notice when the child's temperature is rising, and when to take that kid to the hospital.'* (former PHO)

The coverage was reported to be a problematic shortcoming in terms of healthcare service provision in the Ewaso Narok Swamp, as reported by the former Public Health Officer:



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*'So, the challenge is we don't have the required health facilities, they are not enough. They are readily available so I don't think that is an issue. But the problem is the distance. That could be a very big issue because of the time and the cost...'* (former PHO)

A potential adverse consequence of not seeking healthcare, very relevant and problematic for the healthcare system, was formulated by the chemist:

*'Possibly, they [the wetland users] can go unreported because in those swampy areas, mostly they don't come up to the health centre; not unless they are critically ill. They know it is there but they cannot go to the hospital because they cannot afford, because it is so far and you know and when they do diagnose it's too late and possibly patients don't survive.'* (Chemist)

As not seeking healthcare is common, but would in severe conditions be recommendable,

*'...[the community health workers] are trying to advise and insist them [ill people] to visit health facilities, even those whose culture might not allow to do so. Many people are coward and don't dare to go to the doctor's and think they might be charged a lot of money. Now with our advice as mashinani daktari's [community doctors] people are cooperative.'* (CHW)

The alternative medical option used by many of the respondents, namely traditional medicine, was promoted by the traditional healer<sup>39</sup> interviewed. He claimed that each possible disease could be cured by herbs from the swamp and its surroundings, including those that were subject to this study: typhoid, malaria, diarrhoeal diseases:

*'Herbs are an alternative medicine. Some people do go to the hospital for a long time without being cured, so they transfer, they seek alternative medicine, just herbs. (...) There are so many diseases that can be cured. We got a medicine which can cure the negative in 3 days only. So now we got another one for malaria, which treats malaria within 3.5 hours. If you take the medicine for 6 days, you can have a guarantee of 20 years without malaria. It is true. The medicine is all around me, there is no need to go to the chemist. The medicines are very good because of this sun, they grow slow, they are better than in the highlands.'* (Herbalist)

He described himself able to use traditional practices, measures, ingredients and procedures to gut against disease, to leave suffering and to cure and moreover, he mentioned to be enrolled in research on herbal medicine, claiming to invent the medicine. The community health worker participating in this study also swore by herbal medicine. However, this enthusiasm is not necessarily shared by those in need for cure.

*'Here they don't understand me. A prophet cannot be recognized by his people. There was a time when I went around to cure the people, [but now] I travel far.'* (Herbalist)

The former Public Health Officer, however, would neither believe in the power of medicinal herbs as described by the herbalist, nor in his research capacities:

*'Me personally, I don't trust them. [The medicinal plants] won't work. I don't believe in somebody who has not been trained in anything to do with disease, who has never seen a class of a medical school? How did he learn this information? Although some learn from their parents. It is just the traditional belief and a lack of knowledge.'* (former PHO)

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<sup>39</sup> The herbalist possessed a certificate of the Traditional Development Medicine Agency, making him a herbal doctor.

### 4.3 Modelling health risks by self-reported symptoms in the Ewaso Narok Swamp

The data on the types of wetland use, the situation of water, sanitation and hygiene, as well as the preventative measures undertaken by the wetland users are linked with self-reported symptoms in the following. Univariate and multivariate models for abdominal complaints, fever, skin irritations and eye conditions were calculated, with all odds ratios fully provided in the digital annex of this work and significant results highlighted in the respective tables.

#### 4.3.1 Risk factors linked to wetland users' abdominal complaints

The univariate analysis revealed that the risk of contracting abdominal complaints was closest associated with domestic water supply, sanitation and hygiene and with related health and hygiene behaviour (Table 24). Whereas an unsafe water source such as water purchased from a vendor would significantly increase the odds of self-reported abdominal complaints by 7.5, a safe source such as a private tap water would reduce the risk by the factor 0.6.

**Table 24: Univariate abdominal complaint risk factor model**

	Total (n=400)		OR	Abdominal complaints		
	n	%		CI 95%		p-value
				low	up	
<i>Risk factors</i>						
Female vs. Male	171	42.8	1.440	0,944	2.199	0.090 .
Primary incomplete	100	25.0	1.508	0,984	2.526	0.057 .
Middle SES	128	32.0	1.733	1,114	2.692	0.014 *
Smallholder farmer	106	26.5	1.319	0,824	2.097	0.244
Start after 1975 until 1995	95	31.7	1.649	0,988	2.746	0.054 .
Vendor water****	15	4.0	7.481	2,585	26.999	0.001 ***
Boiling water	264	79.5	1.828	0,997	3.523	0.059 .
<i>Protective factors</i>						
No formal education	124	31.0	0.679	0,421	1.079	0.107
Pastoralist	99	24.8	0.732	0,437	1.198	0.223
Start before 1975****	21	7.0	0.328	0,075	0.999	0.079 .
Private tap	90	23.9	0.614	0,353	1.034	0.074
Discontinuous	56	14.0	0.529	0,258	1.011	0.065 .
Negative water score	117	38.2	0.724	0,429	1.204	0.218
Positive environment score	159	40.4	0.727	0,466	1.125	0.156
Cleaning latrine	39	11.7	0.435	0,171	0.968	0.056 .
Preventing stagnant water	46	13.9	0.227	0,076	0.543	0.002 **

Significance levels: \*\*\* =  $p\text{-value} \leq 0.001$ ; \*\* =  $p\text{-value} \leq 0.01$ ; \* =  $p\text{-value} \leq 0.05$ ; . =  $p\text{-value} \leq 0.1$

\*\*\*\* n is very small.

The significant factors are marked in yellow.

A clean domestic surrounding would reduce abdominal complaints by 0.7, the regular cleaning of a sanitation facility by 0.4, and the prevention of stagnant water near the home would significantly protect from the symptom by 0.2. Moreover, wetland-use-related aspects mattered: smallholder farmers had a 1.3 higher risk of abdominal complaints compared to other groups, whereas the pastoralists were less at risk at 0.7. Individuals who

had started using the Ewaso Narok Swamp before 1975 had a 0.3 lower risk. Sociodemographic factors such as gender (1.4 increased risk among women), incomplete primary education (1.5 higher odds) and socioeconomic status (1.5 significantly increased odds for those with middle SES) contributed to the contraction of self-reported abdominal complaints also. Neither the distance to the Ewaso Narok Swamp, nor to the nearest river, played a role in the exposure to or prevention of the risk.

Several factors were surprising, such as boiling water before drinking increasing the risk by 1.8 and such as a lack of formal education reducing the risk by the factor 0.7, a negative water score by 0.7 and discontinuous water supply by 0.5 (Chapter 6.5).

### 4.3.2 Risk factors linked to wetland users' fevers

Fever was mainly associated with wetland use for irrigated agriculture, increasing the risk by 1.5 (Table 25). Moreover, the time of use was significantly determining the risk in terms of increase by use in the afternoon (1.5) or decrease in the case of use in the morning (0.5).

**Table 25: Univariate fever risk factor model**

	Total (n=400)		OR	Fever CI 95%		p-value	
	n	%		low	up		
<i>Risk factors</i>							
Primary education incomplete	100	25.0	1.316	0.831	2.079	0.239	
1 to 3 children	222	55.5	1.417	0.945	2.131	0.093	.
Irrigation water from wetland	165	55.0	1.450	0.909	2.325	0.121	
Wetland use in the afternoon	33	15.1	2.198	1.043	4.735	0.040	*
Public tap drinking water****	13	3.5	1.602	0.898	2.856	0.109	
Wetland drinking water	54	14.4	1.412	0.793	2.502	0.237	
Supply dirtier than usual	69	17.3	1.372	0.811	2.312	0.236	
Boiling water before drinking	264	79.5	1.448	0.832	2.582	0.199	
Taking traditional medicine****	21	6.3	1.775	0.727	4.383	0.205	
<i>Protective factors</i>							
No formal education	124	31.0	0.652	0.416	1.011	0.059	.
4 or more children	92	23.0	0.750	0.458	1.211	0.245	
Wetland water for domestic use	223	74.3	0.629	0.372	1.063	0.082	.
Wetland use in the morning	186	84.9	0.455	0.211	0.959	0.040	*
501-1500m distance to river	82	20.5	0.683	0.405	1.130	0.144	
Private tap drinking water	90	23.9	0.650	0.391	1.059	0.088	.
River drinking water	137	36.4	0.735	0.481	1.116	0.151	
Negative water score	117	38.2	0.661	0.403	1.072	0.097	.
Negative sanitation score	141	41.1	0.748	0.478	1.165	0.202	
Cooking food before consumption	87	26.2	0.620	0.365	1.035	0.072	.
Handwashing after latrine use	47	14.2	0.549	0.269	1.062	0.085	.
Cleaning latrine regularly	39	11.7	0.574	0.265	1.168	0.140	
Use of mosquito bed net	112	33.7	0.635	0.391	0.019	0.063	.
Preventing stagnant water near home	46	13.9	0.283	0.119	0.599	0.002	*
Taking prescribed medicine****	10	3.0	0.166	0.009	0.900	0.091	.

Significance levels: \*\*\* =  $p\text{-value} \leq 0.001$ ; \*\* =  $p\text{-value} \leq 0.01$ ; \* =  $p\text{-value} \leq 0.05$ ; . =  $p\text{-value} \leq 0.1$

\*\*\*\* n is very small.

The significant factors are marked in yellow.



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Water, sanitation and hygiene were important factors both in terms of risk and prevention of fever: whereas using public taps as main water sources increased the odds by 1.6, wetland water by 1.4, and a dirtier than usual water supply by 1.4, respectively, the use of private taps would reduce the risk (0.7).

Washing hands after the use of the latrine reduced the risks by 0.5, as did regular cleaning of the sanitation facility (0.6). Food hygiene in terms of cooking food before eating reduced the fever risk by 0.6, and so did the use of mosquito bed nets by 0.6, the prevention of stagnant water near the home (0.3) and the intake of medicine (0.2). Both the education (increased risk for those with incomplete primary education by 1.3) and number of children (fewer increasing the risk by 1.4, more reducing the risk by 0.6) were aspects that influenced the risk of contracting fever, whereas socioeconomic status did not play a role. Living rather close to a river would reduce the risk of fever by 0.7.

The increase of fever risk due to the intake of traditional medicine (1.8), as well as drinking river water reducing the risk by 0.7, using wetland water for domestic purposes by 0.6, negative water score by 0.7, negative sanitation score by 0.7 and a lack of formal education by 0.7, were all surprising results (Chapter 6.5).

#### **4.3.3 Risk factors linked to wetland users' skin irritations**

The univariate analysis indicated that the risk of skin irritations (Table 26) was increased by the agricultural use of the Ewaso Narok Swamp for crop production (1.5), especially among commercial farmers (1.5) and for those applying chemical fertilizers to their fields (1.4 increased risk). Moreover, water source, supply sanitation and environmental hygiene mattered. Using drinking water from the vendor would increase the skin irritation risk by 2.4, as did discontinuous (1.9 increased odds ratio) and too little water supply (1.5 increase). Safe water supply by private taps reduced the risk of skin irritations by the factor 0.7, and the same kind of water supply as usual also (0.6). The possession of a sanitation facility reduced the risk by 0.2, and a positive sanitation score, indicating a high level of sanitation hygiene, also by 0.2. Poor environmental hygiene around the house accelerated the risk by 1.5, whereas the prevention of stagnant water by the house reduced the risk by 0.6. Again, the level of education had relevance in terms of risk, as incomplete primary education would increase the risk of skin irritation by 1.5. The distance to the wetland or the nearest river or stream did not influence the risk of skin irritations.

Several factors' impact on the risk of skin irritations, such as the protective factors low socioeconomic status (0.5 reduced risk), wetland water for domestic use (0.6 reduced risk) and large number of children (0.6 increased risk) as compared to few children increasing the risk of skin irritations (1.7) were surprising (Chapter 6.5).

**Table 26: Univariate skin irritation risk factor model**

	Total (n=400)		OR	Skin irritations		p-value	
	n	%		low	up		
<i>Risk factors</i>							
Primary incomplete	100	25.0	1.506	0.860	2.584	0.143	
1 to 3 children	222	55.5	1.699	1.017	2.897	0.046	*
Possession of TV	141	35.3	1.642	0.984	2.726	0.056	.
Possession of motorcycle	73	18.3	1.518	0.814	2.736	0.175	
Middle SES	128	32.0	1.612	0.957	2.692	0.069	.
Commercial farmer	95	23.8	1.519	0.861	2.623	0.140	
Crop production in wetland	235	78.3	1.597	0.769	3.660	0.235	
Use of chemical fertilizers	157	52.3	1.442	0.807	2.617	0.221	
Vendor drinking water****	15	4.0	2.439	0.817	6.638	0.089	.
Supply discontinuous	56	14.0	1.893	0.974	3.550	0.052	.
Supply too little	43	10.8	1.544	0.711	3.140	0.247	
Negative environment score	79	20.1	1.465	0.796	2.612	0.206	
<i>Protective factors</i>							
4 or more children	92	23.0	0.572	0.282	1.079	0.100	
Possession of sanitation facility	37	9.3	0.223	0.036	0.755	0.042	*
Low SES	139	34.8	0.477	0.259	0.839	0.013	*
Wetland water for domestic use	223	74.3	0.627	0.339	1.188	0.143	
Private tap drinking water	90	23.9	0.662	0.333	1.233	0.213	
Supply same as usual	232	58.0	0.628	0.379	1.037	0.069	.
Positive sanitation score	37	10.8	0.216	0.035	0.735	0.039	*
Preventing stagnant water near home	46	13.9	0.565	0.207	1.304	0.216	
Use of traditional medicine****	21	6.3	0.406	0.064	1.449	0.234	

Significance levels: \*\*\* =  $p\text{-value} \leq 0.001$ ; \*\* =  $p\text{-value} \leq 0.01$ ; \* =  $p\text{-value} \leq 0.05$ ; . =  $p\text{-value} \leq 0.1$

\*\*\*\* n is very small.

The significant factors are marked in yellow.

#### 4.3.4 Risk factors linked to wetland users' eye conditions

The kind of wetland use appeared to be relevant in terms of the risk of contracting eye conditions as was confirmed by the univariate analyses (Table 27). Overall, wetland users had a 1.6 higher risk than service sector workers. When stratified by groups, the pastoralists had a 1.6 higher risk of eye conditions, and smallholder farmers 1.4. Working as a commercial farmer served as a protective factor in terms of eye conditions, they had a reduced risk at the factor 0.6. The use of chemical fertilizers had a protective effect (0.7), and so did the use of manure in agricultural production (0.5). The distance of the respondents' homesteads to the nearest river or the wetland would also determine risk, with distance to river increasing the risk and proximity to swamp reducing the risk by 0.6. Moreover, a safe water source such as tap water for drinking reduced the risk by 0.6, as well as the use of mosquito bed nets (0.5 reduction).

Eye conditions were associated with numerous sociodemographic and socioeconomic factors. Not only would women be more susceptible (1.7) than men, but also would age increase the risk by 1.02 per year, would a lack of formal education cause a 1.6 higher risk and a middle SES a 1.6 risk, respectively. A high SES, on the other hand, turned out to be

protective (0.6), as well as education (0.5 reduced risk with complete primary education) and small households (0.7 less risk).

**Table 27: Univariate eye condition risk factor model**

	Total (n=400)		OR	Eye conditions		p-value	
	n	%		CI 95%	low		
<i>Risk factors</i>							
Female vs. male	171	42,8	1,717	0,993	2,986	0,053	.
Age (per year)			1,024	1,004	1,044	0,016	*
No formal education	124	31,0	1,550	0,873	2,712	0,128	
No children	86	21,5	1,668	0,889	3,035	0,101	
Middle SES	128	32,0	1,591	0,901	2,776	0,104	
User versus service sector workers	300	75,0	1,618	0,834	3,399	0,175	
Smallholder farmer	106	26,5	1,435	0,785	2,557	0,229	
Pastoralist	99	24,8	1,605	0,876	2,870	0,116	
Distance to river (per km)			1,072	0,995	1,152	0,059	.
Cooking food before eating	87	26,2	2,139	1,129	3,994	0,018	*
Frequent bathing	60	18,1	1,539	0,725	3,090	0,240	
Traditional medicine****	21	6,3	3,116	1,126	7,951	0,020	*
<i>Protective factors</i>							
Education (per year)			0,954	0,907	1,003	0,070	.
Primary complete	176	44,0	0,524	0,287	0,927	0,030	*
4 or less HH members	168	42,0	0,686	0,382	1,101	0,195	
Children in household (per child)			0,901	0,763	1,056	0,208	
Possession of TV	141	35,3	0,609	0,327	1,101	0,112	
Possession of running water	243	60,8	0,619	0,357	1,073	0,086	.
High SES	133	33,3	0,611	0,318	1,116	0,121	
Commercial farmer	95	23,8	0,586	0,270	1,159	0,146	
Service sector workers	100	25,0	0,618	0,294	1,199	0,175	
Use of chemical fertilizers	157	52,3	0,669	0,360	1,230	0,198	
Use of manure	166	55,3	0,524	0,281	0,966	0,040	*
0-500m distance to swamp	92	23,0	0,615	0,283	1,218	0,186	
Private tap drinking water	90	23,9	0,635	0,292	1,259	0,218	
Use of mosquito bed net	112	33,7	0,505	0,237	0,999	0,060	.

Significance levels: \*\*\* =  $p\text{-value} \leq 0.001$ ; \*\* =  $p\text{-value} \leq 0.01$ ; \* =  $p\text{-value} \leq 0.05$ ; . =  $p\text{-value} \leq 0.1$

\*\*\*\* n is very small.

The significant factors are marked in yellow.

Surprisingly, the intake of traditional medicine increased the risk of eye conditions by 3.1, as well as frequent bathing (1.5). An increase in number in children per household would reduce the risk of eye condition, whereas a lack of children would increase the risk (Chapter 6.5).

## 4.4 Modelling wetland-related disease risks by approximation with symptoms

Multivariate models were built for the wetland-related infectious diseases diarrhoea, malaria, typhoid and trachoma by approximation with self-reported symptoms serving as proxies (Table 28, Figure 17) based on the literature review on exposure and diseases transmission (Chapter 3).

**Table 28: Multivariate modelling of wetland-related infectious disease risks: considered variables**

<b>Model 1</b>		<b>Approximated diarrhoea risk</b>			
		CI 95%			
Independent variables	OR	low	up	p-value	
Incomplete primary education	1.960	1.144	3.356	0.014	*
Middle SES	1.651	0.981	2.771	0.058	.
Drinking water from the vendor	6.710	2.133	25.774	0.002	**
Regular cleaning of sanitation facility	0.347	0.130	0.810	0.022	*
Preventing stagnant water near home	0.251	0.083	0.614	0.006	**
Model 1 includes abdominal complaints as the dependent variable, and the five above mentioned independent variables as predictors; n=332.					
<b>Model 2</b>		<b>Approximated malaria risk</b>			
		CI 95%			
Independent variables	OR	low	up	p-value	
Irrigated agriculture in wetland	2.096	1.077	4.173	0.032	*
Wetland use in the afternoon	2.201	0.882	5.687	0.094	.
Use of mosquito bed nets	0.681	0.322	1.407	0.305	
Preventing stagnant water near home	0.191	0.042	0.627	0.013	*
Model 2 includes fever as the dependent variable, and the four above mentioned independent variables as predictors; n=117.					
<b>Model 3</b>		<b>Approximated typhoid fever risk</b>			
		CI 95%			
Independent variables	OR	low	up	p-value	
Irrigated agriculture in wetland	1.727	0.995	3.039	0.055	.
Handwashing after latrine use	0.537	0.248	1.104	0.100	
Preventing stagnant water near home	0.285	0.079	0.808	0.030	*
Model 3 includes fever as the dependent variable, and the three above mentioned independent variables as predictors; n=238.					
<b>Model 4</b>		<b>Approximated trachoma risk</b>			
		CI 95%			
Independent variables	OR	low	up	p-value	
Distance to river (per km)	1.087	0.982	1.197	0.096	.
Use of traditional medicine	2.479	0.840	6.772	0.084	.
Possession of running water at home	0.626	0.324	1.229	0.167	
Model 4 includes eye conditions as the dependent variable, and the three above mentioned independent variables as predictors; n=332.					
<b>Model 5</b>		<b>Approximated skin disease risk</b>			
		CI 95%			
Independent variables	OR	low	up	p-value	
Commercial farmer	1.533	0.861	2.673	0.138	
Supply discontinuous	2.349	1.181	4.549	0.012	*
Possession of a sanitation facility	0.182	0.029	0.636	0.023	*
Model 5 includes skin irritations as the dependent variable, and the three above mentioned independent variables as predictors; n=400.					

Significance levels: \*\*\* =  $p\text{-value} \leq 0.001$ ; \*\* =  $p\text{-value} \leq 0.01$ ; \* =  $p\text{-value} \leq 0.05$ ; . =  $p\text{-value} \leq 0.1$

OR = Odds ratio

CI=Confidence interval

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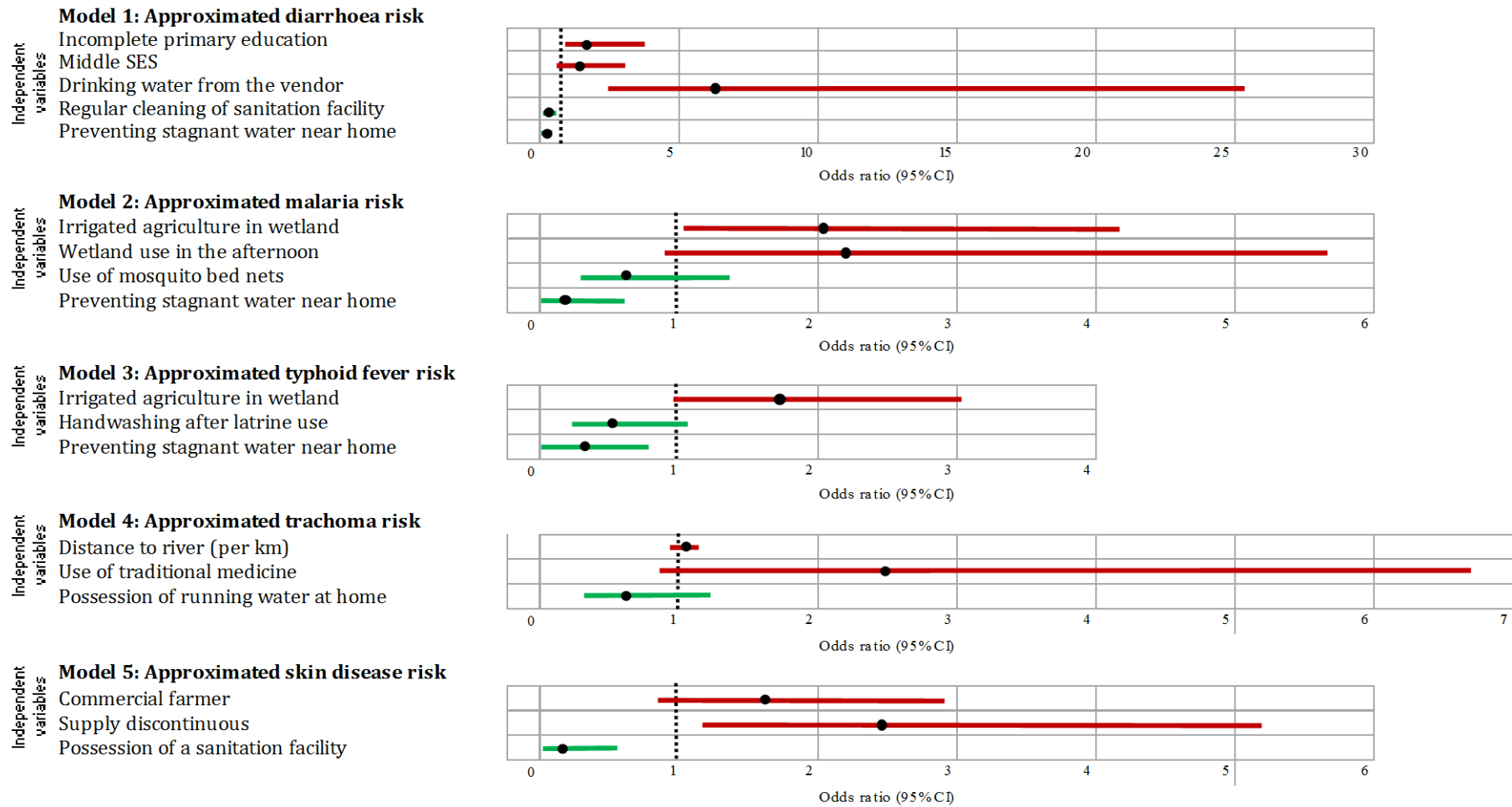
The models would only consider those independent variables which would remain statistically significant ( $p\text{-value} \leq 0.05$ ) after computing, and those which are very plausible, which is why fewer variables than in the univariate models were included.

As outlined before, self-reported abdominal complaints were used as a proxy for modelling the burden of diarrhoeal diseases in the investigated wetland population. The multivariate diarrhoea model revealed that drinking water from the vendor increased the risk of contracting diarrhoea by the factor 6.7, with other factors contributing to the risk being an incomplete primary school education (1.9 increased risk), and middle SES (1.7). Protective factors included the regular cleaning of the domestic sanitation facility, which reduced the risk by the factor 0.4 as well as the prevention of stagnant water sources near the home, reducing the risk by 0.3.

Self-reported fever served as a proxy for modelling the burden of malaria in the Ewaso Narok Swamp and aspects that increased the risk included irrigation activities (2.1 increased risk) and the use of the swamp in the afternoon (2.2). The prevention of stagnant water sources on the compound reduced the risk of contracting malaria by the factor 0.2 and so did the use of mosquito bed nets, though not statistically significant. Fever was also used as a proxy for typhoid fever. Practicing irrigated agriculture accelerated the risk of typhoid fever by 1.7, whereas the prevention of stagnant water sources near the house would significantly reduce the risk by the factor 0.3, as did regular handwashing after the use of a latrine, though not on a significant level.

Trachoma risk in the Ewaso Narok Swamp was approached by the presence of self-reported eye conditions. According to the multivariate analysis, increasing distance to rivers or streams would increase the risk of contracting trachoma by 1.1 per km. Even more of an increased risk did the use of traditional medicine take (2.5). The possession of a tap or any kind of running water in the household would reduce the trachoma risk by 0.6.

The risk of contracting skin diseases, approximated by the symptom skin irritation, was significantly increased by 2.3 for those respondents living in households where water supply was reported to have been discontinuous in the weeks preceding the survey. Commercial farmers were at a 1.5 higher risk of skin diseases; this result was not statistically significant, though. As the multivariate analysis showed, sanitation played a noticeable protective role in terms of skin diseases, as the possession of a sanitation facility would reduce the risk by 0.2.



**Model 1** shows the approximated diarrhoea risk and includes abdominal complaints as the dependent variable, and five independent variables as predictors; n=332.

**Model 2** shows the approximated malaria risk and includes fever as the dependent variable, and four independent variables as predictors; n=117.

**Model 3** shows the approximated typhoid fever risk and includes fever as the dependent variable, and three independent variables as predictors; n=238.

**Model 4** shows the approximated trachoma risk and includes eye conditions as the dependent variable, and three independent variables as predictors; n=332.

**Model 5** shows the approximated skin disease risk and includes skin irritations as the dependent variable, and three independent variables as predictors; n=400.

**Figure 17: Forest plots of wetland-related infectious disease models**

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#### **4.5 Synopsis: The impact of water on health and ill-health. A two-sided coin**

This chapter evaluated numerous wetland-use-related, socioeconomic and demographic risk factors, as well as water-, sanitation- and hygiene-related and behavioural factors in terms of their relevance for and association with self-reported symptoms serving as proxies for diarrhoeal diseases, typhoid fever, malaria, trachoma and skin diseases, all of which are real health threats in wetlands (Appleton 1983; Horwitz et al. 2012).

The assumption of different wetland user groups being differently exposed to water and water-related diseases could partly hold true in descriptive, univariate and multivariate analyses: smallholder farmers are, compared to other groups, at higher risk of contracting abdominal complaints. They also are at higher risk of eye conditions, and so are pastoralists. Working as commercial farmer or service sector worker reduces the risk of eye conditions. With regard to self-reported fever prevalence, there is no difference between different groups, contradicting previous evidence base, which suggests that farmers are more exposed to malaria and typhoid fever, both of which have been approached by self-reported fever. Skin irritations are most likely among commercial farmers since farming activities adopting irrigation activities and chemical fertilizers increase the risk of skin diseases (Chapter 6.8). Overall, the people working in the service sector worker, who were hypothesized to be least exposed to the swamp and the water-related risks, were the group least reporting symptoms, thus confirming the previous assumption.

Nevertheless, these findings cannot fully attribute separate risk factors to different groups based on their different occupational characteristics and exposure to water contact at different levels. The main reason lies in the fact that none of the groups exclusively uses the Ewaso Narok for one purpose only (Table 3): commercial farmers do not exclusively farm and pastoralists do not exclusively herd their livestock in the wetland. All of the user groups extract water from the swamp, collect building materials there, and some crop farmers use the wetland also for grazing livestock they possess, whereas some pastoralists also grow crops. So attributing one main use (and thereby one main level of water exposure) to each group was considered not conclusive enough. This points out that regardless of the predefined group membership, the different uses required consideration as separate risk factors.

Considering separate occupational use-related risk factors that agricultural production or pastoralism in wetlands entail allowed for a more distinct and detailed perspective. As the analyses revealed, the agricultural use of wetlands, specifically if including irrigation activities, is a high risk factors for self-reported fever, approximating the occurrence of typhoid fever, a disease which was linked with agriculture in wetlands before (Anchang et al. 2014, Neogi et al. 2014). Besides irrigated agriculture, the tending of the fields in the afternoon is also a high risk factor for self-reported fever, indicating the risk of contraction of malaria, also evidenced by literature (Carver et al. 2015, Dale and Knight 2008,

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Omukunda et al. 2012). Commercial farming, crop production and the use of fertilizers were all associated with a higher risk of skin irritations, indicating that the use and direct skin contact with (water containing) agrochemicals leads to skin diseases. As skin irritations are also symptoms that develop for those affected by schistosomiasis, one could hypothesize that those working in agriculture might be exposed to a higher risk of contracting schistosomiasis. An increased risk of abdominal complaints, inter alia an indicator for schistosomiasis, was associated with smallholder farmers, but not with irrigated agriculture, which makes the link to schistosomiasis weak, although the disease has been closely associated with irrigated agriculture in wetlands (Anchang et al. 2014, Appleton and Madsen 2012). The increased risk of abdominal complaints, however, supports previous evidence of farmers being exposed to a higher risk of contracting diarrhoeal diseases, a finding which is supported well by literature (Chapter 3.2.2). Pastoralism was closely associated with a higher risk of eye conditions, which likely indicates a higher prevalence in trachoma, a phenomenon which has widely been described also (Chapter 3.2.3), but generally, those users engaging in any sort of farming activity were at a significantly higher risk of contracting diseases than does being engaged in pastoralism. As such, the assessment of wetland-use-related health risks nicely corresponds with the available literature on use-related disease exposure in wetlands (Chapter 3).

However, the data indicate that although the described occupational risks are relevant, they play a minor role in the investigated population when compared to risk factors such as domestic water, sanitation and hygiene, health-related behaviour and environmental hygiene, thus indicating that the contraction of diseases mainly takes place in the domestic domain (Cairncross et al. 1996, Curtis et al. 2011, Herbst et al. 2008). The risk of abdominal complaints was significantly increased in those people that relied on unsafe water sources for drinking, underlining the evidence on diarrhoeal diseases being linked to unsafe water and poor sanitation. Safe water sources and sanitary, as well as environmental hygiene significantly reduced the risk of diarrhoeal diseases, respectively, and so did the prevention of stagnant water by the house. Feverish symptoms were more likely in people drawing their drinking water from unsafe sources such as the wetland, for those whose water supply was dirtier than usual, and significantly reduced in those people who would take care of a sound sanitary hygiene and wash their hands after using the sanitation facility, and a reduced risk was identified for households that would prevent stagnant water in the surrounding with all aspects pointing to the fever being a proxy for typhoid fever. The prevention of stagnant water, as well as the use of mosquito bed nets, an increased distance of the household to the nearest river or stream protected from what based on the approximation by fever symptoms and based on previous research might be malaria. Skin irritations were more prevalent in people using unsafe water sources and whose water supply was discontinuous or limited, whereas safe water sources, as well as the possession of a sanitation facility and positive sanitary hygiene and a water supply which was the same as usual would reduce the risks, as would the prevention of stagnant water near the house.



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The risk of contracting eye conditions was also strongly associated with water, sanitation and hygiene, both in terms of exposure and prevention. Whereas the increased distance to rivers or streams would significantly increase the risk of what could be interpreted to be trachoma, the possession of a tap or any kind of running water entailed a reduced risk – both of which is evidenced by previous research on risk factors for trachoma. Both aspects make pastoralists, who mainly live far from infrastructure and in the drier parts of the Ewaso Narok Swamp, most at risk of contracting trachoma. Living in close proximity to their livestock which at the same is their livelihood and occupation is an additional risk factor for trachoma, which indicated that with regard to the group of pastoralists and the risk of contracting, the line or distinction between the occupational and the domestic domain become blurred.

Concurring with the current literature on water-related infectious diseases in wetlands (Chapter 3.3), these risk assessments show that it is not necessarily the occupational proximity to water and occupational characteristics that determine the contraction of diseases. Rather are the role of human behavioural practices in the domestic domain and cultural aspects underlined with regard to the impact of health and ill-health in the Ewaso Narok Swamp. The major disease transmission pathways, namely contaminated and stagnant water and the health risks entailed can be considerably reduced by health promoting water management: safe water supply and storage; adequate sanitation; good personal and environmental hygiene (Cools et al. 2013, Esrey et al. 1991, WHO and UNICEF 2012, WHO 2006).

Apart from proper wetland management to reduce the intermediate host populations, the construction of sanitary facilities preventing untreated excreta from reaching the water bodies can be used to control and reduce the prevalence of water-related infectious diseases. Moreover, appropriate behavioural practices and the application of health-protective measures have the potential to reduce the vulnerability towards contracting diseases when using wetlands. Such include the use of protective gears (e.g. gumboots and gloves) during and handwashing after fieldwork in the occupational domain, the coverage of water storage containers and treatment of water for drinking (e.g. by use of household filters) and domestic purposes in order to prevent water-washed and waterborne diseases such as diarrhoeal diseases and typhoid fever (Cools et al. 2013). Moreover, the prevention of stagnant water near the homestead and the use of mosquito bed nets in the domestic domain, respectively, can prevent the transmission of vector-borne diseases such as malaria (Githinji et al. 2010, Hetzel et al. 2008).

Water and wetland use and the entailed vulnerabilities to acquiring diseases can furthermore be influenced by health-risk perception, health-related knowledge and education, as well as socio-economic status, lifestyles, traditions and beliefs (Cools et al. 2013, Dale and Knight 2008, Michelson 1993). All of these aspects play a significant role in disease transmission. Schistosomiasis prevalence rates, for example, differ as a function of

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socio-cultural practices (such as bathing in surface waters as a spiritual preference among some pastoral groups), educational attainment (knowledge on exposure to disease), socioeconomic status and domestic habits (such as choice of main drinking water source and sanitation) (Farooq et al. 1966). Such specific behaviours contributing to exposure of wetland users to diseases need to be considered in any sort of conceptual framework on water-related infectious diseases in wetlands. For this reason, the health-related knowledge and risk perceptions of wetland users will be presented in the following chapter.

## 5 HEALTH RISK PERCEPTION IN THE EWASO NAROK SWAMP

As is depicted in the literature review provided in Chapter 3, and as calculated in risk assessments from the Ewaso Narok Swamp in Chapter 4, the contraction of infectious water-related diseases in wetlands is associated with the actual use that entails different health risk factors. Part of the risks is any individual's risk perception, as it may shape the health-related behaviour, thereby reducing or accelerating the risk and exposure. Whether the people in and around the Ewaso Narok Swamp associate their forms of use to health risks and specific diseases will be clarified in this chapter. Therefore, the perceptions around wetlands, water, health and disease exposure that were probed among people in the Ewaso Narok Swamp are presented. Quantitative data of users (n=400), stratified by user groups (n=4) are complemented by qualitative results from in-depth interviews with a representative sample (n=20) of those individuals and groups. Moreover, knowledge on diseases and transmission pathways, as well as associated risk factors in wetlands were investigated and differences between different user groups were detected and analyzed. Quantitative and qualitative perception data were brought together, compared and triangulated, before the same data was integrated into the theoretical framework on wetland-related infectious diseases as presented in Figure 13.

### 5.1 Health risk perception and knowledge on disease exposure

#### 5.1.1 Perceiving health, health risks and diseases in the Ewaso Narok Swamp

Several questions on the implications of wetlands on human health and on the use-related health risks in wetlands were raised as closed questions.

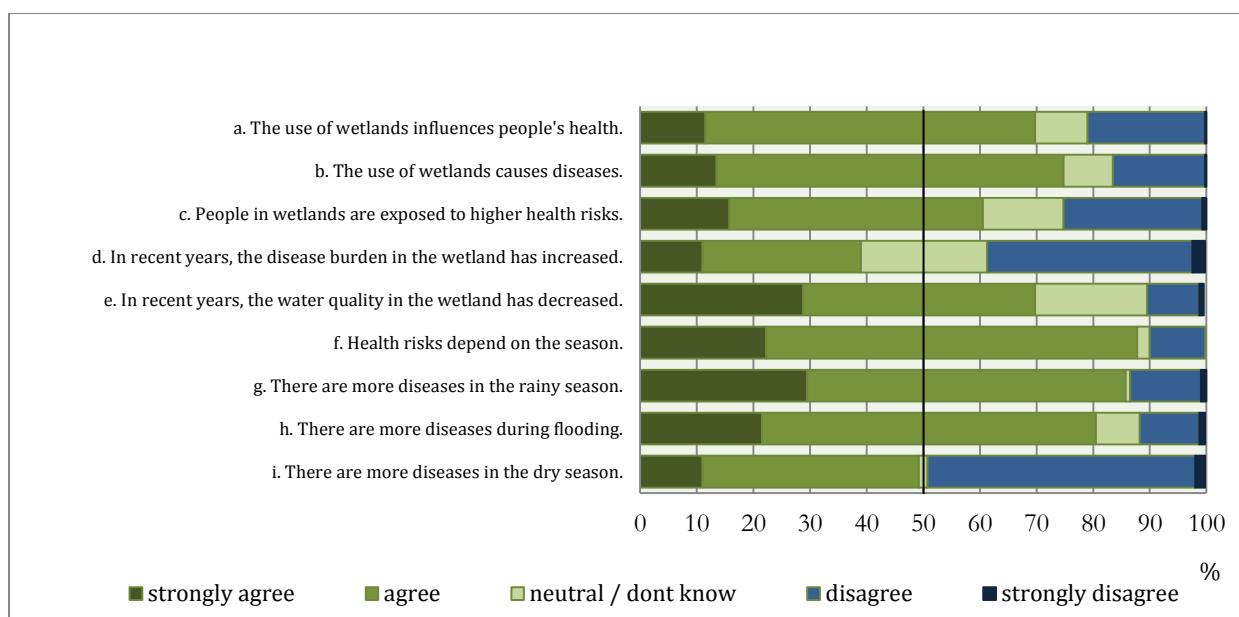


Figure 18: Perceptions on human health & disease [%] in the Ewaso Narok Swamp

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These were then followed by an open-ended possibility of specifying the answer for all respondents willing to give in-depth statements.

Moreover, the same type of questions addressed the temporal dynamics of disease burden and water quality in recent years as perceived by the interviewees, as well as perceived seasonal variations in the burden of diseases in wetlands (Figure 18).

#### **5.1.1.1 Perceptions on wetlands' positive influence on human health**

Out of all 400 respondents, 70% agreed on the statement of the marsh influencing human health, while 21% disagreed and 9% did not know or did not have an opinion on this. The question was not supposed to lead into a certain direction, and the subsequent open-ended specification clarified the perceptions on whether the influences are rather negative or positive. The notion of wetlands causing health risks and diseases for humans and for livestock was opposed the view that wetlands and their use make contribute to human well-being and make people healthier. Since this work aimed at assessing health risks, risk perception and diseases in wetlands, only these issues were discussed in detail. The positive implications of wetlands on the well-being of wetland communities are mostly excluded from this work<sup>40</sup>. Just this being said prior to presenting the negative perceptions on wetlands and wetland use regarding health risks: The wetlands are crucial for their users in terms of livelihoods and survival, as described by one community health worker and several respondents of in-depth interviews.

*'The marura [wetland] is very much helping us because in this place people don't have shambas [fields] or let me say land. So they usually use this land as their daily bread, they farm there, so it is helping the people, the community, even the livestock.'* (CHW)

*'The swamp is the only green area, the only water in the area comes from there wetland. All residents in this area depend on the swamp, only the Ewaso Narok Swamp makes the people survive. We use it for growing vegetables and food, farming, for livestock.'* (sh4)

The water resources and ecosystem services provided are major pull factors for immigration and thus, a health asset per se, as reflected in several statements made during the in-depth interviews with different wetland users:

*'The swamp is good for the people's health, as it gives them water, it helps people fetching water and allows farming and it helps their animals also.'* (co2)

*'We get benefits from the water for our families.'* (pa1)

*'The number one benefit of the swamp is food production and livestock feeds, and water. Health-wise, it feeds us and makes a good diet possible.'* (sh2)

*'The marura [wetland] gives us many things; it provides sege [material to weave mats]. We use it for domestic and for selling, this is the most benefit that it brings to the people. Then there is another thing, we use water for irrigation, for watering our crops.'* (co5)

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<sup>40</sup> Within the GlobE Wetlands in East Africa project, Ms. Sophie-Bo Heinkel's PhD study deals with aspects related to mental health and well-being, as well as place attachment to wetlands, thus investigating positive health effects of wetlands of Uganda.

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Similar results were achieved during open-ended statements following the closed question on wetlands influencing health: the people around the Ewaso Narok Swamp perceived health gains in terms of immunity and resistance against diseases due to staying and working in the wetland (n=11), reported being healthier due to the wetland environment (n=11) and the food provided (n=9). Health benefits from the swamp also included the medicinal plants provided (n=3). Especially the rainy season was underlined to bring all of these benefits to the people using wetlands (n=3). Such benefits were portrayed as outweighing the threats:

*'The benefits of the wetland are higher than the challenges.'* (pa5)

*'We do benefit because if it was not beneficial, we would have come here.'* (co1)

*'The benefits outweigh the negatives.'* (sh1)

### **5.1.1.2 Perceptions on health risks and diseases in the Ewaso Narok Swamp**

Two of the survey questions aimed at clarifying the links between wetlands and their contribution to the burden of disease by capturing the respondents' perceptions. Out of all people interviewed, a total of 75% believed that the use of wetlands causes diseases, compared to only 17% disagreeing and to 9% not knowing (Figure 19). When asked whether people in wetlands are exposed to higher health risks compared to people outside of wetlands, 61% agreed, 25% disagreed and 14% did not know whether there was any difference. Besides the respondents further could specify their answers in the form of an open, qualitative answer, with qualitative results quantified and are displayed in the following: Numerous febrile, respiratory, abdominal, eye, skin, joint and other conditions and symptoms were linked to the Ewaso Narok Swamp and its use and to certain risk factors. The disease mostly named by respondents was malaria (n=204), followed by typhoid fever (n=182), several diarrhoeal diseases (diarrhoea n=27, amoeba n=21, cholera n=18), pneumonia (n=46), flu (n=31), joint conditions (body pains n=24, arthritis n=19), and several eye and skin diseases, as well as other conditions.

Many of the respondents were able to attribute the named diseases to underlying risk factors and mostly named the poor water quality of surface wetland water (n=170) to cause waterborne diseases (typhoid fever, diarrhoea, amoeba, cholera) in those people using that specific water for drinking (n=18) and for domestic purposes (Figure 13). The awareness becomes visible in the in-depth interview statements, also:

*'If you stay near a wetland, you can get more diseases. And then also, the water from the river passes many places and collects a lot of dust. The people living nearby, they use it as the only source of water and that causes typhoid fever, diarrhoea and cholera. The dirty water is also used for cooking and the food is dirty too.'* (se4)

*'Diseases are mostly caused because the water is dirty. Then the people step in the water, they bathe in the same water and also animals use the same water.'* (pa2)

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The wetland water was described as being contaminated, thus affecting the health of humans and livestock. Compared to other areas, the Ewaso Narok Swamp with its water resources was perceived to provide large mosquito habitats (n=67) and stagnant surface water (n=23) exposing the people in the wetland to a higher risk of contracting malaria and yellow fever.

*'The biggest health challenge in the Ewaso Narok Swamp is malaria, because there is so much stagnant water and so many mosquitoes.'* (sh4)

The cold temperatures in the swamp compared to the surrounding areas (n=40) were linked to respiratory and cold-related conditions (pneumonia, flu, other respiratory illnesses), as well as physical conditions (joint pains, arthritis and feet disease).

*'Coldness mostly is the problem and wetness at the same time. It gives the people pneumonia, upper respiratory tract infections, on and off. Especially in children.'* (se2)

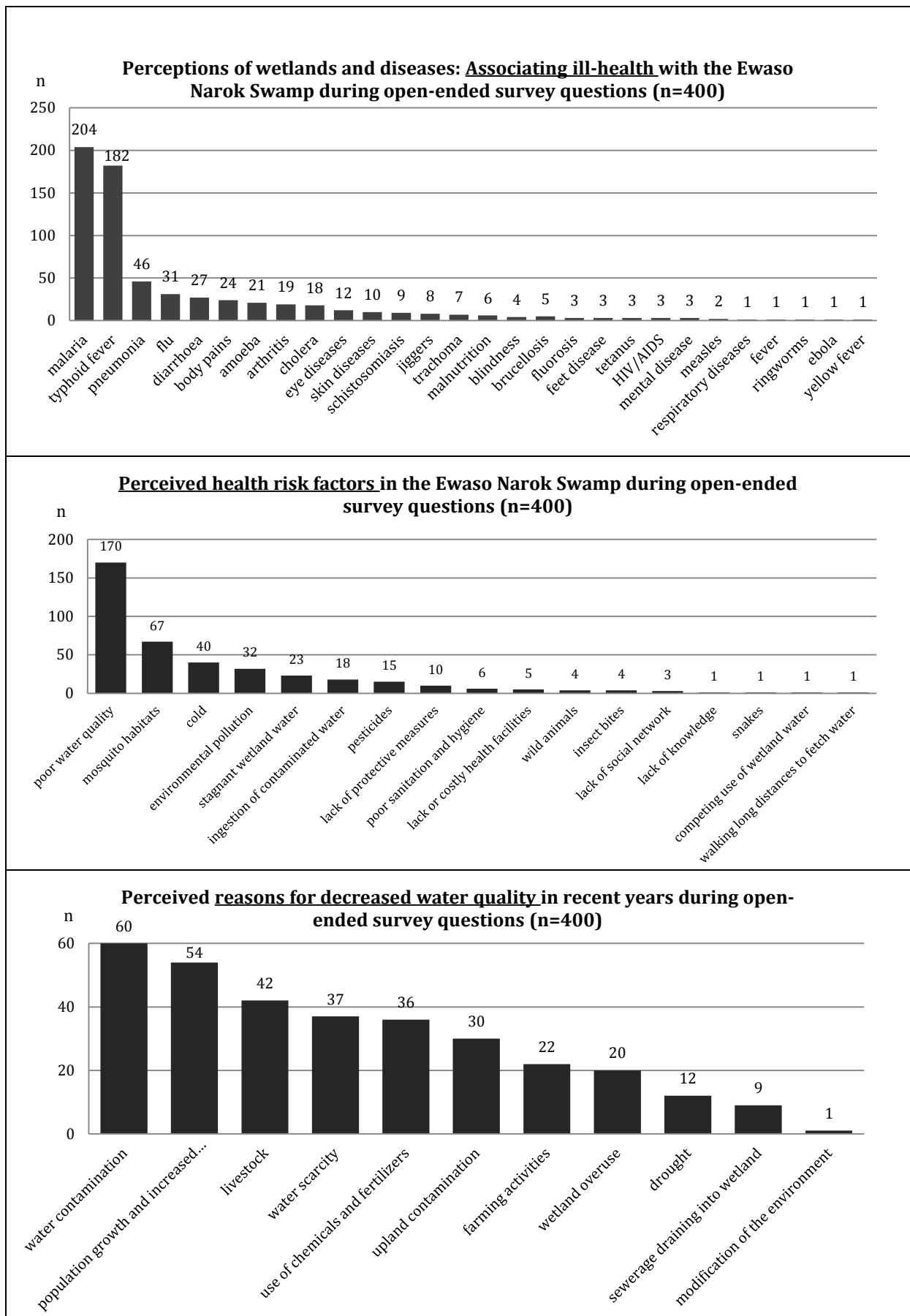
Environmental pollution (n=32) was named as a health risk factor by several respondents, and so were the use of pesticides and poor sanitation and hygiene (n=6), all contributing to the former and linked with a wide range of water-related infectious diseases (waterborne, water-based and water-washed diseases, e.g. eye and skin diseases, trachoma, schistosomiasis, jiggers).

*'There is water contamination. Animals contaminate the source and many users share the same water. (...) The water comes from the rain, goes to the river, and due to a lack of toilets, it is contaminated and causes typhoid fever, diarrhoea and vomiting. Skin conditions occur because of the contamination, the unclean environment and the lack of toilets, and insect bites. The people living here also face eye conditions due to the dust, the water and the environment. One problem is that the environment is very dirty.'* (sh4)

*'These people are using that water for irrigation and a lot of chemicals to their plants. When that water drains it's the same water which is going to the river and they fetch that water to wash their face and eyes, so in my own opinion, they can cause problems.'* (se2)

*'All the chemicals used in agriculture, they are entering the eyes and cause eye conditions and even blindness. But the people think that chemicals don't affect their health.'* (se4)

Other risk factors covered rather behavioural and infrastructural issues, such as the lack of protective measures (n=10), poor sanitation and hygiene (n=6), lack or cost of health facilities (n=5), lack of social support system (n=3) in the case of disease or the lack of knowledge on how to handle risks and disease (n=1), referring to almost all of those diseases. In the same category, the competing use of wetland users (n=1) and long distance to water supply (n=1) were named. Also, wild animals (n=4), insect bites (n=4) and snakes (n=1) were mentioned as entailing risks for the health of wetland users.



**Figure 19: Perceptions on diseases & risk factors in the Ewaso Narok Swamp**

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### 5.1.1.3 Perceptions on an increase of diseases in the Ewaso Narok Swamp

Regarding a potential increase in the burden of diseases among people living in and using the Ewaso Narok Swamp, the perceptions among the respondents were controversial. About 40% perceived the disease burden to have increased, the same amount as respondents disagreeing, while 20% claimed to not know.

Those arguing the burden of disease to have increased mentioned reasons such as growing population in the swamp, increased wetland use, including increased use of chemicals for agricultural production, increased number of livestock using the wetland. All were described as contributing to the increased contamination of wetland water and the environment. One aspect highlighted in terms of causing an increased burden of diseases was the scarcity of water and droughts forcing people to use and drink surface water. This water was described to often be contaminated due to the lack of sanitation facilities, and all these issues were associated abdominal conditions and amoeba. Increased deforestation activities and clearing of bushes throughout the past years were mentioned to have caused the environment to be dirtier, thus having increased the burden of disease. Besides, changing weather conditions and climate change in recent years were named to be contributing also, particularly the increased loads of dust having led to more respiratory complaints over the past years. The accelerating farming activities and the substances applied to crops, especially chemicals were made responsible for the increasing numbers of skin diseases. An increased burden of emerging diseases and of pests was perceived to be stemming from wild animals. Some of the respondents made the lack of good health services and available drugs responsible for an increased disease burden.

Those perceiving the burden of disease to have reduced in the Ewaso Narok Swamp in recent years gave deeper insights during the open-ended survey question as well. They underlined the role of the development of the area in recent years in terms of improved infrastructure, roads, transport options and household wealth, as well as improved medical services available, accessible and easier to reach for the inhabitants of the marsh. Credit was given to community health workers and their effort to educate the inhabitants in the swamp with respect to health-related topics and to improve the sanitation situation by building toilets. Several opposed the wetlands' and its uses' role as being the sole drivers of exposure to disease, but laid the responsibility of staying health into the users' hands and their health-related behaviour. One respondent, for example, said that the health depends upon one's body and on how individuals take care of themselves. According to some of the respondents, health-related knowledge, awareness and thus, healthy behaviour, and the application of protective measures have improved in the past years, all contributing to a decreased burden of disease.

*'Now there are less diseases than there were before, because nowadays there is more education. Information and health education is disseminated at school, on the radio and in health class at school.'* (se5)



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The adaptation to the environmental conditions by living in the wetland area was mentioned to reduce health risks, and also the creation of immunity by having been exposed to the environmental conditions for years. The benefits provided by the use of the swamp, especially the nutritional aspects, were seen as having supported health rather than having caused increased loads of disease. The clearing of vegetation, as well as reduced rains and increased drought and water scarcity were mentioned to have contributed to a decrease in malaria-transmitting mosquitoes as well as to a reduction in typhoid fever.

#### **5.1.1.4 Perceptions on a decrease of water quality in the Ewaso Narok Swamp**

The vast majority of the respondents perceived water quality to have decreased in recent years (70%) (Figure 18). Reasons for decreased water quality (Figure 19) included the contamination of wetland water (n=60), and multiple sources of contamination were named: the growing population along with increasing use of the Ewaso Narok Swamp was made responsible for the low water quality by 54 respondents. The increasing numbers of livestock living in and polluting the wetland caused concerns (n=42). Farming activities, both for crop production and livestock, were seen as a major polluter of the water (n=22) and particularly the large-scale agribusinesses were addressed. The excessive use of fertilizers and chemicals in agriculture was claimed to be alarming (n=36), used both upland (n=30) and in the surrounding area, but finally draining into the swamp. Due to extensive use, e.g. for irrigation activities in this water-scarce area, the pressure on the water resource was reported to be increasing, leading to reduced water quantity in the swamp and reduced quality of the surface water remaining (n=37), even worse in times of drought (n=12). Wetland overuse was named by many of the people (n=20) as causing a reduction in the water quality and the multiple and concurring uses by many different actors was especially underlined as causing a problem, as reflected by the following pastoralist statement.

*'The quality of water is poor now, it is not as good anymore because of the contamination. A lot of people right now are using this water. It is coming from way up there [the Aberdare Ranges] and it is flowing down this way so by the time it gets here... The water is so little and it's the same water we are using for everything, for the livestock. We share it with wild animals, and with the farmers for irrigation, so it's posing as a challenge for us.'* (pa4)

Domestic and industrial waste, as well as sewerage dumped into or draining into the low-lying wetland, were indicated as being water contaminants by nine respondents. One respondent mentioned the modification of the wetland environment and the deforestation activities as reasons for the perceived low water quality. Whereas one respondent described the water to be cleaner during the rainy season as compared to the dry season when the water level is lower, another respondent felt the water quality to be especially low in the rainy season. Another interviewee reported the water quality to remain unchanged, since the elders take care of the wetland water.

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### 5.1.1.5 Seasonality of disease in the Ewaso Narok Swamp

Out of all respondents interviewed, 88% rated health risks as dependent upon the season. The open-ended specification gave a first insight into the perceptions: 139 respondents perceived the burden of disease to be higher during the rainy season, 12 respondents found the burden to be higher during flooding and 20 of the interviewees claimed that diseases were more during the dry season. According to outcomes of the open-ended interview questions, every season has their own diseases which are emerging irrespective. Specific diseases and health risk factors were attributed to either the rainy or flooding or the dry season as reflected in this service sector worker's quote and as displayed in the following:

*'We get affected with the level of water both the dry season and the flood.'* (co3)

*'There are different diseases for different seasons. In the rainy season, there is more malaria. And then also in the rainy season, more people have colds and even pneumonia due to the cold weather and lack of a good bedding. In the dry season, air-borne diseases are more common and cough, also dehydration and malnutrition.'* (se5)

Out of all respondents, about 86% perceived the burden of disease to be higher in the rainy season (Figure 18). When the respondents were asked to specify the implications in the Ewaso Narok Swamp (Figure 20), 160 stated malaria to be more prevalent during the rainy season. The wetness was described to provide large breeding grounds to attract a lot of mosquitoes (n=51), increase malaria risk and facilitate transmission.

*'When the rainy season comes it also may bring a lot of mosquitoes which cause diseases like malaria'* (co4).

Flu was reported to be affecting more people during this season (n=51), mainly caused by the cold weather conditions (n=73). The increase in malaria and flu, however, was not mentioned to be only referring to wetlands, but an increase was also reported to be visible in the uplands. The cold and dampness during the rainy season were also made responsible for pneumonia (n=43), common colds and coughs (n=40), arthritis (n=3), leg pain (n=2) and fever (n=1). Within this time of the year, the water was perceived as being more polluted due to the rain and resulting flood carrying all dirt from surrounding areas into the wetland waters, posing the risk of increased waterborne diseases such as typhoid fever (n=51), diarrhoea (n=12), cholera (n=3) and amoebiasis (n=2).

*'In the rainy season, there is a lot of water. The floods carry dust and dirt. But still, the people use that water for drinking, for cleaning, washing. This causes typhoid fever.'* (se4)

The water pollution and resulting waterborne health problems were associated with the lack of proper means of sanitation and toilets and the sharing of water resources by many users. An increased burden of schistosomiasis (n=2), eye (n=1) and skin diseases (n=1) were also linked to the rainy season. 13% of the respondents did not perceive the rainy season to cause health problems. Instead, they claimed the rains to bring safe water, reducing dust and cleaning the environment, provide more food and thus, improving human

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and livestock health. Flooding was perceived as posing a higher burden of disease to the inhabitants in the Ewaso Narok Swamp by 81% of the respondents (Figure 18). Malaria was linked to the large amounts of stagnant water (n=98), facilitating mosquito breeding grounds (n=7).

*'Here when it rains, there is so much flood but it flows, you know the landscape. It brings more diseases like malaria.'* (se1)

Several respondents linked typhoid fever (n=48) to flooding and the waste from surrounding areas and the upland washed into rivers draining into the wetland as a major risk factor (n=44).

*'Even that typhoid because when the people help themselves in the bushes and then it floods. When there is flooding, that river collects dirt from different places to go into the water and carries it to all the places. And then the water can be contaminated also.'* (se1)

Flooding was described as the time of the year that brings the dirt and contamination that had been accumulated during the dry season into the wetland.

*'During floods, the water just carries a lot of waste coming from uplands, which flows to the wetland and also it makes them relocate to higher grounds.'* (co4)

Especially the lack of sanitation facilities was claimed as incorporating health threats. Besides, the high loads of contamination of wetland water during times of flooding was linked to diarrhoea (n=10), cholera (n=9), amoebiasis (n=2), especially for those people using and drinking the waste-carrying wetland water without any treatment. Just as was mentioned with regard to the rainy season, the dampness and cold (n=19) during floods was associated with cold-related diseases, flu (n=24) and pneumonia (n=23), as well as feet and leg disease (n=6), arthritis (n=4) and fever (n=1). A greater burden in skin diseases (n=2) and schistosomiasis (n=2) were linked to flooding as well. Besides the named, another flood-related health risk named was the physical danger by the water masses, eventually leading to drowning of those trying to cross the wetland (n=7). This danger and the uncontrollability of the water, the increased burden of disease, the fact that water enters the inhabitants' homesteads during flooding and also destroys vital infrastructure, prevents many to use the wetlands and farms and makes many people move out of the low-lying areas and stay away from the swamp until the waters recede.

*'When it rains a lot, flooding affects communication and hinders us [the pastoralists] to move'. It even affects the farmers because it floods their shambas [fields]'*. (pa1)

*'Sometimes flooding destroys everything and washes away all the crops.'* (sh5)

The dry season was reported to increase the burden of disease by 49% of the respondents (Figure 18). The condition mostly associated to the dry season was flu, as mentioned by 97 people in the open-ended question following their subjective assessment (Figure 20). The main risk named and associated to the dry season was the high loads of dust (n=62), carried

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by the winds and brought from far into the wetland, causing airborne diseases. Those winds were described to carry contaminated air, blow dust that causes the named flues, respiratory diseases (n=4), pneumonia (n=2), TB (n=1) and asthma (n=1). The dust was often used as a synonym for dirty and dry environment, likely to cause eye diseases (n=22, trachoma n=1) and having insects affecting the eyes.

*'There are diseases especially during drought. Such as eye diseases, they come from dust. Eye diseases may also be caused by the sun, like now people don't see well, but when it is not so sunny they will see well. And the wind.'* (pa5)

*'Eye diseases occur when it is dry. It depends with weather conditions and the seasons, basically drought, rain. Like this time, sunny dryness. Mostly it's the climate.'* (pa4)

*'When it is dusty, there is mostly flu. And typhoid fever.'* (sh1)

One issue that was underlined was the limited water resources and reduced water levels in that season, causing poor water quality, but making people dependent upon stagnant water from the wetland which is perceived to be contaminated (n=14) and entailing the risk of contracting waterborne diseases such as typhoid fever (n=16), diarrhoea (n=9) particularly in children, cholera (n=1) and amoebiasis (n=1).

*'I think that the dry season really causes a lot of problems, because there is a lot of dust and the dust causes a lot of flu and malaria because of the reduced water level. And also where I live there are so many mosquitos, so there is no way to avoid this malaria issue. The water is contaminated and this causes typhoid.'* (co5)

*'The swamp brings diseases like malaria and diarrhoea, during drought especially.'* (pa5)

*'There is mostly flu, eye diseases and jiggers because of the dust and poor hygiene.'* (co4)

An increased burden of malaria was perceived by 14 respondents due to stagnant and polluted water inviting mosquitoes to breed, and the dry season malaria was described as more dangerous. The hot temperatures and arid weather conditions were associated with increased headaches (n=8) and the absence of water with jiggers (n=2), skin diseases and measles (n=1). One serious health threat perceived by the people in the Ewaso Narok Swamp was the food scarcity and hunger (n=9) resulting from water scarcity. The dry season was described as leaving people with poor harvest, without a good diet or enough food and negative nutritional effects, especially in children.

*'In the dry season, not getting enough food is a problem. Health depends with your nutrition, diet and fluids.'* (sh3)

Another aspect, which was not raised in the open questions following the survey, but which was underlined in the in-depth interviews, is the loss of livestock in the dry season or due to drought. This was much highlighted by the pastoralists interviewed:

*'Drought is a real challenge to the people, when there is no food, and the animals lack water and they die.'* (pa5)

*'When it really dry like now and you lose all your cattle, it causes a lot of stress.'* (pa3)

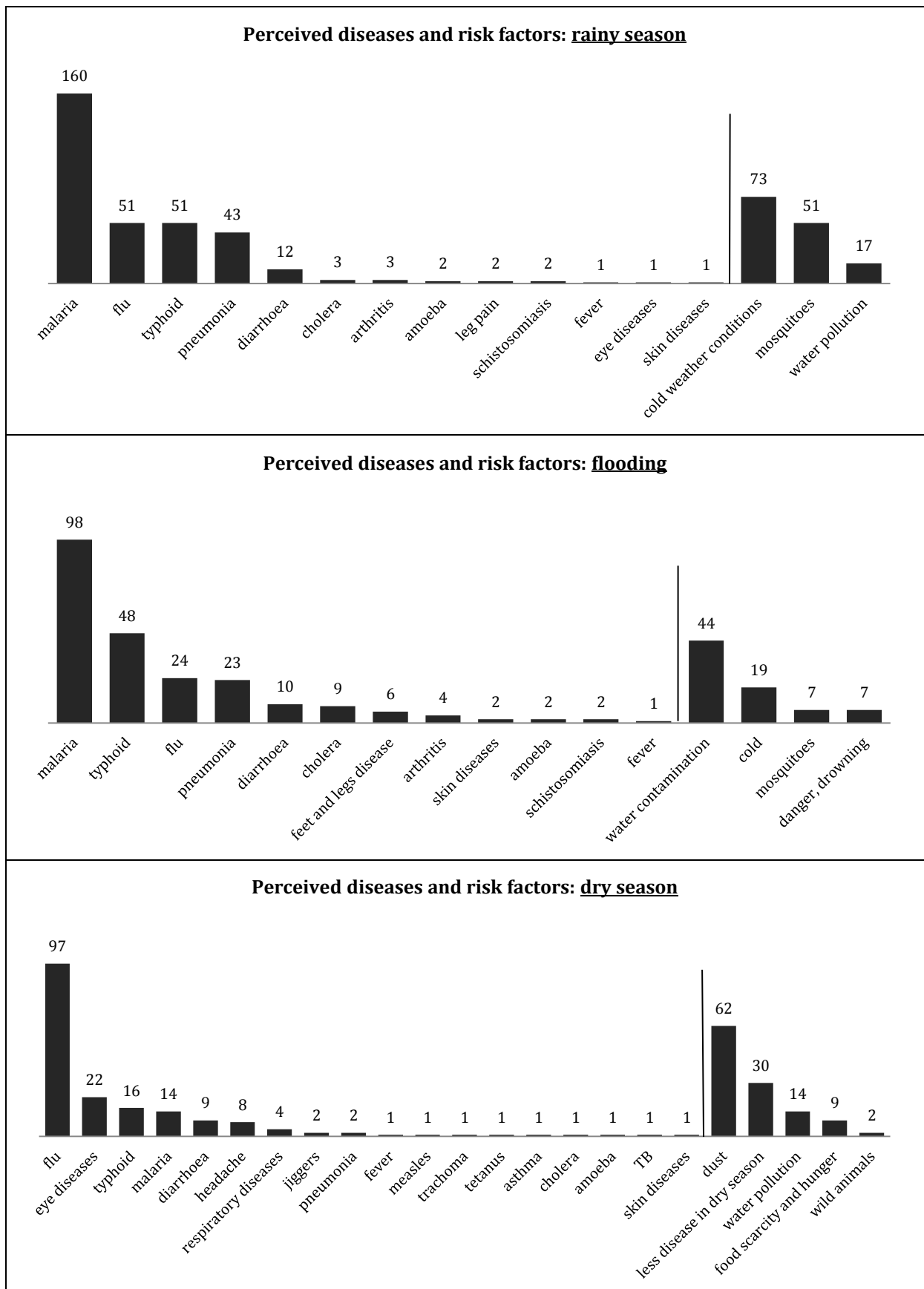


Figure 20: Perceptions on seasonal diseases and risk factors in the Ewaso Narok Swamp

This created conflicts between pastoralists and farmers, because in the dry season especially,

*'The pastoralists wait for the people to disappear from their shamba [field], and then they let their livestock eat the maize and other crops.'* (sh5)

Moreover, wild animals (n=2) were mentioned as causing health risks and especially elephants were named to be responsible for diseases such as tetanus (n=1).

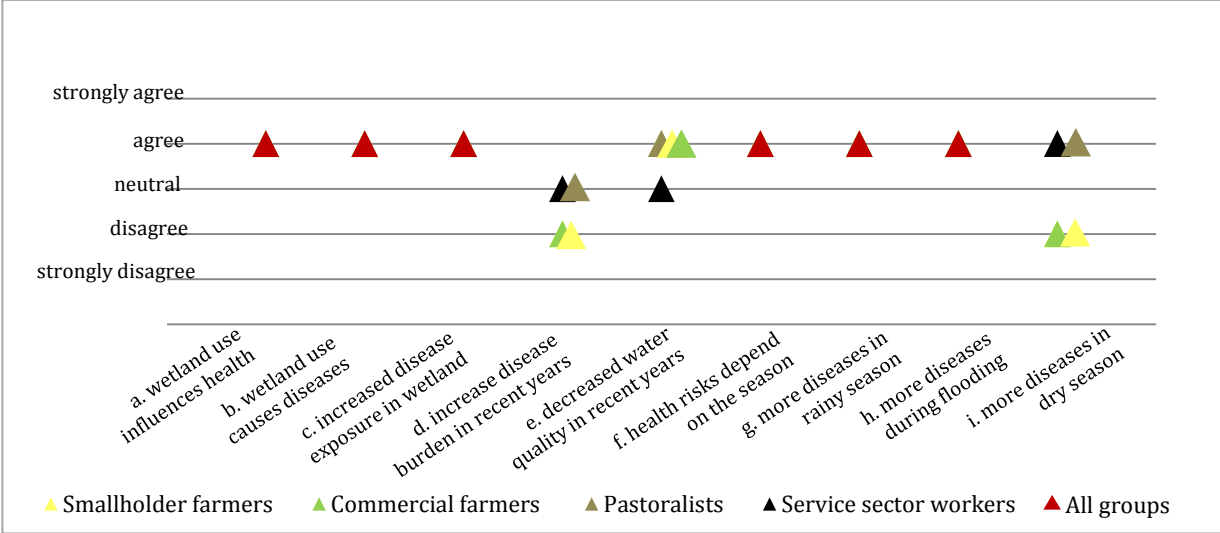
Half of the people (49%) argued the dry season not to be associated with an increased burden of diseases. Instead, they claimed it may pose even less disease risk due to the lower water levels that prevent mosquito breeding sites and thus, malaria, besides less cold-related diseases due to the heat (n=30).

*'In the dry season there are little diseases, because when there is less water, there are also less diseases.'* (se4)

The dry season was even perceived as having no bad climate, always good weather and no water which can expose to diseases'. Drought was named as a cause for less disease.

**5.1.1.6 Stratification of perceptions on wetlands, health and diseases by groups**

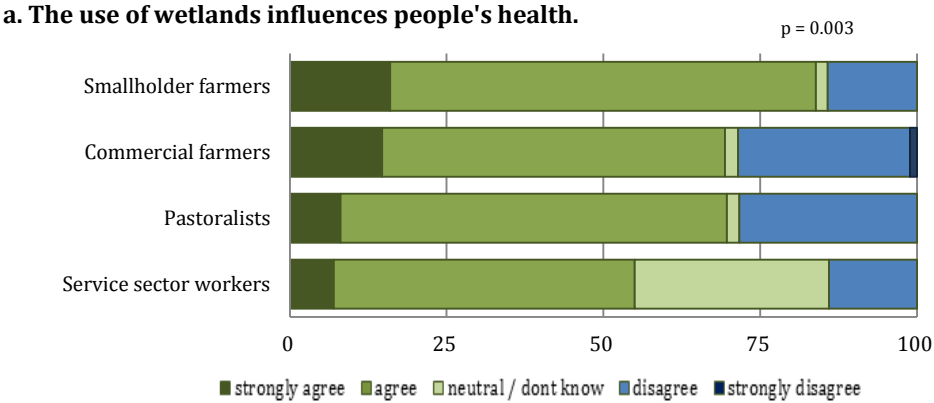
The set of questions on the perceived implications of wetlands on human health and on the use-related health risks in wetlands (a.-c.), on the temporal dynamics of disease burden (d.) and water quality (e.) in the Ewaso Narok Swamp in recent years, as well as perceived seasonal variations in the burden of disease in wetlands (f.-i.) were stratified by user groups. The medians are displayed in Figure 21.



**Figure 21: Perceptions on wetlands, health and diseases by user groups (median)**

While the medians do not differ when addressing (a.) the influence of wetlands on human health, (b.) the use as wetlands as causing disease, (c.) increased exposure towards diseases

for wetland users, (f.) seasonality of health risks, (g.) increased disease burden in the rainy season and h. during flooding, differences manifest themselves in terms of the remaining questions. The commercial and the smallholder farmers did rather disagree the statement of (d.) the disease burden in the Ewaso Narok Swamp having increased over the past years, whereas both the group of service sector workers and the pastoralists did not know or had a neutral opinion. The commercial and smallholder farmers, as well as the pastoralists found the (e.) water quality in the wetland to have decreased in recent years, but the service sector workers had a neutral opinion on this. Regarding the (i.) increase in burden of disease during the dry season, differences in the perceptions became visible as well. The service sector workers and the pastoralists rated diseases to occur more often during the dry season, while both groups of farmers disagreed on this statement.



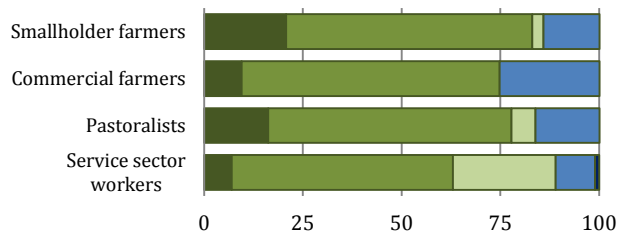
\* The p-value indicates the difference of risk perceptions between the different wetland user groups as calculated with a Kruskal-Wallis H test.

**Figure 22: Perceptions on wetland use influencing people’s health in Ewaso Narok Swamp [%]**

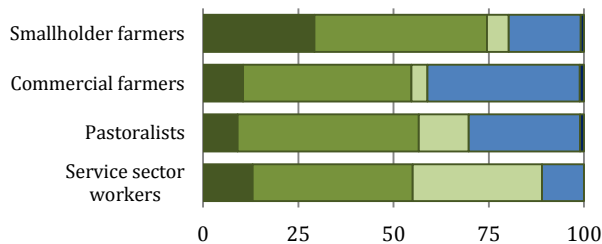
The descriptive stratification of questions and answers by groups (Figures 22-23) reveals the most obvious outcome: the service sector workers are the group with the largest share of respondents being neutral or not knowing about the implications of wetlands and health compared to all other groups. Especially when addressing wetlands and their uses’ implications on health, a rather large share has difficulties in positioning themselves and answer different from most of the other groups. Also, when addressing flooding, more of the service sector workers than any other group are unclear about the health consequences.

Regarding wetland and disease-related aspects, the smallholder farmers are the group mostly perceiving wetlands, health and diseases to be closely interlinked (a.-c.), opposing to the service sector workers who least perceive these links. The pastoralists out of all groups perceive the disease burden in the swamp to have increased over the years (d.) and the water quality to have decreased, (e.) as compared to the other groups, who also saw this connection, but perceived it less severe. All groups agreed on the statement of health risks depending upon the season (f.) with no differences between groups. Moreover, all groups agree on the rainy season exposing to more diseases (g.). In terms of flooding, the three user groups close to the swamp perceive disease burden to be increased.

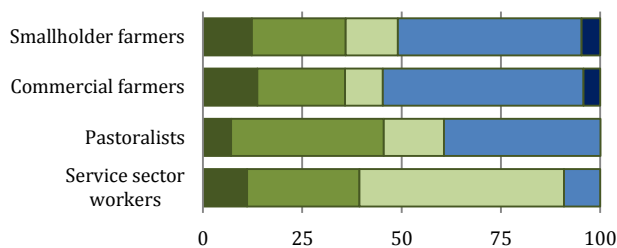
**b. Use of wetlands causes diseases.**  $p < 0.001$



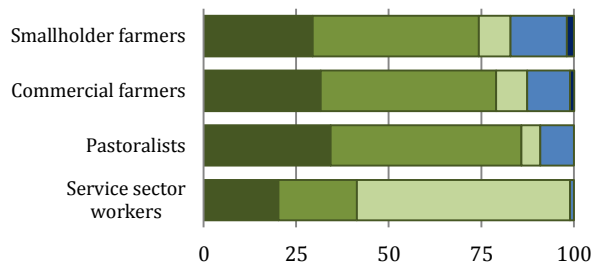
**c. Higher health risks in wetlands.**  $p < 0.001$



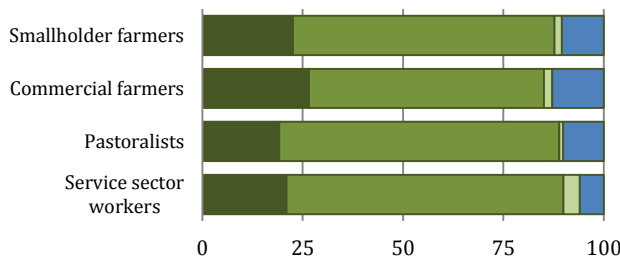
**d. Increased disease burden.**  $p < 0.001$



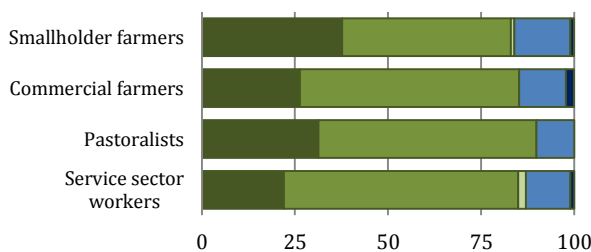
**e. Decreased water quality.**  $p < 0.001$



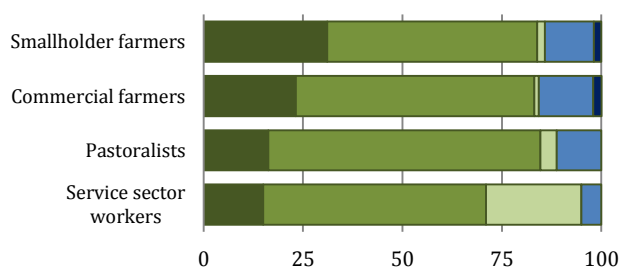
**f. Health risks depend on season.**  $p = 0.960$



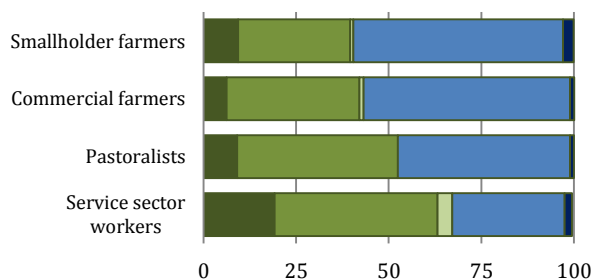
**g. More diseases in rainy season.**  $p = 0.266$



**h. More diseases during flooding.**  $p < 0.001$



**i. More diseases in dry season.**  $p < 0.01$



■ strongly agree ■ agree ■ neutral / dont know ■ disagree ■ strongly disagree

\* The  $p$ -value indicates the difference of risk perceptions between the different wetland user groups as calculated with a Kruskal-Wallis H test.

**Figure 23: Perceptions on health & disease in the Ewaso Narok Swamp by user groups [%]**

The portrait is mixed regarding the implication of the dry season on diseases. The service sector workers and pastoralists both perceive the risks to be higher compared to both farmer groups.



Besides showing the variation in perceptions, Figure 23 describes the statistical difference between user groups as calculated with a Kruskal-Wallis H test. The strongest statistical differences were found in terms of wetlands, health and disease related to (c.) perceived exposure to higher health risks by wetlands [ $\chi^2(3) = 19.780$ ,  $p = 0.000$ ] and to (e.) perceived decreased water quality in the Ewaso Narok Swamp in recent years [ $\chi^2(3) = 22.065$ ,  $p = 0.000$ ]. Also, (d.) increased burden of diseases in the Ewaso Narok Swamp in recent years differed statistically significant [ $\chi^2(3) = 17.683$ ,  $p = 0.001$ ], as well as (a.) wetlands' influence on human health statistically significantly differed [ $\chi^2(3) = 14.170$ ,  $p = 0.003$ ], while (b.) use of wetlands causing diseases differed [ $\chi^2(3) = 13.014$ ,  $p = 0.005$ ]. The statements on seasonality of health risks and diseases in wetlands provided party statistically significantly different results between the user groups. Significant differences were measured for the (i.) increased disease burden during the dry season [ $\chi^2(3) = 17.822$ ,  $p = 0.000$ ], and (h.) during flooding [ $\chi^2(3) = 7.954$ ,  $p = 0.047$ ], whereas (f.) health risks depending on the season and (g.) increased disease burden during the rainy season were numerically, but not statistically significantly different.

A Mann-Whitney-U test served to compare the pairwise differences between the groups in terms of significance (Table 29). What the results indicate is that the perceptions statistically significantly differ between service sector workers and smallholder farmers in particular, but also between many other group combinations.

**Table 29: Different perceptions between groups calculated with Mann-Whitney-U tests**

	smallholder vs. commercial farmers	smallholder farmers vs. pastoralists	smallholder farmers vs. service sector workers	commercial farmers vs. pastoralists	commercial farmers vs. service sector workers	pastoralists vs. service sector workers
a. The use of wetlands influences people's health.	0.055	0.006	0.000	0.571	0.237	0.437
b. The use of wetlands causes diseases.	0.017	0.281	0.001	0.193	0.397	0.027
c. People in wetlands are exposed to higher health risks.	0.000	0.000	0.010	0.528	0.053	0.207
d. In recent years, the disease burden in the wetland has increased.	0.843	0.151	0.000	0.118	0.000	0.054
e. In recent years, the water quality in the wetland has decreased.	0.494	0.109	0.009	0.367	0.001	0.000
f. Health risks depend on the season.	0.842	0.740	0.927	0.610	0.911	0.669
g. There are more diseases in the rainy season.	0.257	0.886	0.109	0.280	0.632	0.103
h. There are more diseases during flooding.	0.312	0.110	0.009	0.598	0.097	0.158
i. There are more diseases in the dry season.	0.774	0.104	0.000	0.165	0.001	0.028
Legend:	p < 0.001		p < 0.01		p < 0.05	

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### 5.1.2 Knowledge on diseases in the Ewaso Narok Swamp

The diseases that resulted from the theoretical review on use-related diseases in wetlands (Figure 13, Chapter 3) served as a basis for assessing the level of knowledge of diseases in a quantitative manner. The list was expanded by diseases that the wetland users mostly associated with wetlands during the open-ended statement questions (Figure 19). One disease was excluded from the questionnaire after pre-testing and this was onchocerciasis or river blindness, since none of the respondent knew this rare neglected tropical disease.

While some diseases or conditions were well-known to all or almost all users, such as malaria (100%), diarrhoea (99%), flu (100%) and pneumonia (100%), others were not. Eye diseases were known by 96% of all respondents, cholera by 87%, skin diseases by 86%. The share of people knowing typhoid fever (61%), trachoma (58%), blindness (56%), or schistosomiasis (37%) was much lower. Moreover, the share of respondents knowing the diseases differed largely between different groups. With regard to almost all of the diseases, the service sector workers were the group that knew most diseases, while the pastoralists knew the least. As can be seen in the Figure 24, the largest variations became visible in terms of schistosomiasis, in the swamp more commonly known as bilharzia: only 18% of the pastoralists knew schistosomiasis, while 54% of the service sector workers were aware of this disease. Exceptions to this trend are cholera, known by less smallholder farmers than pastoralists (81% versus 84%), trachoma, known by more commercial farmers than service sector workers (63% versus 61%) and typhoid fever, for which the pastoralists had the largest share of people knowing the disease.

The perceptions on whether these selected diseases were common in the Ewaso Narok Swamp differed much. Figure 25 shows the number of those stating a disease to be common in the wetland, considering only those respondents having previously answered to know the disease (Figure 24). Those not knowing the disease were excluded from this part of the analysis. Out of all respondents who knew typhoid fever, 89% reported the disease to frequently occur in the wetland, as well as flu (87%) and malaria (79%). For typhoid fever and for flu, the inter-group differences in terms of perceived high occurrence were rather small compared to the other diseases.

Overall, the following pattern appeared: The pastoralists were the group who mostly reported the selected diseases to be common in the area around the Ewaso Narok Swamp. This applied to all but skin diseases, which the pastoralists reported to be least common when compared to the other groups' answers. The largest variation was regarding trachoma, a disease which 67% of the pastoralists reported to be common, but only 35% of the commercial farmers, 32% of the smallholder farmers, as well as only 18% of the service sector workers.

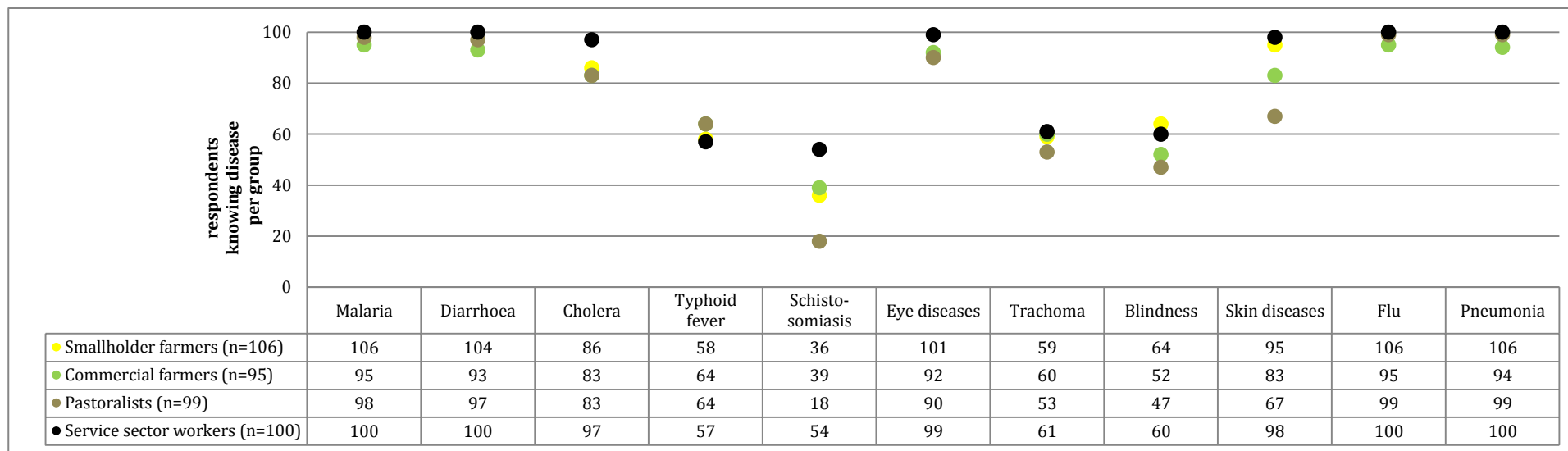


Figure 24: Knowledge of diseases among user groups in the Ewaso Narok Swamp [absolute out of n=400]

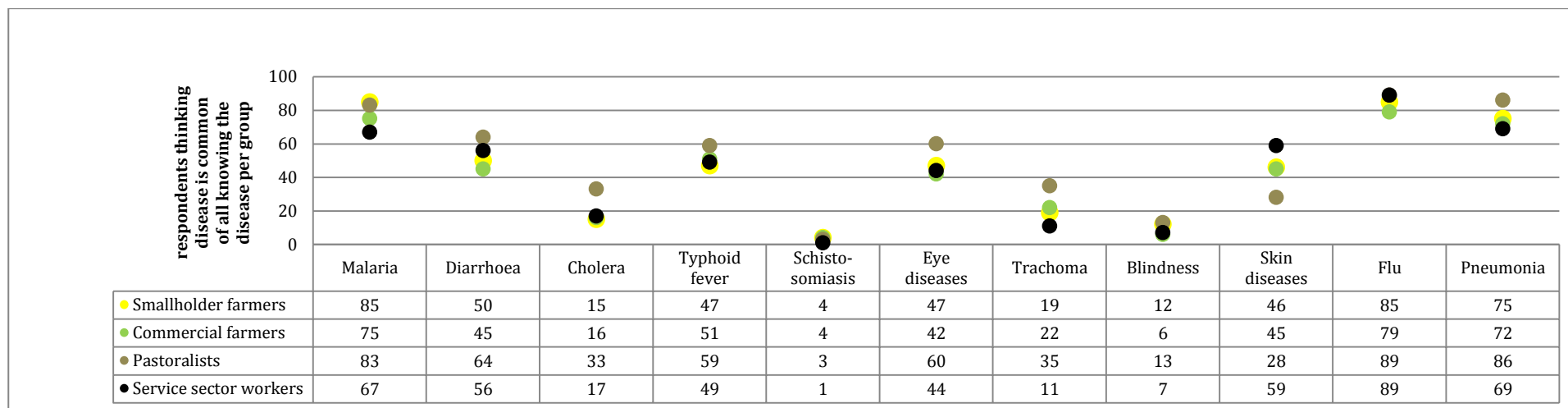
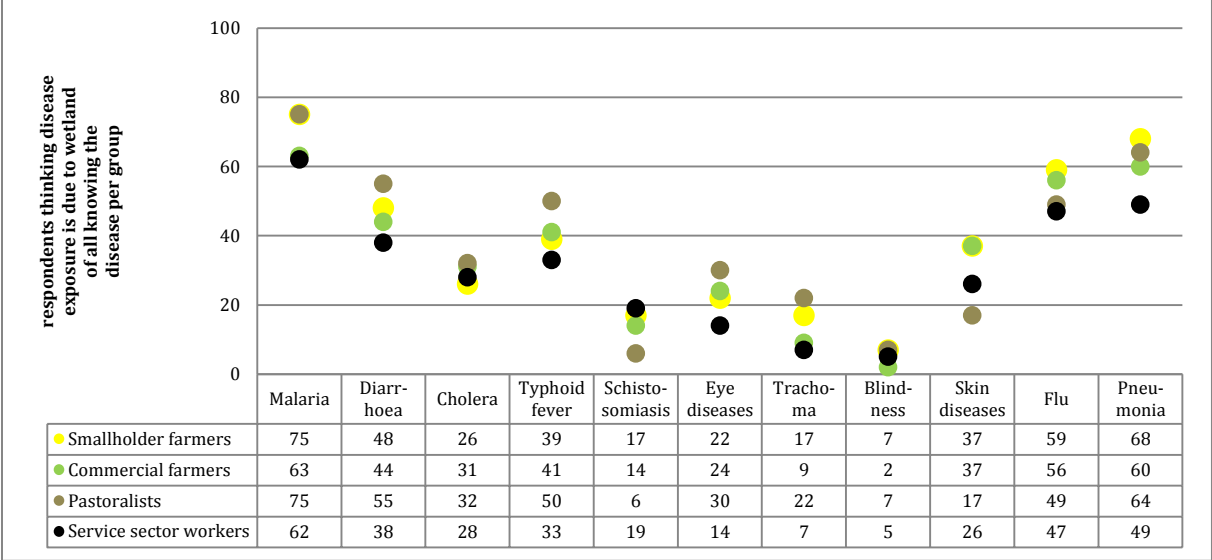


Figure 25: Occurrence of diseases as stated by user groups in the Ewaso Narok Swamp

When asking the respondents from the different wetland user groups that knew the selected diseases about whether the use of the Ewaso Narok Swamp exposed the people to malaria, diarrhoea, cholera, typhoid fever, schistosomiasis, eye and skin diseases, blindness, trachoma, flu and pneumonia, the following results could be obtained: The disease mostly associated with the use of the wetland was typhoid fever (74%), closely followed by malaria (70%). Moreover, more than half of those knowing the diseases linked pneumonia (61%) and flu (53%) to wetland use. Diarrhoea (48%) and schistosomiasis (42%) were perceived to be due to wetland-related exposure by less than half of the respondents, as well as cholera and skin diseases (34% each). Only 24% related eye diseases and trachoma to wetland use, and only 10% linked blindness.

As was the case in terms of knowledge on the selected diseases and with regard to the perceived occurrence of these diseases, a certain group-specific pattern appeared concerning the perceived wetland use-related exposure (Figure 26). The group least associating the diseases with the use of the Ewaso Narok Swamp were the service sector workers throughout all diseases and conditions but blindness.



**Figure 26: Exposure to selected diseases as stated by user groups in the Ewaso Narok Swamp**

In the course of the qualitative part of the study, the links between the wetland-related exposure, transmission pathways, and risk factors of malaria, diarrhoeal diseases, typhoid fever, schistosomiasis, eye diseases and skin diseases were disentangled by smallholder and commercial farmers, by pastoralists and service sector workers.

**5.1.2.1 Malaria in the Ewaso Narok Swamp**

The in-depth interviews with twenty respondents gave some deeper insights into the relationship of marshes and malaria. The common sense was that wetlands were intrinsically connected with a high occurrence of so-called *mbu* [mosquitoes], responsible for a perceived high prevalence of malaria:

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*'If you stay near a wetland, you can get more diseases, especially malaria.'* (se4)

*'If you use to stay in the wetland you have to be affected by water and mbu [mosquitos] for malaria.'* (sh3)

*'Where I live there are many mosquitos, so there is no way to avoid this malaria issue.'* (co5)

*'Those wetlands that harbour mosquitos are not good for health, so the people will be prone to malaria.'* (se2)

The mosquitoes were described to somehow belong to this environment:

*'You cannot really control malaria...you can never... because it has something to do with the environment.'* (se3)

### **5.1.2.2 Diarrhoeal diseases in the Ewaso Narok Swamp**

Diarrhoeal diseases were especially associated with unsafe water sources, with pollution, contamination and low water quality, as is reflected in the following statements:

*'Well sometimes, kuna kuna kuna, sometimes you find that contaminated water brings about some abdominal problems like diarrhoeas, or you get mostly abdominal problems.'* (co1)

*'People have amoeba due to contaminated water and their diet. It is common here because we use the water straight from the river.'* (sh2)

Moreover, the lack and inadequacy of sanitation itself, but also as a cause for water contamination and especially during rains and flooding, were described as causes for diarrhoeal conditions. In particular, pastoral tribes were considered susceptible:

*'Diarrhoea is also common, because we don't have toilets and there are these intestinal worms. Diarrhoeal conditions, they are so common. Because most of the people here, like these marginalized groups like the Turkana, the Nandi, most of them do not have toilets in their homestead. So they normally use the bushes. So when it rains, it collects a lot of waste, a lot of faeces and they normally take it where they do collect their water in the dams. Then mostly when the people have diarrhoea, like let's say a child who is under one, they normally say its teeth which are growing so they ignore it. (...) 'They don't really know. Most of them they are ignorant.'* (se2)

Moreover, chemical fertilizers remaining on food due to a poor food hygiene were named as causing abdominal complaints.

*'When you buy food that has been sprayed by those chemicals and you eat without washing, then you get sick. You get a blocked nose, coughing and an itchy throat. And abdominal pains.'* (pa2)

### **5.1.2.3 Typhoid fever in the Ewaso Narok Swamp**

Typhoid fever was much associated with the wetland water used for multiple purposes and by many different users, contaminated by people, livestock, agriculture and domestic waste, and sanitation especially, and due to parasites:

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*'Typhoid, so you get it from dirty water. The water in the swamp is dirty sometimes, because people will go and wash their clothing there, they misuse it, they will not use it properly. Because you are supposed to fetch that water and take it a bit far from the river so that when it goes back to the river it will be safe, but when people use it directly it will be contaminated.'* (se1)

*'Typhoid also is brought about by contaminated water. Not by pesticides but we've got also water pollution, you see people are polluting water by maybe misusing water, maybe animals drink from the river, you see you see all that.'* (co1)

*'Typhoid fever is caused by water which has been contaminated by livestock.'* (se5)

*'Lately there were high cases of typhoid. It is due to the parasites in the water.'* (co3)

The rainy season was mentioned to particularly facilitate the spread of typhoid fever:

*'When it is dusty, there is (...) typhoid fever. When it rains, the water is stagnant. A lot of people use the water and that's the same water that they drink at the shamba [field]. We have been told in the hospitals that the water they take is what is causing the typhoid.'* (sh1)

Despite the knowledge about typhoid fever's transmission pathways and about preventative measures, these were often not applied as the disease was not taken too serious.

*'The water is dirty and is consumed like that. The same same bacteria are being washed to the river so we will have the typhii bacteria for the typhoid, and we later get that untreated water, we consume it, most of the people here don't wash their vegetables before cooking (...). Still after taking that water, unclean vegetables, fruits, people don't even deworm themselves, even their kids they don't deworm them. It's not expensive but here am telling you now about the ignorance. Because even to spend that 30 bob for a dewormer, they don't value that. They may use that 30 bob for something else but lateron that child will fall sick, and it will cost possibly 200 shillings.'* (se2)

#### **5.1.2.4 Schistosomiasis in the Ewaso Narok Swamp**

Several of the respondents from the in-depth interviews knew schistosomiasis and its transmission route, linking the disease closely to wetlands. Despite them perceiving schistosomiasis as uncommon in the Ewaso Narok Swamp they were aware of this risk:

*'Another disease related to wetland ecosystems is bilharzia, but it is not common here, (...) but you see still it is related to marura [the wetland]. Working in the water you expect those kinds of diseases to occur because of the environment.'* (se3)

*'I think also they [the inhabitants and users of the Ewaso Narok Swamp] get bilharzias, because of those worms.'* (se2)

They knew that the presence of schistosomiasis-hosting snail species was dependent upon the presence of stagnant water which is typical for wetlands, the risk factor of physical skin contact in terms of penetration of the pathogen exposing to disease and even the increased risks near dams:

*'Bilharzia is brought about by water flukes and this is where most let me say get [it] from the stagnant water. That is water that is not moving, that is where we get those water flukes. If you tamper with stagnant water or play there or you find people moving, let me say walking or using the water, that's where people get this from.'* (co1)

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*'It is caused by bacteria in the water, snails in the water that cause the bilharzias. It is not common, but when it is dry, the disease is there.'* (pa3)

*'Wetlands harbour snails, then when you go there and work on those wetlands, you get bilharzia because the snails will harbour larvae in those swamps. (...) The larva will find a host where they will thrive and then they will go in the water when they are grown, then when you touch that water they will get in to your body through the skin.'* (se1)

One interviewee was even aware of the transmission of schistosomiasis via the faecal-oral route besides the already described water-based direct exposure:

*'It can be chronic but the thing I want to say is that if a person who is sick from bilharzias the excreta and also when they urinate they can contaminate more people. There is a reason, you can get it from me and the whole community can get it when one person is affected. I don't think it is very common here. But you never know.'* (se1)

#### **5.1.2.5 Eye diseases in the Ewaso Narok Swamp**

Wetland water, particularly when dirty, environmental contamination and dust were made responsible for the contraction of eye conditions. Eye diseases were directly linked to poor personal hygiene, as well as to insects and flies, attracted by this lack of personal hygiene.

*'The people living here also face eye conditions due to the dust, the water and the environment.'* (sh4)

*'Eye diseases are also caused by water, even dirty water. Like washing the face with dirty water. And when you step over dirty water, especially during floods.'* (co2)

*'People lack hygiene and this can cause conjunctivitis of the eyes, and trachoma. I think it's this persistent being attacked by flies. You know the flies will be attracted due to the poor hygiene, the eyes are sticky when they have not been washed.'* (se2)

Moreover, environmental hygiene and bacterial loads in the wetland were associated with poor hygiene and given as a reason for eye diseases.

*'I don't think that eye conditions have to do anything with the water. (...) They can come because of poor personal hygiene. (...) Eye diseases are caused by poor hygiene, lack of water, lack of sufficient water.'* (se3)

Even trachoma was linked to inadequate WASH and attributed to a messy environment by several of the in-depth interview partners in the Ewaso Narok Swamp:

*'Then also there is trachoma. I can affect you when using dirty water to wash your face. That causes the disease and even the night blindness also.'* (sh1)

*'Trachoma is a disease that comes with flies. (...) The flies are going to the dirty things like maybe there is a dog somewhere they go there and they come and infect, you know if your child is not clean, it has to be affected. It [the disease] is transmitted from one person to another. It comes from you it goes to one another, the whole family becomes sick. To prevent it, you need to be clean, and keep washing your child.'* (sh3)

*'Trachoma is...due to the dirty environment.'* (pa4)

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As a consequence to their close interaction with livestock that attract flies and insects and due to the proximity to animals in their homesteads, certain marginalized, pastoral groups were seen as especially prone to eye diseases:

*'There are eye diseases. They are not affecting mostly the Samburus and Turkanas [pastoral tribes]. Because they interact a lot with cows and these flies that you are seeing are attracted to milk and these people don't have the habit of good hygiene. They don't bathe a lot and when they take the milk, it pours on them, and they don't get cleaned. So insects are attracted by the smell of milk. This is common in this place a lot and causes these diseases. They don't have latrines where they stay, they use the bushes.'* (co3)

*'Eye diseases in the dry land are common among these marginalized people due to their hygiene. They have sick eyes, they don't go for treatment, and they don't have money so later on they end up having blindness.'* (se2)

Other explanations were provided for eye diseases also, such as the weather conditions:

*'The wind causes eye diseases, and also sometimes there is this disease that starts off as a chest problem and then ends up as an eye problem.'* (pa1)

#### **5.1.2.6 Skin diseases in the Ewaso Narok Swamp**

The in-depth interviews gave a deeper insight into the prevailing knowledge on skin diseases, related risk factors and transmission routes. Again, contact with contaminated and unsafe water was the main risk factor named for this group of diseases, especially during the rainy season.

*'When people have only low water quality available for washing the skin, then they get skin diseases. And also from another person who is sick. And from works even.'* (se5)

*'Even the daily use of water causes skin diseases, itching and flakey skin. Because when it rains the water that flows down carries a lot of dirt and sewer contamination from the higher grounds to the lower grounds. That is drained into the rivers and that is the water that we fetch to use.'* (sh2)

Again also, poor personal hygiene was named as a reason for contracting skin diseases:

*'And also poor hygiene can cause rashes and skin diseases.'* (sh1)

*'People lack hygiene. This can cause skin conditions, scabies, fungal infections.'* (se2)

As reported by several respondents, two main transmission pathways for skin diseases related to water were known, but sometimes seen as in a relationship: the transmission by insects and worms inhabiting the wetland water and the contact to chemical fertilizers and pesticides during irrigation activities or during cattle spraying:

*'Skin diseases, well skin diseases you might find that maybe some people have got some (...) parasites, you find we've got these what do we call them... some worms. Different types of worms, yeah, you can get from maybe water (...). You see for example when I am watering the farm, when I am irrigating, if I get contact with a lot of water, the skin gets irritation. This comes from the soil, the chemicals, fertilizers and pesticides that we use. It affects.'* (co1)



*'As for the pastoralists, when we go to spray or take our cattle to the dip, if we don't wash our hands well, the chemicals get to our eyes and cause diseases and skin rashes.'* (pa3)

*'Skin diseases can also be due to worms, you scratch yourself, you have roundworms in your body and there they form nodules and drain the body water and when it does not have water you start having these things.'* (sh3)

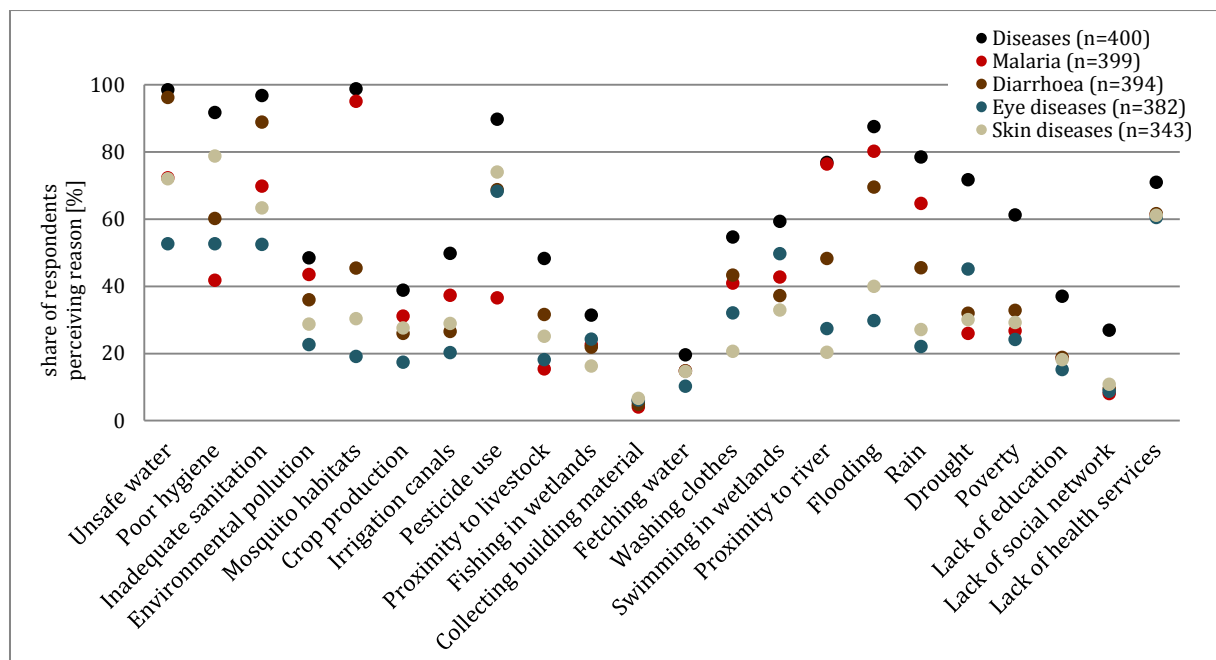
A variety of reasons was perceived as possible for causing skin diseases, ranging from the already named unsafe WASH, insects and chemicals to poor nutrition, poor sanitation and even the weather conditions:

*'Skin conditions also occur because of poor feeding when there is no harvest, but it can also be caused by the contamination of water, the unclean environment and the lack of toilets. Also it can happen due to insect bites, like in some areas people struggle with jiggers.'* (sh4)

*'Skin diseases are due to poor weather conditions, sunny, windy yeah weather.'* (pa4)

### 5.1.3 Associating use-related risk factors to wetland-related diseases

The mostly named risk factors for diseases in the Ewaso Narok Swamp were quantitatively probed with the survey of 400 respondents. These included WASH-related, vector-related, environment- and climate-related, work- and livelihood-related and occupational, vector-related, behaviour-related and infrastructural factors. Only those responses of the people knowing the diseases malaria (n=399), diarrhoea (n=394), eye (n=382) and skin diseases (n=343) were included. Figure 27 shows that different diseases were perceived to be associated with different risk factors to different extents.



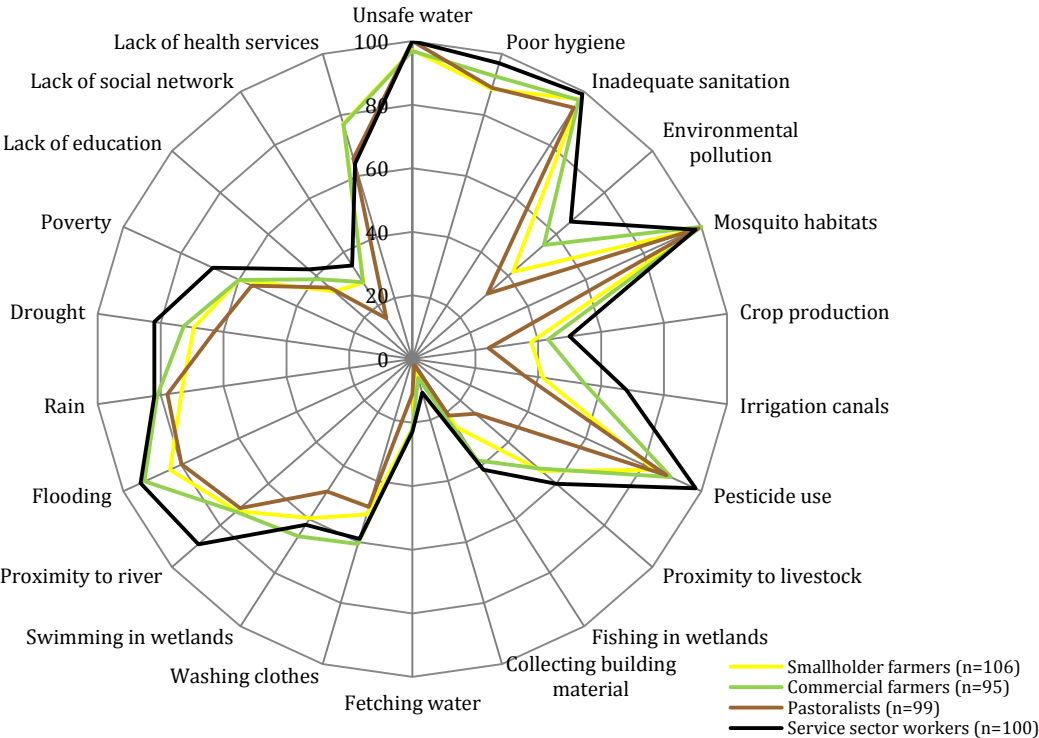
**Figure 27: Associating reasons and risk factors with diseases in the Ewaso Narok Swamp [%]**

Especially WASH is being perceived as responsible risk factors for diseases, as well as mosquito breeding sites, the use of pesticides in agricultural crop production and seasonal

features. Also, the lack of health services was linked with diseases in the Ewaso Narok Swamp. Malaria is mostly associated with mosquito breeding sites (95%), but also with flooding (89%) and rain (65%), the proximity to rivers (76%), as well as unsafe water (72%) and inadequate sanitation (70%). Diarrhoea is mostly linked to unsafe water (96%) and inadequate sanitation (89%), but also to poor hygiene (60%). Moreover, rain is attributed as a risk factor by 70%, as well as pesticide use by 69%. Eye diseases are first and foremost associated with the use of pesticides (68%), but also with unsafe WASH (53%), with swimming in wetland water (50%) and with drought (45%).

Skin diseases also are perceived to be caused especially by poor hygiene (79%), unsafe water (72%) and inadequate sanitation (63%), and also by the use of pesticides (74%). As well malaria, as diarrhoeal diseases, eye and skin diseases were associated with the lack of health services by a large share of the respondents (more than 60% each).

These associations of reasons and risk factors with diseases in general, with malaria, diarrhoea, eye and skin diseases in specific, were stratified by the different user groups in and around the Ewaso Narok Swamp. As becomes visible from the results, the trends shown in Figure 28 are quite similar for all groups: no matter the risk factor, the service sector workers are the group that mostly associates the risk factors with diseases throughout all categories.



**Figure 28: Associating reasons and risk factors with diseases. Stratified by user groups [%]**

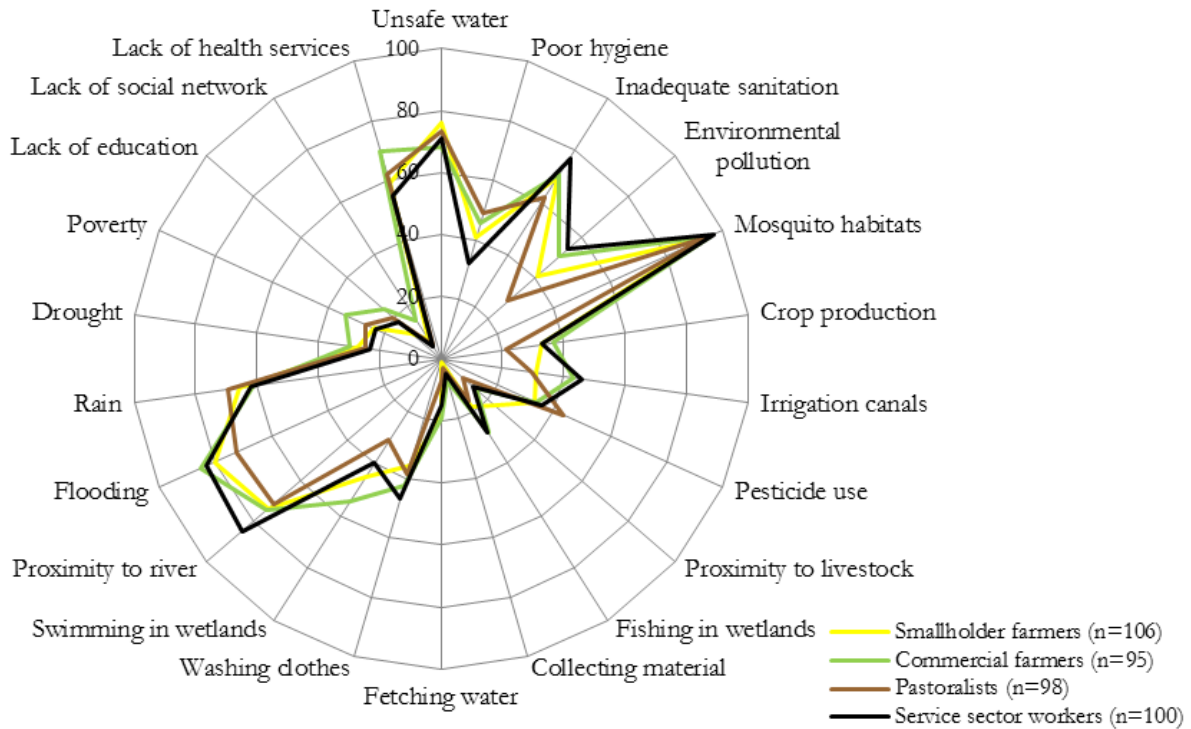
The visualization of percentages perceiving certain risk factors as reasons for diseases reveals that a higher share of service sector workers than smallholder or commercial

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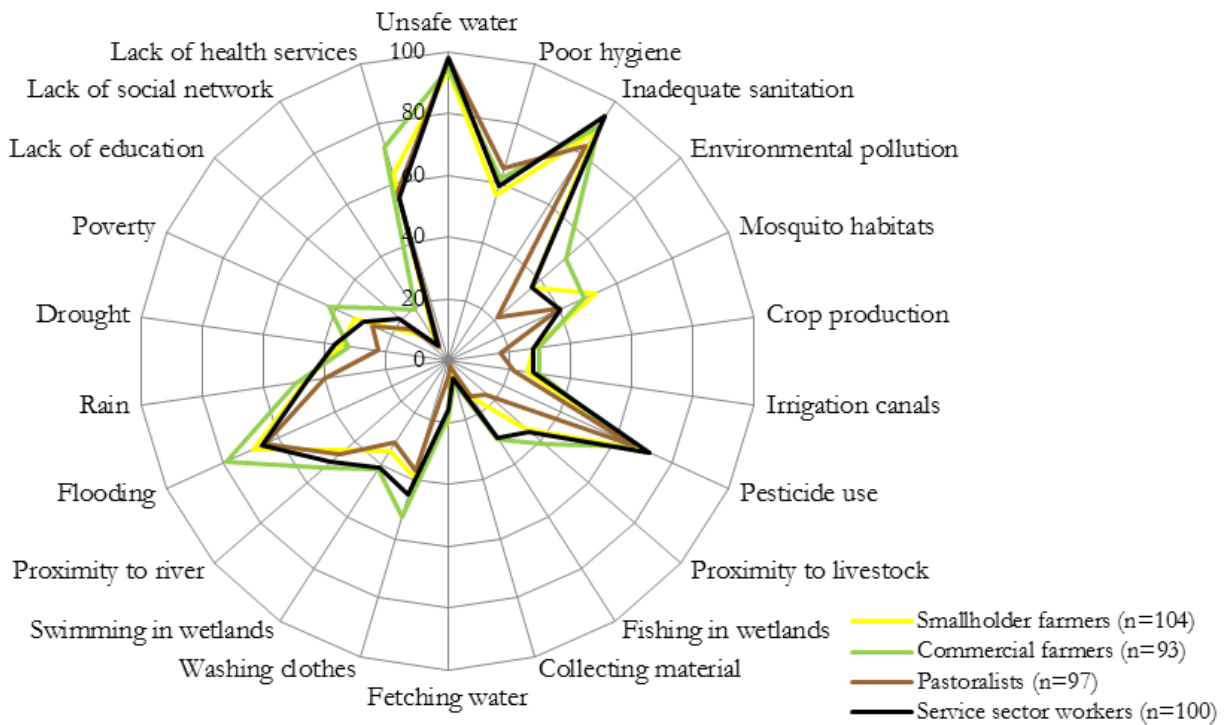
farmers is aware of health-related risk factors. The group of pastoralists least associates risk factors with diseases. One exception of this pattern is the lack of health services, which is seen as a contributor to diseases by more smallholder and commercial farmers (77% each) than pastoralists (64%) or service sector workers (64%).

When assessing the stratification of perceived associated reasons and risk factors for malaria, diarrhoea, eye and skin diseases in the Ewaso Narok Swamp by wetland user groups, a different pattern becomes visible (Figures 29-32): In terms of specific risk factors for malaria, more of the pastoralists than any other group perceive unsafe WASH as exposing to malaria, and least perceive environmental pollution to contribute to its spread.

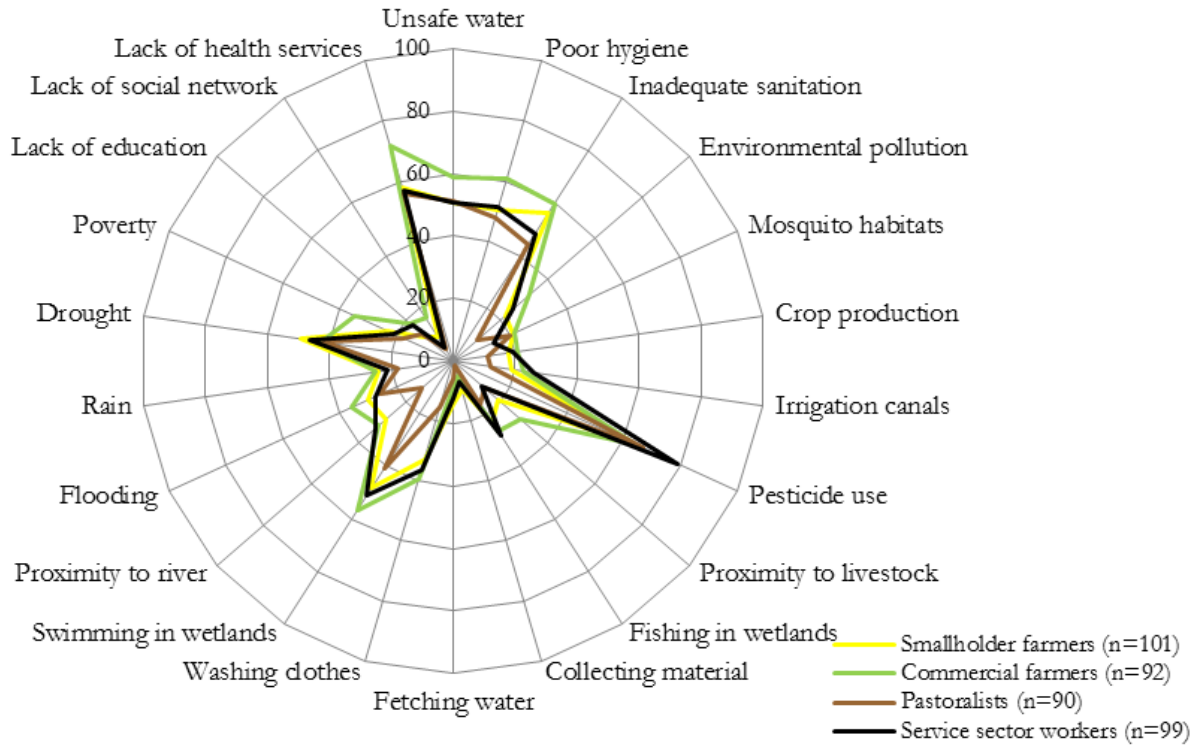
The commercial farmers, on the other hand, outstandingly associate socioeconomic and infrastructural factors with the incidence of malaria. When it comes to diarrhoeal diseases, the commercial farmers are the group that has the largest share of respondents that associate any risk factors compared to the other groups. They link any specific form of occupational or domestic wetland use, any seasonal risk factors, socioeconomic and infrastructural factors more to diarrhoea than any of the other three groups. Exceptions are only pesticide use in agriculture, associated to the same degree by all groups, mosquito habitats which are linked to diarrhoea by more smallholder than commercial farmers and inadequate WASH, which more of the service sector workers and the pastoralists find more risky. Regarding eye diseases, again, the commercial farmers are the group out of which most members associate the different risk factors to. They have the highest share of respondents linking unsafe WASH and environmental pollution, different wetland uses and climate-related risk factors, as well as socioeconomic and infrastructural risks to eye conditions when compared to the other groups in the Ewaso Narok Swamp. As is the case with diarrhoeal diseases, all groups associate pesticide use with eye diseases to the same degree. Skin diseases are mostly associated with any risk factor by more of the commercial farmers than any other group. This applies especially to wetland uses, environmental conditions, seasonal changes in the climate, as well as the aforementioned socioeconomic and infrastructural risk factors. Exceptions are unsafe water in the swamp linked by more service sector workers than any other group, pesticide use as mentioned by more service sector workers as well. Throughout the results, it seems that the commercial farmers are most aware of potential risk factors in the wetland: Notwithstanding the disease of interest, it is continuously the commercial farmers who see more risks in poverty, in a lack of education, a lack of a social network and a lack of accessible health services compared to the other groups.



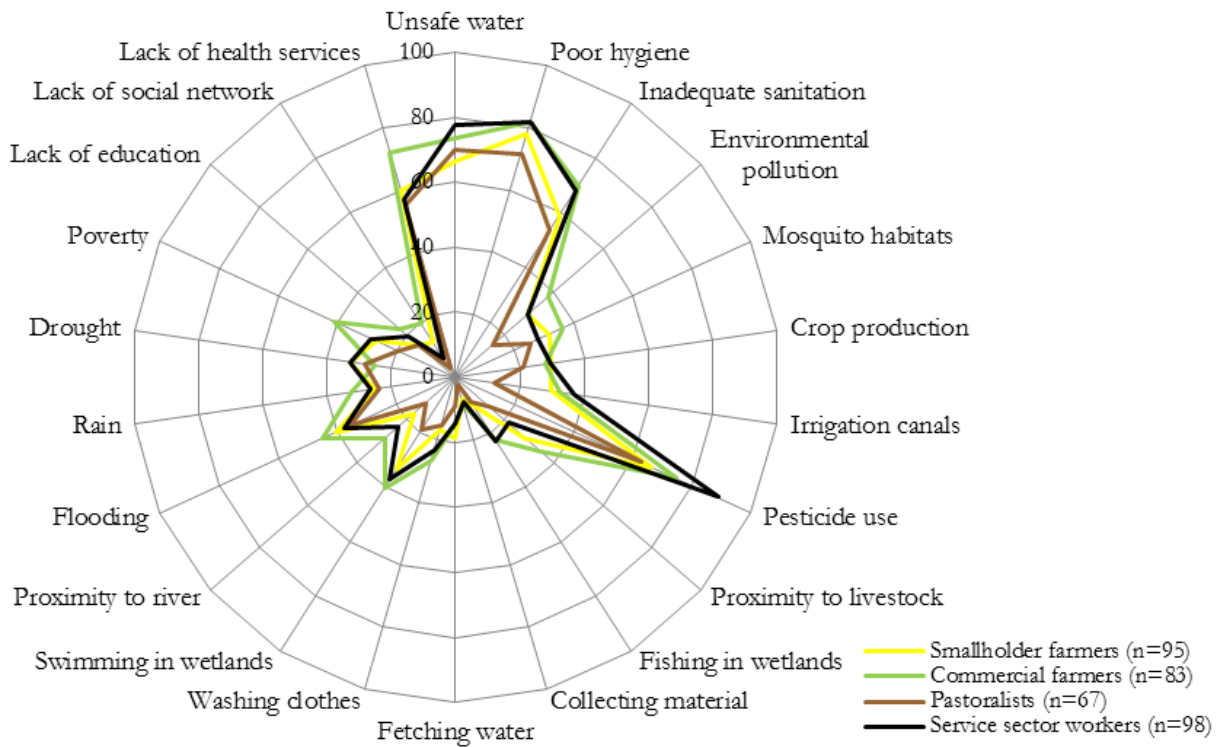
**Figure 29: Malaria: Associated reasons and risk factors [%]**



**Figure 30: Diarrhoea: Associated reasons and risk factors [%]**



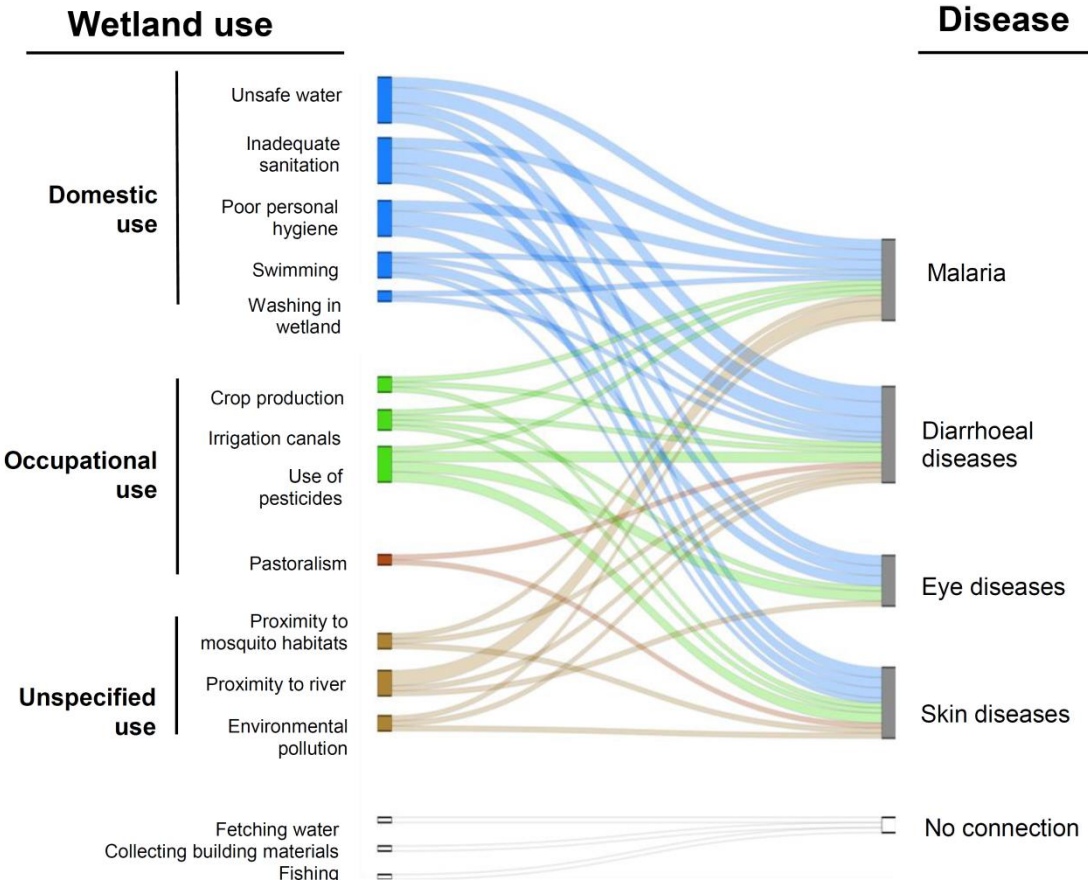
**Figure 31: Eye diseases: Associated reasons and risk factors [%]**



**Figure 32: Skin diseases: Associated reasons and risk factors [%]**

## 5.2 Integrating risk perceptions into the theoretical framework

The literature-based framework displaying a detailed overview of wetland uses, related health risk factors, transmission pathways and resulting diseases (Figure 13) was fed with the risk perception data from the people in the Ewaso Narok Swamp. The respondents associated the most common domestic, occupational and other uses (i) with selected diseases, including malaria, diarrhoeal diseases, eye and skin diseases in the quantitative part (Figure 33) and (ii) with all diseases brought up by the respondents in the qualitative part, such as malaria, schistosomiasis, typhoid fever, diarrhoea, trachoma, eye and skin diseases (Figure 34).



\* The figure is based on findings from a cross-sectional survey (n=400) with smallholder, commercial farmers, pastoralists and service sector workers.  
 \*\*\*The thickness of the connecting lines represents the percentages of in-depth interview respondents having mentioned the connections between specific wetland use and disease. The thinnest line represents 25-50% of the respondents, the medium line represents >50-75% of the respondents and the thickest line shows >75% of the respondents having referred to a certain connection.

**Figure 33: Integration of quantitative perception data into theoretical framework (n=400)**

The findings indicate that the users connected different risk factors with different uses exposing to diseases. Corresponding with the analytical literature review, the people in the Ewaso Narok Swamp perceived exposure to water-related infectious agents as dependent upon the type of use, domestic and occupational characteristics and understood disease transmission as driven by users’ physical contact to water, characteristics of pathogens and vectors of disease: The share of people perceiving the different risk factors and diseases in



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the Ewaso Narok Swamp is displayed in the Figure 23<sup>41</sup>. The overall level of risk perception regarding the contraction of diseases in the wetland was high. Strongly perceived diseases in the swamp were diarrhoeal diseases and malaria. This goes hand in hand with the literature on diseases in wetlands (Appleton 1983, Chapter 3).

The risk factors mostly associated (more than 75% of the respondents knowing the diseases) included domestic features of wetland inhabitants, most of all unsafe water sources, inadequate sanitation, poor hygiene. In specific, unsafe water and inadequate sanitation were perceived to expose to diarrhoea, and poor hygiene to eye diseases by the majority of the users. Moreover, unsafe WASH was linked to malaria and skin diseases by a large share of the respondents (50-75%). Washing in wetlands was associated with malaria and diarrhoea by less of the respondents (25-50%). Fetching water and collecting building materials in wetlands were to a very limited level perceived as risk factors to the contraction of health risks.

These findings well correspond to the literature available with regard to wetland uses in connection with diseases (Chapter 3), as well as with the risk assessments (Chapter 4). The use of wetland water for domestic purposes, the limited sanitation infrastructure and poor hygiene have been linked to numerous waterborne, water-based (e.g. Derne et al. 2015, Fuhrmann et al. 2015), water-washed (Berthe and Kone, 2008) and vector-related diseases (Prothero, 2000) in the review chapter of this work, whereas the collection of building materials was neither specifically thematised as a perceived risk factor to the contraction of diseases, nor in the reviewed literature.

Besides, several occupational use-related risk factors were associated with diseases: most of all, the use of pesticides was thematized with regard to diseases in the wetland (>75% of the respondents), and to eye and skin diseases (50-75% of the respondents). The same share of the respondents attributed irrigation canals to the risk of exposure to diseases, less (25-50%) linked irrigation schemes with malaria, diarrhoea and skin diseases. Crop production in the Ewaso Narok Swamp was linked with malaria, diarrhoea and skin diseases by just as many respondents and this also corresponds with literature available (e.g. Appleton and Madsen 2012, Resh 2010). The proximity to livestock was associated with diseases generally, and diarrhoea and skin diseases specifically, by less than half of the respondents and thus can be supported by the literature on pastoralism- and livestock-related disease exposure in wetlands (Appleton 1983). Fishing was perceived to expose to diseases by a few respondents, too.

On top of those domestic and occupational wetland-use related risk factors, the proximity to mosquito habitats by just staying in the water environment and near rivers were perceived to expose to diseases in general and to malaria in specific by the majority of the users (>75% of all respondents). Here again, the theoretical framework (Figure 13) on wetland-related

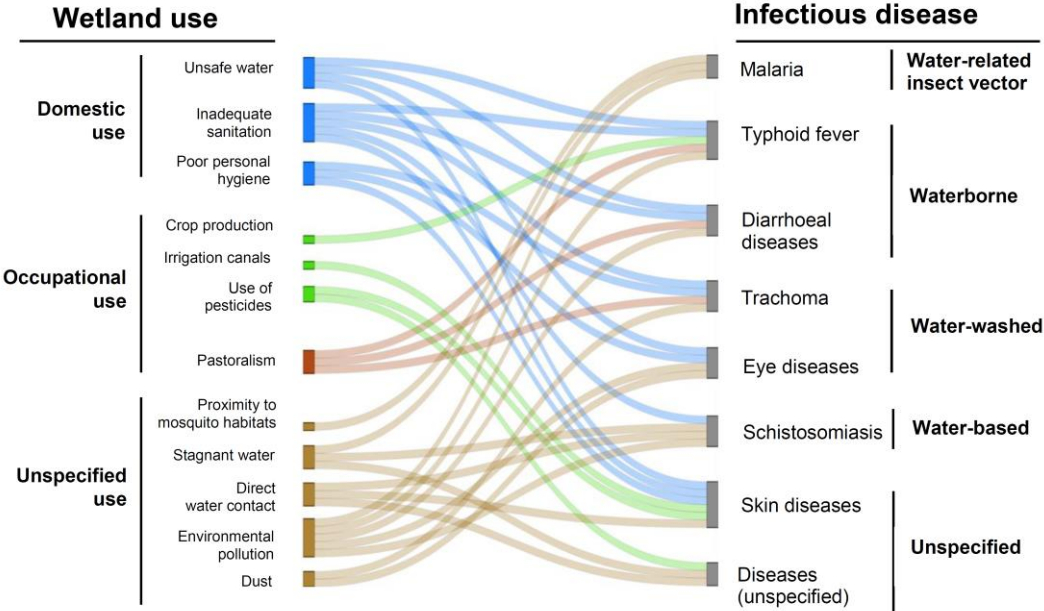
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<sup>41</sup> Those risks perceived by less than 25% of the respondents were excluded from this figure.

risk factors can be well be translated into perceived practice. The direct water contact during swimming is perceived a medium risk factor for eye diseases (50-75%) and for malaria, diarrhoea and skin diseases (25-50%). Several studies, however, have very closely linked this risk factor to diseases, most of all to schistosomiasis (e.g. Appleton and Madsen, 2012). The perception of polluted wetland environments as contributors to diseases, malaria, diarrhoea and skin diseases was comparably low (25-50%), even though this risk factor can significantly impact on the water source, thus directly affecting human health.

The weighing of risk factors and perceived diseases made a comparison of theory, actual risk and perception possible. The literature review showed, that wetland use associated with malaria, typhoid fever, diarrhoeal diseases, eye and skin diseases. The evaluation of users' perceptions shows that they mainly expect malaria and diarrhoeal diseases, followed by eye diseases, well reflecting the theory. However, while the literature base mainly addresses crop production-related risk factors such as irrigation canals favouring disease exposure most, the wetland users perceived unsafe wetland water, inadequate sanitation and poor hygiene as way more hazardous than any occupational-related risk factor. Overall, some risk factors seem better understood than others.

Figure 34 shows diseases and risk factors associated with different wetland uses during the in-depth interviews with twenty individuals (Chapter 2.3.3.1). The figure exclusively illustrates what was proactively brought up by the respondents when being asked about the implications of wetlands on the incidence of water-related diseases.



\* The figure is based on findings from qualitative in-depth interviews (n=20) with smallholder, commercial farmers, pastoralists and service sector workers (n=5 each).

**Figure 34: Integration of qualitative perception data into theoretical framework (n=20)**



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Although the transmission pathways and risk factors of all diseases were described more thoroughly and in greater detail than can be summarized in this framework, what becomes visible is that domestic use of the wetland as drinking water, for personal hygiene and related to sanitation were associated with all of the diseases listed. This perception holds true as described in Chapter 3. Whereas the quantitative data suggested that only occupational wetlands use for crop production would expose users to diarrhoea, these in-depth qualitative data reveal that this kind of use is also perceived as a risk factor for typhoid fever, which was proved by Anchang et al. (2014). This disease was perceived to possibly be brought along by the use of pesticides, too. Additionally, this risk factor is made responsible for skin diseases. While the first association cannot be substantiated by the literature, skin diseases indeed can be brought along by the use of chemicals in agricultural crop production. This, however, was initially not part of this investigation, but was researched elsewhere (Fuhrimann et al. 2015, Schwarzenbach et al. 2013, Smeester et al. 2015, Stauber and Casanova 2015, Villanueva et al. 2013). The diseases associated with the proximity to livestock, which is extraordinarily high for pastoral groups in the Ewaso Narok Swamp, covered typhoid fever, diarrhoea and trachoma, all of which had been evidenced by literature as well. Whereas the risk perception of environmental pollution in the Ewaso Narok Swamp was rather low (25-50% of the respondents) when compared to other risk factors, the qualitative methods prove to be very valuable to underline the risk factors' importance and broad perceived impact: besides skin diseases and malaria, that environmental pollution was linked with in quantitative part of this study, the qualitative part could associate it with typhoid fever, diarrhoea and schistosomiasis in addition to the already mentioned. Interestingly, dust was addressed as risk factor for trachoma and eye diseases in general, and given that dust is a very loose term which in the study area stands for waste, pollution and dirt, these diseases could be attributed to environmental pollution, too. As was discussed above, the proximity to mosquito breeding grounds in the swamp was perceived as a high risk factor for diseases in general and malaria in specific by the majority of the respondents. The qualitative findings nicely complement this risk factor by the presence of stagnant water, which is, besides malaria, perceived to be associated with the occurrence of schistosomiasis, a fact that is evidenced (Chapter 3).

### **5.3 Focus on the perceptions of use-related occupational health risks**

The in-depth interviews conducted with representatives of the four wetland user groups facilitated deeper insights into use-related and occupational health risks in the Ewaso Narok Swamp and underlined the differences between the farmers and pastoralists (Table 30).

With regard to water-related infectious diseases in wetlands, what became clear from the statements made is that farmers face challenges due to the occupational proximity to water, irrigation canals and insects. The main risk associated with the wetness and with staying near water during farming activities was contracting malaria.

**Table 30: Qualitative themes: Perceptions of use-related and occupational risk factors**

	Farming	Pastoralism	General
water-related infectious diseases	<i>The farmers are very much exposed to the wet areas and get a lot of malaria. (se4)</i>	<i>With livestock farmers, (...) the homestead where they keep the livestock, that animal waste can bring problems because (...) it becomes a good environment for insects (...) You expect those people to be affected by eye and skin disease because of they are not hygienic, they are moving long distances to get water and once they get water its meant for their animals (se3)</i>	<i>There is a difference when it comes to health risks for pastoralists and for farmers. When you are a farmer, you will stick to one place so (...) you will not be prone to diseases because you are situated in one place. But as a pastoralist, you will move from one place to another so we will not know whether it is an outbreak in this place or not. So when you go to a place where there is an outbreak, you will just get it. And because of environmental changes, when you come from hot to cold places, you know the temperatures affect the pastoralists. (se1)</i>
	<i>So the biggest challenges that one faces at their work place are amoeba, typhoid and malaria and brucella, and the cold water is also bitter for people who work long hours in the wetland. They dig furrows and then they pump the water to farms, so when you pumping the water you actually standing in the water. (...) Also, flooding is a big threat for people who work here (co3).</i>	<i>Pastoralists migrate to different areas. They live under poor conditions in tents. They have a poor diet with meat and milk only. Sometimes the animals are sick and cause diseases. (se5)</i>	<i>The diseases are not any different for farmers or pastoralists. And both of them cause diseases. (pa1)</i>
	<i>Farmers are mostly exposed to malaria and insects and affected by dirty water, they take it. (sh4)</i>	<i>I know that the pastoralists watch over the cattle at night and get exposed to the cold hence get flu. Livestock also gets sick after getting the dust and they cough. But they don't transmit diseases to humans. (pa3)</i>	<i>There is no difference between pastoralists and farmers in terms of diseases. (sh5)</i>
	<i>The farmers do irrigation of their fields. They stay always in the water and many wear no safety clothes. They easily get malaria and even typhoid fever. And they get colds. (se5)</i>	<i>Their cattle drinks dirty water, they get worms. (se4)</i>	<i>There are no different health risks for different wetland users. (sh1)</i>
	<i>There are no problems health-wise that arise from the wetlands, except fatigue from farming too much. (sh5)</i>	<i>The pastoralists are more at risk than farmers. (co3)</i>	<i>The pastoralists and the farmers are exposed to the same health risks, there is not any difference. The pastoralists spray their animals near the water or in the water. This causes poisonous contamination of the water, it is bad for the body. Many farmers use chemicals on their fields, they cause the same contamination and health problems, so it comes from both sides. (co4)</i>
	<i>Farming can harm health. (pa5)</i>	<i>As for the pastoralists, when we go to spray or take our cattle to the dip, if we don't wash our hands well, the chemicals get to our eyes and cause diseases. It can also bring skin rashes. (pa2)</i>	<i>Nowadays there are more diseases than before, because the people do irrigated agriculture and use chemicals because they do not trust manure. They get ill. (se4)</i>
	<i>It is common to use chemicals and that gives skin problems. Even the inhaling causes diseases. (se5)</i>		<i>The health risks are not different but them. Some have been brought up traditionally by their forefathers to use medicinal plants. So they would approach health issues differently but it's not that [risks] would affect them differently. (sh1)</i>
	<i>Those who use the fertilizers have skin pimples and eye problems, and respiratory problems. (sh5)</i>		
	<i>The chemicals that we spray (...) have some effect on your body. They make you feel tired. (co3)</i>		
	<i>Using those chemicals without protective gear they get diseases, headache, and dizziness. (pa3)</i>		
use of chemicals	<i>There was a time when I used some pesticide. When I was done I forgot to wash my hands (...) and that caused all that swelling on my face. I am still on medication. It is very poisonous. (co5)</i>		
	<i>They mainly use pest control and fertilizers, but only few of them use a pump. Instead, they use no protection and apply the chemicals with their hands. (se4)</i>	<i>But if you compare them [the farmers] with these nomads, they move from here to there is a lot of temperature in the foot so you find them wearing open shoes yeah... (se3)</i>	
protective measures	<i>The farmers are using fertilizers, they get to your system, your chest and if you do not drink milk, it is going to be a problem. Milk kills the effect in the body. (co5)</i>		

\* These selected quotes reflect information gathered during open-ended in-depth interviews (n=20).

\*\* The individuals interviewed belonged to four different user groups, namely smallholder farmers (sh), commercial farmers (co), pastoralists (pa), and people working in the service sector (se). Each group is represented with n=5.

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Moreover, the contact with and ingestion of contaminated wetland water was linked to the risk of contracting typhoid fever and amoebiasis. Besides, staying in the water was associated with cold and flu.

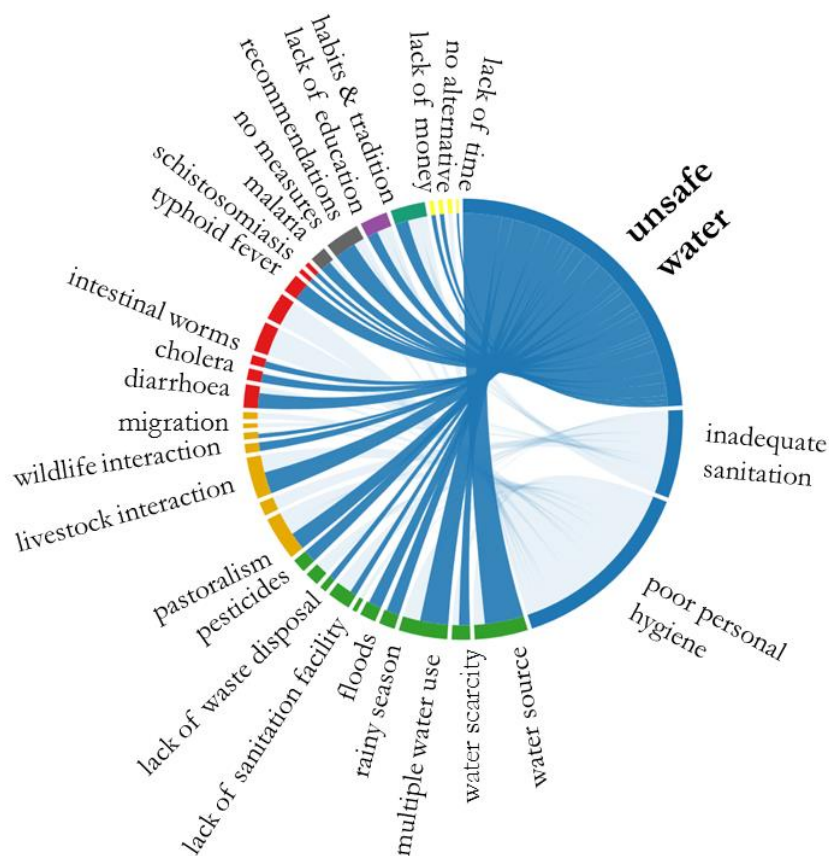
All wetland user groups linked different health risks to farming in wetlands and stated that it may harm health. Occupational health risks affecting pastoralists, on the other hand, were mainly associated with distance to the water source, water scarcity, proximity to livestock and reduced hygiene, all of which was linked to skin and eye diseases. Moreover, livestock-related diseases were mentioned to be health threats, but when comparing the statements by representatives of the user groups, no consensus was reached on whether or not livestock would transmit any diseases to the pastoralists. Whether farmers or pastoralists were exposed to higher occupational health risks differed much, and several perspectives could be identified. Whereas some argued that farmers were exposed to higher occupational and wetland-use-related health risks, others would attribute greater risks to the pastoralists.

An aspect very much underlined as posing a threat to human health throughout the research was the use of chemicals in the Ewaso Narok Swamp, particularly being applied in order to increase the harvest. Due to the use of fertilizers, pesticides, fungicides, herbicides and pest control, the burden of diseases in the marsh was described to have increased. Health risks would cover both water-washed and airborne contact with chemical substances leading to skin irritations, eye conditions, headaches, dizziness and respiratory problems. Even though these risks are increased for farmers, pastoralist also faced similar risks when applying chemicals on livestock in order to control for diseases. The contamination of water sources that resulted from the use of chemicals was rated as a significant contribution to the burden of diseases, which the users considered themselves as responsible for.

All interviewees were aware of the potential that protective measures, especially the use of protective gears, would have for the reduction of risk and thus, disease burden. Still, only few people were reported to be using spraying pumps, gum boots or other tools in order to reduce risks. No protective measures were described to prevent occupational malaria or typhoid risks. In terms of preventing the negative effects of inhaling chemicals, the common practice of taking milk in order to neutralize the chemicals in the body was mentioned. No measures were mentioned with regard to pastoralists preventing health risks. As was put in a nutshell by one respondent, health risks do not differ among farmers or pastoralists, but farmers and pastoralists do. In terms of health protection, some would prevent negative health effects by the intake of traditional medicine, and approach health issues differently, thus they would not be affected by risks differently, but respond or prevent them differently.

## 5.4 Focus on the perceptions of WASH in the Ewaso Narok Swamp

The analysis of the quantitative data from the survey questionnaire, the findings from the open-ended questions and the in-depth interviews strongly indicated that unsafe water, inadequate sanitation and poor personal hygiene were perceived as high risk factors for the contraction of numerous diseases in the Ewaso Narok Swamp. Therefore, a special focus is set on WASH in this section, presenting the outcomes of a WASH-centered qualitative analysis of 20 in-depth interviews which reveals the numerous aspects that the people in the Ewaso Narok Swamp associated, including the water source and environment, lifestyle and tradition, risk perception, health-protective measures, education and others, as is displayed in the following (Anthonj et al. 2016<sup>42</sup>, Figure 35-37, Table 31): As mentioned by most of the respondents, the wetland remains the most important water source for many people living around Ewaso Narok Swamp (90%), despite the wide-ranging perception of it being unsafe. Factors impairing the quality of water (Figure 35) included the multiple uses of the same sources for drinking, hygiene, farming, livestock watering and for other uses (65%). Livestock interaction was underlined as a major contributor to water contamination (50%). The lack of sanitation facilities served as an explanation for negative water quality (15%), causing faecal material from open defecation to enter drinking water sources (15%).



\* The figure is based on in-depth interviews (n=20) with smallholder, commercial farmers, pastoralists and service sector workers (n=5 each).  
 \*\*\*The thickness of the connecting lines represents the percentages of in-depth interview respondents (n=20) having mentioned the connections between unsafe water and the linked aspect.

**Figure 35: Perceptions of unsafe water in the Ewaso Narok Swamp**

<sup>42</sup> Parts of this chapter have been published.

The rainy season was perceived as contributing to the unsafe water supply, as well as floods carrying dirt from higher grounds into the wetland (30%).

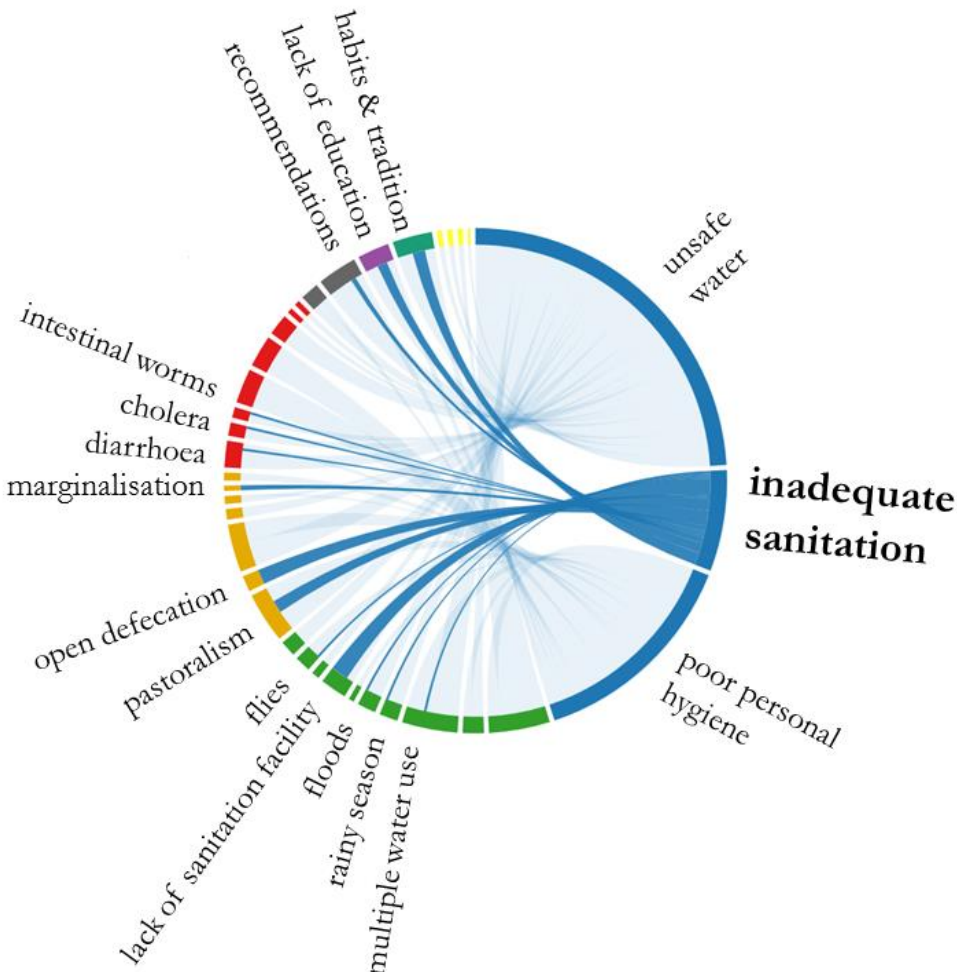
**Table 31: Qualitative themes. Perceptions of WASH in the Ewaso Narok Swamp**

	<b>Water</b>	<b>Sanitation</b>	<b>Hygiene</b>
water sources	<p>Those people in the rural wetland areas, they depend on rain and river water. There are those who have wells, but let me say, not protected wells. Most houses don't have tap water (se3).</p> <p>The water is not clean and it's the same water we are using for everything (pa4).</p> <p>We lack good sanitation, latrines and the bathrooms, so we have to go to the wetland for the services and we also let the animals drink from there. This just contaminates the whole water (pa4).</p> <p>When it rains, dirt that is on the ground gets washed to the river and it's the same water we use (pa5).</p>	<p>Because most of the marginalized groups [reference to nomadic pastoralists] do not have toilets in their homestead. When it rains, a lot of faeces are washed into the wetland. They normally take water where they collect it (se2).</p>	<p>One problem is that the water is contaminated. The people use the same water from Ewaso Narok Swamp for bathing (se5).</p>
water quantity	<p>Now when there is no water. The people use the same water from Ewaso Narok Swamp (co2).</p>		<p>Due to a lack of enough water, personal hygiene could be low (se3).</p>
lifestyle	<p>The pastoralists they migrate to different areas where there is water, and then they drink the same water as their livestock (se5).</p>	<p>Most of the people here, like these marginalised nomadic groups they normally use the bushes (se2).</p>	<p>There is no separation between livestock and humans, it is not hygienic (sh4).</p>
education	<p>They don't know the meaning of clean water (co2).</p> <p>Those people need to be taught, they need to be shown the way to handle swamp water (sh2).</p>	<p>Many people have an issue with sanitation, they don't know (co3).</p> <p>Like some don't have toilets. They don't care, they are ignorant (se1).</p>	<p>We have to educate the people, it's about their health. There are those people who are ignorant, who deny hygiene (sh2).</p>
health risk perception	<p>The wetland water causes diseases. If someone drinks the dirty water, they can be sick. Animals are in the water, people dump their waste in the water, people use the water as latrine to relieve themselves and that is the same water they use in the house. When it rains, dirt is washed to the river. It's the same water we use (pa5).</p>	<p>Diarrhoea is also common, because they don't have toilets and there are intestinal worms (se2).</p>	<p>Eye diseases are also caused by dirty water. Even when you are stepping over dirty water you can get diseases (co2).</p> <p>When people have only low quality of water available for washing their skin, they get skin diseases (se5).</p>
protective measures	<p>In the wetland, there is water which causes disease. If one doesn't boil the water it gives problems (co4).</p> <p>There is a lack of information on how to protect yourself from diseases (sh4).</p>	<p>There is need to have latrines in your compound there is need to clean your compound, there is need to improve your sanitation and hygiene (co4).</p>	<p>To prevent diseases, the majority of the people do hygiene measures (sh2).</p>

\* These selected quotes reflect information gathered during open-ended in-depth interviews (n=20).

\*\* The individuals interviewed belonged to four different user groups, namely smallholder farmers (sh), commercial farmers (co), pastoralists (pa), and people working in the service sector (se). Each group is represented with n=5.

The lack of water in the semiarid swamp area was seen as negatively affecting water supply and quality (25%). Lifestyle and tradition played a major role in the respondents' explanations in terms of water safety, too. Several respondents (40%) described the pastoralists as mostly using unsafe sources due to their nomadic lifestyle of migrating from one place to another. Unsafe domestic water storage was mentioned to be due to traditional habitual behaviour (30%), the lack of education (25%), and included other reasons, too. Unsafe water sources and limited water hygiene were perceived to be associated with several diseases, such as typhoid fever (40%), diarrhoea (35%), cholera (20%), intestinal worms (15%), schistosomiasis and malaria (10% each). Half of the respondents suggested concrete health-protective measures with regard to water, but only 25% reported actually applying them.



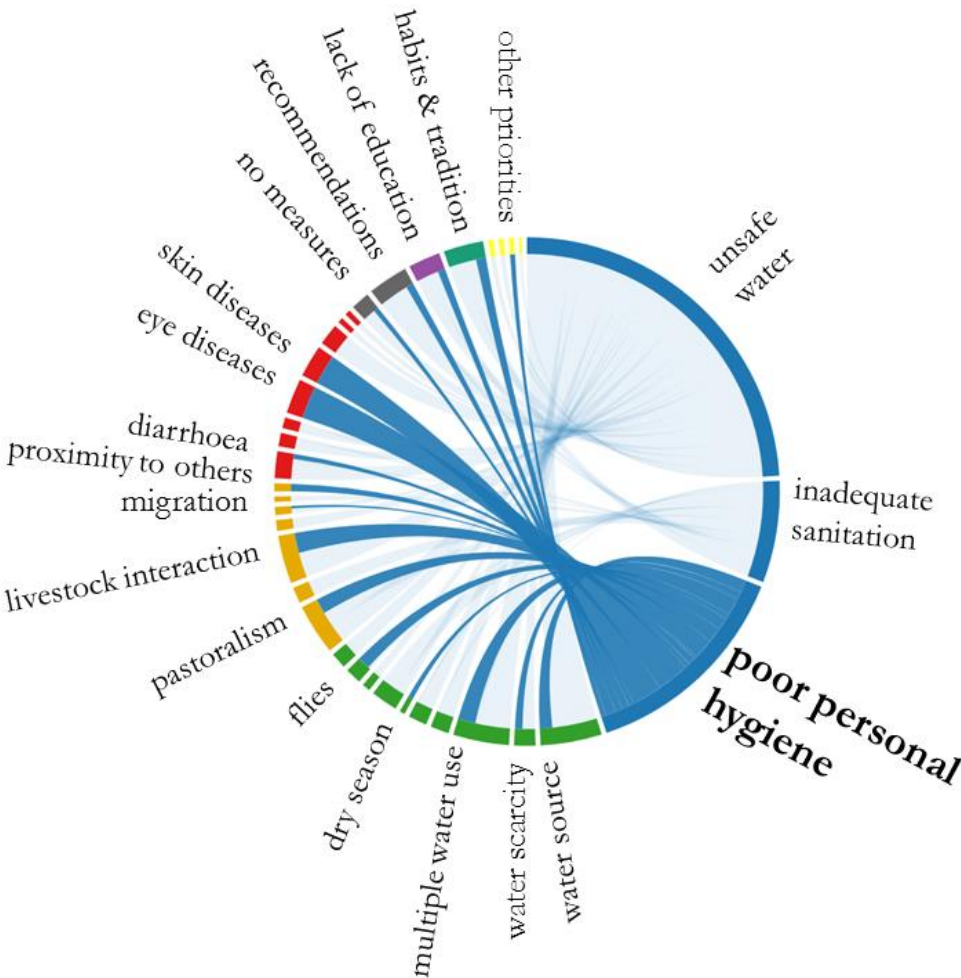
\* The figure is based on in-depth interviews (n=20) with smallholder, commercial farmers, pastoralists and service sector workers (n=5 each).  
 \*\*The thickness of the connecting lines represents the percentages of in-depth interview respondents (n=20) having mentioned the connections between inadequate sanitation and the linked aspect.

**Figure 36: Perceptions of inadequate sanitation in the Ewaso Narok Swamp**

A lack of sanitation facilities in households all over the Ewaso Narok Swamp was reported (35%), and consequently, the need to practice open defecation (30%). Some of the in-depth interview respondents (25%) perceived this to be the case especially among pastoralists due to their nomadic lifestyle in remote areas (10%). The rainy season was assessed as

negatively impacting the sanitation conditions, as well as floods (5%) and multiple use of water (5%). Not using sanitation facilities was explained as determined by tradition and habits (25%) and by a lack of education (20%). Inadequate sanitation was perceived to be linked to the risk of contracting diarrhoea, cholera and intestinal worms (5%). Still, only 10% of the people interviewed suggested concrete measures to improve sanitation (Figure 36).

The inadequate water sources (25%) available were reported as being responsible for poor personal hygiene (Figure 37). Water that was being used for various purposes and by different groups (35%) was seen as impairing personal hygiene, with water scarcity and semi-aridity contributing as well (15%). Lifestyle and tradition were associated with poor personal hygiene. In this regard, the pastoralists were mentioned by almost one third of the interviewees (30%) due to their lifestyle as nomads in dry areas living in close proximity to livestock (40%). Poor personal hygiene was explained by habitual behaviour (20%) and was linked to a low education level (15%).



\* The figure is based on in-depth interviews (n=20) with smallholder, commercial farmers, pastoralists and service sector workers (n=5 each).  
 \*\*The thickness of the connecting lines represents the percentages of in-depth interview respondents (n=20) having mentioned the connections between poor personal hygiene and the linked aspect.

**Figure 37: Perceptions of poor personal hygiene in the Ewaso Narok Swamp**

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Eye (65%) and skin (60%) diseases as well as diarrhoea (10%) were attributed to poor personal hygiene. Fifteen percent of the respondents suggested hygienic measures for health protection, and 10% stated they would not apply any such measures.

During the in-depth interviews, the pastoralists were the group that was described and described themselves to have least access to sanitation facilities and to practice most open defecation. They were also perceived having the poorest personal hygiene. All has been mostly attributed to their nomadic lifestyle in dry and remote areas and in close proximity to their livestock and to traditional habitual behaviour. Most are lacking school education, have a relatively low level of health risk perception and undertake the fewest health-protective measures of all groups. On top of this, their socioeconomic status is low compared to the other groups (Chapter 1.3.3).

## **5.5 Focus on health beliefs in the Ewaso Narok Swamp**

Not only occupational or WASH-related health risk perceptions were described by the people in the Ewaso Narok Swamp, but also numerous health beliefs involving the meaning of water and disease in local cultural or traditional contexts (Table 32). These were included in this thesis because they might partly serve as explanations for health-related decisions the people take in the prevention or response to ill-health. Particularly the pastoralists had some very distinct beliefs, driven by tradition, which would influence their behaviour. In their culture, bathing in surface water sources, especially in the river, was perceived as important and healing.

Also, their tradition would attach a great importance to their livestock, with their cattle, camels and goats being perceived as equally important as humans and partly more important than own needs, including health. Religious aspects and symbols were meaningful to the respondents also, particularly in terms of health-seeking behaviour: whereas some religious affiliation would discourage to seek care from hospitals or conventional medicine, others would rely on God's power and the content of the holy bible. The beliefs also differed widely when it came to water quality issues. Some of the respondents believed that the capacity of the swamp in purifying the water and making it ready for consumption was sufficient, whereas others believed that treatment had no effect whatsoever. Moreover, weather and environmental conditions were believed to be responsible for water-related infectious diseases, with dust and rain causing malaria, wind causing skin and eye diseases, as well as the sun. The first rain drops at the onset of the rainy season were believed to carry loads of pathogens. Pesticides used in agriculture were believed to cause malaria. Moreover, malaria was believed to be brought about by elephants. In terms of health service provision, cure was believed to be only possible after medical injections, whether possible or not.



**Table 32: Qualitative themes. Health beliefs in the Ewaso Narok Swamp**

Theme	Local belief/idea of disease cause
Traditional aspects	<p>People use river water for cultural reasons. It is traditionally important to bathe in the river. (CHW)</p> <p>This turkana tribe [pastoral group] is paying more attention to livestock than it's own health and people. (co3)</p> <p>There are those traditional beliefs, where people don't trust in drugs and rely on herbal medicine. (former PHO)</p> <p>Some communities like Samburu [pastoral group], let me say that they prefer their animals more than their health than their lives. (...) They believe that they can't survive without those animals. (former PHO)</p>
Religious aspects / symbols	<p>There are some [medicinal] herbs which grow especially close to the river [Ewaso Ngiro] and they are very good. If you read the bible at the revolution chapter 22, you know that the trees at this side of the river will be healing people, that is what it says. Therefore, the herbs near the river heal so quick, they are so good. (Healer)</p> <p>You should rely on God's power to help you understand some diseases. (Healer)</p> <p>For our culture we like going to a witchdoctor [for cure] who gives instructions on what needs to be done, you do it and if not doesn't work, he gives you another direction, or other instructions. (pa3)</p> <p>They [the pastoralists] had a belief that once you try to remove that the flies, when you are trying to chase them away... that you are trying to send away the wealth. The moment, you do this you are trying to chase the wealth away. Yeah that is the argument they had. So that is where you find that most of such diseases [trachoma] are affecting the livestock farmers. (former PHO)</p> <p>They are many people who never go to hospital even if they are sick. There are some religions they refuse, they don't believe in this but in their God, who heals them. (CHW)</p> <p>There are those religions, that will not allow to take the medical advice because they believe that medicines are manufactured from people's body parts so they cannot take those medicines because they say they are eating people's meat. (CHW)</p>
Water quality	<p>You are supposed to fetch that water and take it a bit far from the river so that when it goes back to the river it will be safe, but when people use it directly it will be contaminated. (se1)</p> <p>We clean the water, we use a sieve. The water settles but it does not make any difference. (pa5)</p> <p>Clearly you see what we have here, like now, you see the river that forms the marura [wetland] passes under the ground. I believe that because of that water sieving through the soil, at least some of these germs are sieved by the soil so by the time that water is used, we don't have a big complain here. (former PHO)</p>
Weather and environmental conditions	<p>The dry season causes a lot of problems because there is a lot of dust that causes malaria. (co5)</p> <p>Here when it rains, there is much flood, it flows, you know the landscape and brings malaria. (se1)</p> <p>Skin diseases are due to poor weather conditions, sunny, windy yeah weather. (pa4)</p> <p>Eye diseases may be caused by the sun, (...) and the wind. (pa5)</p> <p>Since December we have not had any rains therefore you expect the air to be very much contaminated, and the first drops of the rain, you expect them to carry each and every germ. The air, the dust carry so many germs that can cause so many diseases, like cholera. (former PHO)</p> <p>As found in the risk perception study, around 40% of the respondents linked malaria to the use of pesticides in agricultural production.</p>
Child health / well-being	<p>When the people have diarrhoea, like let's say a child who is under one, they normally say its teeth which are growing, that's why they are showing those symptoms. So they ignore it. (se2)</p>
Animals	<p>Mammals are a challenge. Elephant waste brings diseases, mostly diarrhoea. And malaria. (pa5)</p>
Health service provision	<p>My grandmother believed that if she goes to any facility without being given an injection, then she won't get well. So I used to take her to the hospital and asked the health worker to do something, even just inject her water, so she would be ok. Because if you believe that this drug will heal you and will cure the problem the problem that you have, you will do it, but if you have some doubts, do I expect my problem to be solved? (former PHO)</p>

\* These selected quotes reflect information gathered during open-ended in-depth interviews (n=20).

\*\* The individuals interviewed belonged to four different user groups, namely smallholder (sh), and commercial farmers (co), pastoralists (pa), and people working in the service sector (se). Each group is represented with n=5.

\*\*\* Moreover, expert views of a chemist, community health worker (CHW) and former Public Health Officer (PHO) were included.

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Out of these beliefs, none has a direct causal relationship. However, indirect or secondary relationships can be discovered, such as malaria occurring more often where people farm in the inner parts of the wetland, where also more pesticides may be applied, thus explaining the perceived link between pesticides and malaria. Or elephants increasing the risk of malaria, not by their presence, but by the breeding sites that their footprints are possibly creating for *Anopheles* mosquitoes that may transmit malaria. The links between eye diseases and sun are also comprehensible, given that eye diseases are more common in the drier parts of the Ewaso Narok Swamp, where the pastoralists live far from water supply, infrastructure and close to livestock, all of which are risk factors for eye diseases. The traditional importance of pastoralists' livestock is understandable also, considering that they are usually their main and only livelihood which pastoralists completely depend on as compared to farmers, who might have alternative income options and side business as a backup and resilience. Also, the purifying potential of the wetland is not only a belief but real (Masamba and Mazvimavi 2008), however, given the high population in the area, the capacity might not be enough.

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## 5.6 Synopsis: WASH as biggest perceived health risks

This chapter aimed at capturing the wetland users' understanding of health, the knowledge on diseases and their health risk perception. The analyses showed that the people in and around the Ewaso Narok Swamp strongly see the connection between wetlands and adverse effects on human health. They are aware of the environment-animal-human health nexus, commonly now described as 'One Health' and link the cause-relationship of the WASH nexus and health. They are aware of numerous diseases that the use of the swamp may expose them to. Especially unsafe water, inadequate sanitation and poor hygiene (WASH) and environmental pollution are being perceived as responsible risk factors for the exposure to infectious agents and pathogens eventually leading to the contraction of water-related infectious diseases in wetlands, in particular to diarrhoeal diseases and typhoid fever. As summarized by one pastoralist in the Ewaso Narok Swamp

*'...the quality of water is poor now, it is not as good anymore because of the water contamination. A lot of people right now are using this water and it is coming from way up there [the Aberdare Ranges]. We lack good sanitation, latrines and the bathrooms, so we have to go to the wetland for the services and we also let the animals drink from there. So this situation just contaminates the whole water. Water is the main problem in this area. It's dirty, water is the major cause of diseases in this area. The water is so little and it's the same water we are using for everything, for the livestock, wild animals, and with the farmers for irrigation, so it's posing as a challenge for us.'* (pa4)

Moreover, the wetlands' water resources providing mosquito breeding sites are rated as harmful and exposing users to malaria. Occupational factors, such as the use of pesticides in agricultural crop production and environment- and climate-related features are widely perceived risk factors as well. Several diseases, especially diarrhoeal conditions, typhoid fever and malaria are perceived as being accelerated during seasonal specifics. The perceptions of the health risks posed by wetland use differ according to different groups. In particular, the smallholder farmers and service sector workers have the widest discrepancy in their respective risk perceptions: The service sector workers least perceive potential risks and diseases in wetlands and this is likely due to their occupational features, working in small businesses in rather centralized areas, farther away from the Ewaso Narok Swamp, they are neither dependent upon the wetlands for their livelihoods, nor being directly exposed to this specific environment with its health risks on a daily basis and therefore lack experience on risks associated to the wetland. Smallholder farmers, on the other hand, perceive the links between wetlands, risks and diseases at most as compared to the other groups, likely due to their proximity and dependence on wetland water source. The pastoralists perceive an increased burden of diseases and decreased water quality strongest compared to the other groups, potentially due to high dependence on water for drinking and due to their long history of living in and depending upon the swamp, therefore having extraordinary experience and knowledge on the environment – human relationships.

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The knowledge on wetland-related infectious diseases differed widely. Most of all people were able to link typhoid fever and malaria with wetlands; neglected tropical diseases such as schistosomiasis or trachoma were linked with wetlands by less people. However, overall, these perceived disease exposures correspond with the actual diseases potentially prevalent in wetlands (Appleton 1983). The overall knowledge on diseases was highest among the service sector workers. However, the more wetland-specific the questions became, the less they were able to associate diseases, whereas specific questions could best be answered by the pastoralists. The explanation for this lies in the experience of pastoralists with this specific environment. Unlike all other groups, the pastoralists have been inhabiting such semiarid wetland areas as is the Ewaso Narok Swamp for centuries, have gained knowledge, have passed this on for generations and therefore best know the environment and disease exposures it can contain.

The quantitative probing of association between use-related risk factors to wetland-related infectious diseases revealed that occupational, work- and livelihood-related, WASH-related, environment- and climate-related, behavioural and infrastructural factors were associated with diseases in general and with malaria, diarrhoea, eye and skin diseases in specific in the Ewaso Narok Swamp. The risk factors people were most aware of again included unsafe water, inadequate sanitation and poor personal hygiene, environmental pollution, proximity to mosquito habitats and the use of pesticides in agricultural crop production. It appeared that the commercial farmers have the highest level of awareness associating different risk factors to diseases as compared to any of the other groups. The reason most obvious that explains this high awareness is that the commercial farmers, due to their occupational feature of growing water- and irrigation-intensive cash crops in the closest proximity to the Ewaso Narok Swamp know best which type of use entails which specific risk factors exposing to disease due to their wide-ranging experience.

When contrasting theory and perception by feeding the theoretical framework on wetland use-related infectious disease exposure (Chapter 5.2) that resulted from the analytical literature review with the health risk perceptions by the wetland users, the following came out: Corresponding to the results of the review, the wetland users connected different risk factors to different uses exposing to numerous water-related diseases. They perceived exposure to infectious agents as dependent upon the type of use, domestic and occupational characteristics and understood disease transmission as driven by users' physical contact to water, characteristics of pathogens and vectors of disease. Overall, the perception of use-related risks was high and diseases linked most to the wetland include diarrhoeal diseases and malaria, but also typhoid fever, schistosomiasis and trachoma. The risk factors perceived as most hazardous by the people in the Ewaso Narok Swamp are unsafe water sources, inadequate sanitation and poor hygiene, as well as environmental pollution or so-described dust. This well corresponds with current literature by Derne et al. (2015) and Fuhrmann et al. (2015), among others. Numerous occupational risk factors were associated

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with diseases and covered the crop production-related use of pesticides, the presence of irrigation canals, pastoralism-related proximity to livestock (Appleton 1983) and general factors such as the proximity to mosquito habitats and to rivers, stagnant water.

When contrasting risks and perception by comparing the health risk assessment from the Ewaso Narok Swamp with the respective risk perceptions by the wetland users, the following came out: Overall, those factors assessed to be risky to human health in the risk assessment (Chapter 4.3) were indeed perceived to be highly harmful by the the target population. Thus, the people were aware of the actual 'objective' risks. The risk perceptions even exceeded the calculated risks, and provided in-depth information on transmission pathways, unhealthy behaviours and protective measures, thus extending the known risk factors in their richness of detail. Besides the investigated occupational and use-related infectious disease exposure as found in the literature review (Chapter 3.3), other aspects threatening health were underlined by the target population. This means is that just because a risk is not addressed in the available literature, one must not conclude that the risk does not exist, but rather might the research interest be absent.

Although initially not planned to be part of this research which focused on malaria, schistosomiasis, onchocerciasis, diarrhoeal diseases, typhoid fever and trachoma, the adverse health effects of agrochemicals were largely perceived thematised by the target population and the experts in the Ewaso Narok Swamp. The effects of agrochemicals made up a large part of the communities' perceived health concern, which stresses the importance of it being thematised in the context of wetland use. Not only in the perception part of this study, but also in the risk assessment the use of pesticides and fertilizers play a role with regard to adverse health conditions. Moreover, the emic risk perceptions went beyond the selected diseases, transmission pathways and risk factors probed in the Ewaso Narok, thereby significantly extending the results and adding much value to the study.

The weighing of risk factors and perceived diseases complemented by qualitative statements made a comparison of theory and perception possible: While the literature base mainly address crop production-related risk factors such as irrigation canals favouring disease exposure in wetlands most, the wetland users perceive unsafe water, inadequate sanitation and poor hygiene as way more hazardous than any occupational-related risk factor. Just as is the case in the literature, some risk factors seem better understood than others. What this means, in a nutshell, is that the theoretical framework (Figure 13) on wetland-related risk factors can be well be translated in numerous parts into perceived practice. However, the emic perspectives of the people by the wetland partly differ from the theory base, as well as from the actual risk and have the potential to give a more detailed, more realistic picture. This is well-reflected in the qualitative statements made by wetland users, all of which highlight unsafe and limited water resources, including the pollution by agrochemicals, inadequate sanitation and poor hygiene as biggest perceived health risks in the Ewaso Narok Swamp.

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Such subjective judgements and health beliefs of affected individuals towards health hazards they might be exposed to are vital and can play a pivotal in the management of health and ill-health in wetlands: In the first place, risk perception studies are able to reflect the actual risks, as well as the shortcomings of an area, thus revealing health risk potentials to health officials and wetland managers. And secondly, health risk perception is closely linked to and can motivate the application of positive health- and hygiene-related behaviour as shown in a multi-country study by Curtis et al. (2009), thus providing an entry point for health-related interventions in wetlands based on the shortcomings identified. Coming back to Bergler et al. (2000), it is not the objective, but the subjective probability that make a given risk a personal risk. Therefore, the role of wetland users as key informants should be acknowledged: Since the trend of increasing wetland use is unlikely to be reversed but rather most likely to be exacerbated, there is the need to capture the challenges that wetland communities are facing in order to facilitate healthy wetland use, decide on the way forward or on possible interventions. This makes risk perception studies a potential supportive tool for health-adapted sustainable wetland management that includes users as participants and actors.

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## 6 THEORY, PERCEPTION, BEHAVIOUR AND RISK. TRIANGULATION & DISCUSSION

### 6.1 Theory versus perception, perception versus risk, risk versus behaviour

This section presents an integration of the theoretical framework on use-related disease exposure in wetlands resulting from the literature review (Chapter 3), the risk assessments calculated based on self-reported symptoms (Chapter 4) and the health risk perceptions of wetland users gathered from quantitative and qualitative methods (Chapter 5). The triangulation includes the most common water-related infectious diseases present in the Ewaso Narok Swamps: malaria, diarrhoeal diseases, typhoid fever (Table 33), skin diseases, trachoma and also discusses schistosomiasis and onchocerciasis (Tables 34).

A brief glance at the resulting overviews shows that overall, the theoretical base on diseases in wetlands is well supported by the data from the Ewaso Narok Swamp. Almost all pre-selected diseases investigated in the semiarid floodplain were perceived as health risks by the people living in or around the swamp. Numerous risk factors proved statistically significant for symptoms that served as proxies for the diseases. This procedure worked well for malaria, diarrhoeal diseases, typhoid fever and trachoma, because they could well be approached by self-reporting. For schistosomiasis and for onchocerciasis, the situation was slightly different: these diseases could not easily be approached by symptoms and are also assumed to not be very prevalent. Other than the preselection of diseases, skin diseases were integrated in this study also, as they were reported to be very prevalent.

As for malaria, much knowledge on exposure and transmission pathways is present in the swamp, both quantitatively and qualitatively probed, adequately reflecting the actual risk factors described in the literature. The users were well aware that wetlands provide optimal conditions and breeding sites for mosquitoes that vector and transmit malaria. They were aware of the risk being greater in proximity to the swamp or any stagnant water, they knew that environmental pollution may increase the risk and that according to the season, the risk of malaria may differ. All these factors turned out to be real risk factors when modelling the risks by the use of self-reported fever, with the exception of seasonality, which could not be measured in this cross-sectional study design. The presence of mosquitos as well as stagnant water, are risk factors that could be associated by the multivariate model. In terms of exposure to malaria, wetland use played an important role. Whereas the literature review indicated that farming and irrigation, proximity to livestock, fishing and collection of building material within the wetland would be risk factors for the contraction of malaria, the users' perceptions underlined especially the agricultural irrigation and proximity to water. These two factors, as well as the use in the afternoon or evening hours, were statistically probed risk factors for fever, and thus, potentially for malaria, both in univariate and multivariate analyses. Obviously, these occupational features are more risky in terms of

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malaria contraction than the collecting building material and fishing. Not only the occupational, but in particular the domestic domain seems to matter when it comes to malaria risk: the creation of breeding sites and the unsafe water storage, e.g. in open containers, favouring mosquito breeding as well, were not only perceived risk factors. They were also statistically probed real risks for fever in univariate and multivariate models. An unsafe water source, inadequate sanitation and poor hygiene contributed to the risk of malaria also, and these factors were perceived risks by the wetland population.

Diarrhoeal diseases are associated with several risk factors, including the ingestion of unsafe water, poor personal hygiene and inadequate sanitation, as well as poor waste management and environmental pollution (Tumwine et al. 2002), all of which are the reality in the Ewaso Narok Swamp (Chapter 4). The people in the swamp perceived all of these factors to cause diarrhoeal diseases, as well in general in the wetland, as particularly in the domestic domain also. Statistical analyses revealed that these perceptions reflect the real risk factors that increase diarrhoeal disease incidence. Not only were unsafe water, sanitation and hygiene factors that increased the risk of abdominal complaints, the symptom which was used in order to approach the burden of diarrhoeal diseases, but also did wetland-use related occupational aspects have an effect on the presence of the adverse health outcome: the univariate analyses indicated an increased risk of diarrhoeal diseases for those wetland users engaged in irrigation activities, for those who use manure or fertilizers. Although the results have no statistical significance, they are valuable, because they support the findings from the literature review. Moreover, the same factors were perceived as risks by the wetland users, as well in quantitative, as in qualitative research in the Ewaso Narok Swamp. One finding concerning the occurrence of diarrhoeal diseases was quite surprising: according to the result of the univariate model, the proximity to livestock had a health protective effect, significantly reducing abdominal complaints. This does not only contradict the scientific literature (Anchang et al. 2014, Johnson and Paull 2011), but also the wetland users' risk perception, which would attribute an increased risk of diarrhoeal diseases to those that work and / or live in proximity to livestock, namely and particularly the pastoralists.

When addressing typhoid fever, the triangulation revealed the following: The general risk factors for the contraction of typhoid fever in wetlands resulting from the literature include the waterborne risk and environmental pollution, both amplified during flooding. These three aspects were linked to typhoid fever during the in-depth interviews with the different user groups, and associated with fever, a symptom of typhoid fever, in the quantitative part of this study. Both the ingestion of unsafe water and environmental pollution could be significantly associated with fever, a self-reported symptom which is even a more obvious proxy for typhoid fever, during univariate modelling. Environmental pollution was a risk factor that remained statistically significant during the multivariate modelling also. Again, due to the cross-sectional study design, the seasonality in typhoid fever risk could not be



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calculated. As for the contraction of typhoid fever, use-related occupational features played a role: agricultural activities in wetlands, as well as the use of manure and the proximity to livestock or their waste are not only evidenced risk factors by literature, but also perceived by the wetland users as such. Agricultural irrigation turned out to be a real and statistically significant risk factor for the contraction of typhoid fever in the Ewaso Narok Swamp, based on univariate and multivariate modelling. The proximity to livestock, however, was no real risk for typhoid fever in the swamp, based on the analyses. The opposite was the case: it served as a protective factor concerning the contraction of typhoid fever. The importance of the domestic role in terms of disease transmission is underlined by the results, once again. Especially the ingestion of unsafe water significantly increased the risk of typhoid fever. This is evidenced by previous literature (Fuhrmann et al. 2015, Neogi et al. 2014), perceived by wetland users, both in quantitative probing and in-depth interviews. Moreover, these risk factors would turn out to be an actual risk factor based on the risk assessment and univariate and multivariate analyses. The same is the case for unsafe WASH of wetland users in general – here also, theory equals risk perception and actual risk in the investigated wetland. The intake of unsafe food, an aspect widely described in the literature, was not perceived to be a risk factor for typhoid fever. However, the univariate analysis suggested it to increase the risk of contracting fever, the proxy symptom used to approach typhoid fever. This indicates that it may be a real typhoid risk factor in the Ewaso Narok Swamp.

Skin diseases were not initially included in the analytical review, but perceived a major challenge in the Ewaso Narok Swamp. The wetland users considered skin diseases to be due to water-washed transmission, and caused by environmental pollution. Some also attributed skin diseases to contact with parasites that infest the wetland water. Skin diseases were largely described to be linked to occupational wetland use, to commercial farming, use of agrochemicals and/or pest control, as well as irrigation activities posing high risk factors. These were not only perceived, but also actual health risks, as demonstrated by the univariate modelling. In the multivariate model, commercial farming was included and showed a statistically significant increase in the risk of skin irritation. The proximity to livestock did prove to be a risk factor, even though it was perceived to be causing skin diseases. Not only occupational wetland use, but again, also, behavioural aspects in the domestic domain determined the risk of contracting disease. The univariate and multivariate models revealed that unsafe WASH, in particular poor hygiene, significantly increased the risk of skin irritations, both of which were perceived as such by the wetland users during the quantitative and qualitative data collection (Table 34, Fuhrmann et al. 2016a, Hunter et al. 2010).

Trachoma, a neglected tropical disease commonly associated with water scarcity, remoteness and poor WASH, was also associated with the use of wetlands (Berthe and Kone 2008), especially with such semiarid areas as is the Ewaso Narok Swamp. The transmission of trachoma is water-washed, and factors generally increasing the risk are distance to a

water source, environmental pollution, the presence of flies, large household sizes and low socioeconomic status (Overbo et al. 2016, Tulchinsky and Varavikova 2014).

**Table 33: Triangulating theory, perception & risk: malaria, diarrhoea, typhoid fever**

Water-related infectious disease exposure	Risk factors associated with use / occupation and domestic domain	Results				
		Theory	Empirical findings			
			Risk Assessment		Risk perception	
Analytical review	Univariate models	Multivariate models	Quantitative	Qualitative		
<b>Malaria</b> (vector-related) in risk assessment approached by the symptom 'fever'	<i>General</i>					
	Mosquito vectors					
	Proximity to swamp					
	Stagnant water					
	Environmental pollution					
	Seasonal					
	<i>Use-related &amp; occupational</i>					
	Proximity to water					
	Agricultural irrigation					
	Proximity to livestock					
	Time and duration of use					
	Fishing					
	Collection of building material					
	<i>Domestic &amp; behavioural</i>					
	Man-made breeding habitats					
	Unsafe water storage					
Unsafe WASH						
Surface water source / fetching						
<b>Diarrhoea</b> (waterborne, water-washed) in risk assessment approached by the symptom 'abdominal complaint'	<i>General</i>					
	Waterborne transmission					
	Water-washed transmission					
	Food-borne transmission					
	Environmental pollution / dust					
	<i>Use-related &amp; occupational</i>					
	Wastewater irrigation				NA	
	Agricultural use of manure					
	Agricultural use of fertilizers					
	Proximity to livestock					
	<i>Domestic &amp; behavioural</i>					
	Ingestion of unsafe water					
Unsafe WASH						
<b>Typhoid fever</b> (waterborne) in risk assessment approached by the symptom 'fever'	<i>General</i>					
	Waterborne transmission					
	Environmental pollution					
	Seasonal / flooding					
	<i>Use-related &amp; occupational</i>					
	Wastewater irrigation				NA	
	Agricultural use of manure					
	Proximity to livestock					
	<i>Domestic &amp; behavioural</i>					
	Ingestion of unsafe water					
	Unsafe WASH					
Unsafe food						
Proximity to livestock						

\* The table is based on the results of the study and illustrates risk and protective factors.

\*\* Dark grey represents a high risk, light grey a low risk. Red shows protective factors.

\*\*\* NA stands for data not available.

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In this study, since not all of the respondents knew the disease by name, trachoma was approached by the symptom eye condition. The wetland users of the Ewaso Narok Swamp perceived all of the named risk factors as such, except the household size. The univariate analyses revealed socioeconomic status, household size and the distance to the water source to be real risks for trachoma, with the latter remaining statistically significant in the multivariate analysis. The pastoralists were perceived to be susceptible to eye diseases or trachoma. The proximity to livestock is a risk factor that was evidenced by univariate analysis to increase eye conditions in the Ewaso Narok Swamp, a fact which is well supported by literature also (Hotez and Kamath 2009). Another aspect which resulted to significantly increase the risk of eye conditions was the intake of traditional medicine, a behaviour which is commonly associated with pastoralists. This finding is may be contradictory on the first sight, since herbal medicine does not cause an increased risk of any disease usually. However, since medicinal plants are taken to reduce a negative health effect, they indicate the occurrence, in this case, of eye diseases: not the cause, but the consequence. With regard to trachoma, the domestic domain is described to host health risks also: unsafe WASH, particularly poor personal hygiene and remoteness increase the risk of contraction of this eye disease. Not only are these factors described in the literature, but also perceived as risks by the people in the swamp. In the univariate and multivariate models, unsafe WASH was found to significantly increase the risk of eye conditions.

The water-based disease schistosomiasis, also a neglected tropical diseases, also known as bilharzia is transmitted by parasites hosted by and released into stagnant water bodies by snails. Besides those named, general risk factors include the proximity to wetlands, as well as environmental pollution. All of these risk factors were known by the population sample that participated in in-depth interviews. Also, occupational and use-related aspects determine the risk of contracting schistosomiasis: agricultural irrigation activities, as well as fishing were evidenced to increase the risk of the disease in the literature (Appleton and Madsen 2012), and both risk factors were perceived as such by the people. According to Derne et al. (2015), unsafe WASH, and particularly the ingestion of unsafe water, the use of wetland water for bathing and direct water contact increase the risk of schistosomiasis. All of these WASH-related risk factors were commonly perceived as such in relation to schistosomiasis in the in-depth interviews. Since it is not possible to approach schistosomiasis by one symptom alone, the disease and its approximation was excluded from the quantitative part of this study, from univariate and multivariate modelling.

Onchocerciasis, a vector-related neglected tropical disease affecting the eyes, which is most prevalent near rivers, and thus associated with agricultural activities, fishing and collection of building material and fetching water near rivers or streams, was not known by the people in the wetland. However, all of these factors were perceived to increase the risk of eye conditions. This, however, is not enough of an evidence to prove any occurrence of onchocerciasis, which, according to health officials in Rumuruti, is non-existent in the area.

**Table 34: Triangulating theory, perception & risk: skin disease, trachoma, schistosomiasis, onchocerciasis**

Water-related infectious disease exposure	Risk factors associated with use / occupation and domestic domain	Results				
		Theory	Empirical findings			
			Risk Assessment		Risk perception	
Analytical review	Univariate models	Multivariate models	Quantitative	Qualitative		
<b>Skin diseases</b> (water-washed) in risk assessment approached by the symptom 'skin irritation'	<i>General</i>					
	Water-washed transmission	NA				
	Contact with parasites in water					
	Environmental pollution					
	<i>Use-related &amp; occupational</i>					
	Commercial crop production	NA				
	Use of fertilizers & pest control					
	Agricultural irrigation					
	Proximity to livestock					
	<i>Domestic &amp; behavioural</i>					
Poor hygiene	NA					
Unsafe WASH						
<b>Trachoma</b> (water-washed NTD) in risk assessment approached by the symptom 'eye condition'	<i>General</i>					
	Water-washed transmission					
	Environmental pollution					
	Distance to water source					
	Presence of flies					
	Poverty					
	Household size					
	<i>Use-related &amp; occupational</i>					
	Proximity to livestock					
	<i>Domestic &amp; behavioural</i>					
	Unsafe WASH					
	Poor personal hygiene					
	Marginalization					
<b>Schistosomiasis</b> (water-based NTD) in risk assessment approached by the symptom 'abdominal complaint'	<i>General</i>					
	Water-based transmission					
	Snails infested by parasites					
	Proximity to swamp	NA	NA	NA		
	Stagnant water					
	Environmental pollution					
	<i>Use-related &amp; occupational</i>					
	Agricultural irrigation					
	Fishing	NA	NA	NA		
	<i>Domestic &amp; behavioural</i>					
	Ingestion of unsafe water					
Unsafe WASH						
Bathing in wetland water	NA	NA	NA			
Direct water contact						
<b>Onchocerciasis</b> (vector-related NTD) in risk assessment approached by the symptom 'eye condition'	<i>General</i>					
	Blackfly vectors					
	Proximity to rivers	NA	NA		NA	
	<i>Use-related &amp; occupational</i>					
	Agricultural irrigation					
	Fishing	NA	NA		NA	
	Collection of building material					
<i>Domestic &amp; behavioural</i>						
Surface water source / fetching		NA	NA		NA	

\* The table is based on the results of the study and illustrates risk and protective factors.

\*\* Dark grey represents a high risk, light grey a low risk.

\*\*\* NA stands for data not available.

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## **6.2 Wetland-related infectious diseases: occupational versus domestic domain**

The data collected from the Ewaso Narok Swamp can hardly provide information on the prevailing burden of disease in the wetland. Although the study indicates the prevalence of self-reported symptoms and approaches the risk factors causing these symptoms, a measurement of disease burden cannot be provided, since it is not possible to derive prevalence rates from these symptoms and since official disease surveillance data are largely lacking for the investigated area. Only data on the district hospital admission are available (Figure 2), which serve to capture prevalent diseases in the swamp and to understand the health-seeking behaviour of those people suffering from the diseases to some extent. That data set reveals that with regard to water-related infectious diseases, malaria is most prevalent, followed by amoebiasis and different gastrointestinal conditions, typhoid fever, candidiasis and conjunctivitis. The official recording on the occurrence of these diseases, however, proves that the symptoms chosen for investigation and the diseases that the author linked them to are plausible. Self-reported fever, the proxy used for both malaria and typhoid fever, is more prevalent in the investigated wetland population compared to any other symptom, potentially indicating the prevalence of either of the two diseases. All other symptoms' prevalence rates were quite high, also, potentially indicating the other prevalent water-related infectious diseases that healthcare seekers were admitted for. Although this study cannot offer prevalence numbers, what it can provide is an evaluation of risky environments in wetlands. Corresponding with the concept of Cairncross et al. (1996), who cut across different classifications of disease transmission and include the small-scale level (Herbst 2006) by addressing the role of public and private domains, this thesis approaches the occupational and domestic domains. Following Cairncross et al. (1996), the domestic domain covers the area normally occupied by and under control of the household, whereas adapted to their concept, the occupational domain would include the public places, fields and environments used for work. As the risk assessment (Chapter 4), as well as the triangulation (Chapter 6.1) depict, both play important roles in the exposure to and transmission of diseases: based on the analyses, the occupational risk of irrigated agriculture proves to be relevant in terms of contraction of fever and abdominal complaints and such increased exposure among farmers was also found by Fuhrimann et al. (2016), in an Ugandan wetland. However, the occupational domain seems to play a minor role when compared to risk factors in the domestic domain. In particular, water supply, sanitation and hygiene, health-related behavioural practices and environmental hygiene determine health and ill-health, thereby indicating that not only the contraction of diseases, but also the health protection mainly takes place at the household level (Curtis et al. 2011, Herbst et al. 2008). Thus, any health intervention in wetlands needs to involve the domestic domain.

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### 6.3 The potential of WASH in preventing diseases in wetlands

Safe water, adequate sanitation and personal hygiene are crucial preconditions for the prevention of disease transmission (Esrey et al. 1991, Prüss-Üstün et al. 2008, Prüss-Üstün and Corvalan 2006, Tumwine et al. 2002), and of special importance for people living in wetlands, depending on and being exposed to them, as was found by this study in the Ewaso Narok Swamp (Anthonj et al. 2016<sup>43</sup>). Most of the wetland users were well aware of the importance of WASH in terms of health protection and the short-term and long-term implications on health (Curtis et al., 2011). The risk assessment calculations in this study revealed the protective effects of WASH on each of the investigated self-reported symptoms. The respondents from households with access to a private tap, an improved water source according to the JMP (2015), were at statistically significantly lower risk of contracting abdominal complaints, fever, eye conditions and skin irritations. The latter was also reduced by a regular water supply. Sanitary hygiene significantly reduced the risk of abdominal complaints, fever, and skin irritations. Also, frequent handwashing after the use of a latrine reduced the risk of fever at a significant level. Moreover, keeping waste, dirt and dust outside of a compound reduced the risk of abdominal complaints. The same symptom was reduced by the prevention of stagnant water by the homestead and so were fever and skin irritations. The use of mosquito bed nets had a protective effect on the onset of fever and eye conditions. WASH proved effective health-protective measures in the modelling of the risk of contraction of water-related infectious diseases such as malaria, diarrhoeal diseases, typhoid fever and trachoma.

Despite this crucial importance of safe water, adequate sanitation and good personal and environmental hygiene (Curtis et al. 2011, Prüss-Üstün et al. 2014) for the prevention of waterborne, water-based, water-washed and vector-related diseases, the reality in the Ewaso Narok Swamp presents a distinct picture: safe water sources are inaccessible for a large share of the wetland population. As the household survey in the Ewaso Narok Swamp reveals, only an average of 44% of the people use so-called 'improved' water sources (Figure 14). Comparing this number to the average for rural Kenyan populations (57%) according to the JMP (2015), the access to safe water sources of households in the researched wetland is lagging far behind those country-wide numbers. Considering the high discrepancies between the different user groups paints an even gloomier picture, as the access to improved sources for pastoralists, for example, is elusively low with only 8% in the research area using such sources. The term 'improved' sources suggests protection and safety of water at the point of source that otherwise can be faecally contaminated and microbially unsafe at the point of consumption (Clasen and Bastable 2003, Fewtrell et al. 2005, Hoque et al. 2006, Hunter et al. 2010, Sobsey 2002). In the researched wetland, as domestic water storage and handling revealed to be poor throughout about half of the households, the

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<sup>43</sup> Parts of this chapter have been published.

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consumed drinking water can instead be unsafe, thus potentially contributing to the spread of diarrhoeal diseases and typhoid fever, amongst others.

Domestic water is considered one decisive determining factor for safe drinking water, adequate sanitation and good personal hygiene (Sobsey 2002). The Ewaso Narok Swamp, source of domestic water for numerous inhabitants, is perceived to be inadequate to provide safe WASH due to multiple water use and misuse, a lack of sanitation facilities, and seasonal phenomena such as flooding. Besides the water source, the water quantity is a key factor in terms of WASH, as has been outlined in the in-depth interviews. As in other semiarid areas, the access to water is associated with considerable distances in reaching any source, regardless of its quality (Prüss-Üstün et al. 2014, Sobsey 2002). The users need to invest more efforts and time for collection and transport, which amplifies the risk of using and consuming unsafe water. The factors of effort and time both impair the quality of WASH (Hunter et al. 2010). Where safe water is scarce, it is being used according to the most pressing needs of humans, their livestock and livelihoods thereby becoming a driving factor for poor hygiene, which under such circumstances is less of a priority (Fewtrell et al., 2005). Where safe water is scarce, adequate sanitation is difficult and even impossible. In the Ewaso Narok Swamp the more remote or marginalized a household or homestead is located, the less probable is its access to a sanitation facility and the more likely the household members practice open defecation, as was described during the in-depth interviews. Open defecation negatively influences water quality, as the contaminants are washed into the ground- and surface water (Sobsey 2002), which the people depend upon, especially in the dry season, thus facilitating the spread of waterborne diarrhoeal diseases and typhoid fever.

Lifestyle, traditions and habits turned out to affect WASH and related behaviour, especially in the case of the pastoral group. As could be observed during the household assessment, the nomadic pastoralists' water supply, storage and sanitation conditions were mostly inadequate and compared to the other groups, their hygiene was lower. As the observational assessment revealed only an average of 12% of the households had improved sanitation, whereas the other households had either unimproved or no sanitation at all (Figure 15). Comparing this number to the average for rural Kenyan populations (30%) according to the JMP (2015), the access to improved sanitation of households in the researched wetland is lagging far behind those country-wide numbers. Out of the pastoralist households assessed, none had improved sanitation, and 75% had no sanitation at all in their homestead and most probably practices open defecation. According to the perceptions of the wetland users investigated during in-depth interviews, in a culture of nomadism, the ownership of sanitation facilities is neither usual nor seen as extraordinarily useful, and often they are not used at all as construction is only done for a short period of time until the group leaves the temporary home (White et al. 2002). Living in close proximity to their livestock and with the environment is habitual (Curtis et al. 2011), and so is using surface water sources for drinking, river water for bathing and nature for open defecation. Accordingly, as water

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supply and sanitation are inadequate, personal hygiene deteriorates (Ezzati et al. 2005, Mara 2003, Prüss-Üstün et al. 2014) and priorities are shaped according to the most pressing needs. Those needs likely dictate watering livestock over attending to personal hygiene, thus facilitating the occurrence of water-washed diseases such as trachoma (Anchang et al. 2014, Berthe and Kone 2008). All of these aspects correspond with a negative overall WASH condition, but are deeply rooted in culture and traditions. As stated by Mara (2003), 'rural water supply, sanitation and hygiene do not only incorporate engineering, but also sociology', and this is true in the case of Ewaso Narok Swamp (see also Herbst et al. 2009).

Inadequate WASH has been shown to increase the risk of multiple self-reported symptoms in the investigated wetland, as well as water-related infectious diseases. On a global level, it is responsible for almost 7% of the global burden of disease in terms of disability-adjusted life years (DALYs) and accounts for more than 4% of all deaths worldwide (Esrey et al. 1991, Prüss-Üstün et al. 2014). WASH-related diseases and their consequences affect people's quality of life, their agricultural productivity, their families and social networks, and consequently their overall socioeconomic development (Bartram and Cairncross 2010, Hunter et al. 2010, Mara 2003, Tumwine et al. 2002). This is just a global average and based on the data presented in this study, one may hypothesize the need for improved WASH and WASH-related behaviour to be tremendous in wetlands.

As wetlands provide ideal habitats for disease-causing agents, WASH needs to be prioritized and addressed especially in such wetlands as is the Ewaso Narok Swamp, that are subject to intensive use by different groups, that have a poor sanitation infrastructure, and which only provide limited water resources (Anthonj et al. 2016). The risk perceptions and the mostly applied protective health measure, water treatment, show that the people in the wetland understand the situation and risks that come along with inadequate WASH. However, only few health-protective measures are being applied. This points to WASH-related behaviour not being primarily driven by risk perception, but by the environment and (lacking) access (O'Connell 2014). This makes structural improvements necessary to close the WASH gap. The results confirm the critical importance to initially study WASH in wetlands and underline the previously formulated need of an integrative approach that first and foremost complements wetland management by public health interventions. In order to improve WASH conditions and to change behaviour in the long run, interventions need to include the provision of clean water and sanitation infrastructure. Besides, in order to change WASH-related behaviour, hygiene education, awareness raising and sociocultural acceptance are crucial tools, as for example applied in the Participatory Hygiene and Transformation system (Wood et al. 1998).



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## **6.4 Health-seeking behaviour in wetlands: indicator for severity or for coverage?**

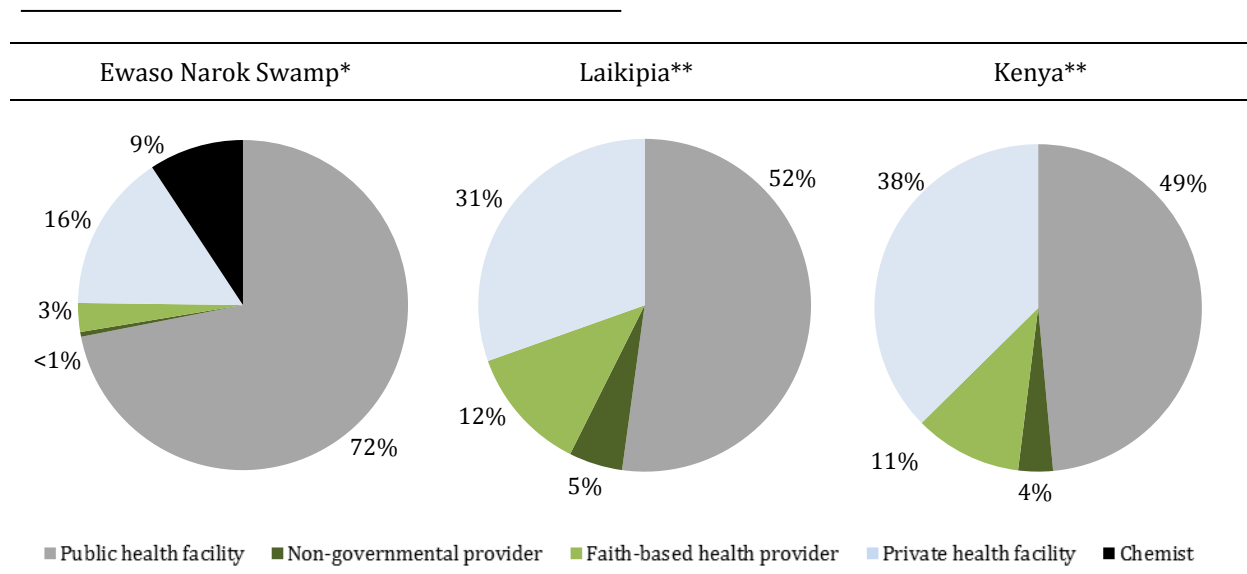
Regardless of the risk factors, transmission pathways and protective health measures applied in order to prevent diseases, the results of this study indicate that the burden of self-reported symptoms is high among wetland users in the investigated semiarid setting. The results of the household survey, as well as the in-depth interviews with wetland users point to perceived high prevalence rates of malaria, typhoid fever, diarrhoeal diseases and abdominal complaints, eye diseases and skin diseases, but also respiratory infections and other adverse health conditions. Since such diseases affect the wetland users' quality of life, their agricultural productivity and thus, the overall socioeconomic development, sufficient healthcare options are of vital importance in order to respond to and meet the care-seeking demand. To date, very few studies had been carried out to determine the level of healthcare utilization among wetland users (Dillip et al. 2009)<sup>44</sup>. Given the challenging provision of and access to healthcare in Kenya in general (Fotso and Mukijra 2012, Turin 2010, Chapter 1.3.1), one aspect of interest in this study was to assess how the people in the Ewaso Narok Swamp behave in times of ill-health and which decisions they take on seeking healthcare. Out of all symptoms reported in the Ewaso Narok Swamp, for 60%, healthcare was sought. The utilization differed according to the symptoms: for abdominal complaints and skin irritations (74%) more would seek a care provider than for fever (67%) or eye conditions (52%). These average numbers strongly contrast and are much lower than the 77% of the Kenyan population utilizing healthcare in times of ill-health according to Turin (2010). Out of those seeking healthcare from a provider in response to the selected self-reported symptoms, public facilities were most common, followed by private facilities, and chemists. Such health-seeking patterns were also evidenced for pastoralists in Baringo district in Kenya suffering from malaria (Mungunti 1998) and for people seeking care during suffering from fever in India (Das and Ravindran 2010).

A comparison of health-seeking in the wetland with the county-wide and national data on utilization of healthcare (MoH 2015) allows for interesting insights (Figure 38): in the wetland, a way higher share of people used public care, less use private facilities, faith-based providers and non-governmental providers. This was explained both by in-depth interviewees and experts as owed to the limited facilities available in the area surrounding the wetland.

This was explained both by in-depth interviewees and experts as owed to the limited facilities available in the area surrounding the wetland. Most people, if they seek healthcare, make use of the District Hospital, which is the biggest and best equipped facility whatsoever, with well-trained health staff. Other clinics exist, but are small and may only have a nurse or health worker to provide health services.

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<sup>44</sup> Within the GlobE Wetlands in East Africa project, a PhD study by Mr. van Soest is currently being conducted that addresses the health-related and health-seeking behaviour among farmers suffering from malaria in an inland valley wetland in Uganda. His work is expected to complement and expand the present findings from the Ewaso Narok Swamp.



\* Health-seeking during last self-reported symptom in the Ewaso Narok Swamp, own data (2015);  
 \*\* National data on Kenya, provided by the Ministry of Health (2015).

**Figure 38: Health-seeking in the wetland compared to county and national level**

These findings go in line with observations made by several authors revealing that rural areas are often deficient in professional medical personnel and healthcare facilities (Aday and Andersen 1974). This may also explain the comparably high share (10%) of respondents reporting to seek healthcare from chemists – a statistic which is neither included in the county- nor the nationwide healthcare information. Where only limited health facilities are available, chemists may be of increased importance and close a healthcare supply gap. This underlines findings from Nigeria (Salako et al. 2001) and from Nepal (Sreeramareddy et al. 2006), who found the most common healthcare provider sought in rural settings to be chemists.

As resulted from the survey, and as elaborated in-depth with interview partners and experts, the utilization of healthcare services is determined by numerous factors. Besides existence and accessibility, the infrastructure and distance mattered in terms of health-seeking, issues that were elaborated before in other contexts (Beogo et al. 2014, Das and Ravindran 2010, Kuuire et al. 2015, Obrist et al. 2007, Salako et al. 2001, Sahyo et al. 2015). It is not much of a surprise that the farther a household was located from a health facility, the less likely would a household member seek care there, given the time, transport and cost that will be involved.

Moreover, the socioeconomic status was found to influence the health-seeking behaviour of the people reporting symptoms in the Ewaso Narok Swamp, since the use of a health facility does not only involve costs relating to admission, but also to potential laboratory tests, medication, hospitalization or accommodation and alimentation and transport, not only for the patient, but also for those accompanying him. According to health professionals in the Ewaso Narok Swamp, very few people possess a health insurance and even if they do, it does not cover the total expenses. Patients need to pay out-of-pocket and therefore, the decision

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on whether or not to seek healthcare may become a privilege for those able to pay (Beogo et al. 2014, Danso-Appiah et al. 2010, Das and Ravindran 2010, Penchansky and Thomas 1981, Shayo et al. 2015).

Given these obstacles, which in a society that relies mainly on the natural capital provided by the Ewaso Narok Swamp for the maintenance of its livelihood are tremendous (McCartney et al. 2015), the decision on whether or not to seek healthcare may be subject to a cost-benefit analysis and a question of priority (Hjortsberg 2003). This circumstance partly makes seeking healthcare an indicator for the severity and duration of the perceived symptom(s) or disease (Aday and Andersen 1974, Danso-Appiah et al. 2010, Nyamongo 2002, Rahman et al. 2012, Shaik and Hatcher 2004, Sreeramareddy et al. 2006). Only if the condition is perceived to be highly problematic, a household which may even be struggling with poverty would consider paying that cost. Here, knowledge is a decisive factor. Health risk perception, the knowledge on symptoms and awareness of diseases significantly determine the care-seeking behaviour (Gabrysch et al. 2009, Kuuire et al. 2015, Salako et al. 2001, Shayo et al. 2015). As described by Sreeramareddy et al. (2006) in a Nepali context, some illnesses are simply perceived as 'not for hospital', and the same perceptions or health beliefs were present in the researched wetland.

All of these aspects mentioned serve to explain the differences that became apparent when comparing the health-seeking behaviour between different user groups: whereas the service sector workers most often used services, the pastoralists least made use of care providers. The households of the latter are usually located in terrains difficult to reach, rather far away from tarmac roads, distant from health facilities. Such roadblocks of actual physical distance could moreover be complemented by cultural emic perceptions of distance and accessibility (Munguti 1998). For the pastoralists in the Ewaso Narok Swamp, travelling to the nearest centre normally involves a lot of effort, which is one of the reasons for deciding not to. Education among indigenous populations is usually lower, because they live in hard-to-reach areas that are culturally and linguistically diverse, less likely to have access to health education spread through community health workers and broadcast (Das and Ravindran 2010, Nyamongo 2002, Shaik and Hatcher 2004), and this is true for the pastoralists in the Ewaso Narok Swamp, also. Pastoral nomads are characterized by their close adherence to tradition, culture and habits, all of which are known to shape health beliefs and health service utilization while experiencing symptoms of illness (Andersen 1995, Geissler et al. 2000). For them, it is important to approach illness in response to their health beliefs. Traditional healers that are able to explain the 'meaning' of the disease (MacKian 2002) are thus an important source of healthcare due to their embeddedness within the community and belief system (Rahman et al. 2012). Especially for them, traditional practitioners are among the main providers of care, which, according to MacKian (2002), are often seen largely as something which should be prevented in favour of official services.

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The service sector workers, on the other hand, settling in central areas and in close proximity to health facilities and chemists, face the fewest of those named challenges, and also possess the highest level of school education, which explains their care-seeking behaviour. As several other studies found, occupation matters with regard to health-seeking (Hjortsberg 2003). Shayo et al. (2015) evidenced care-seeking patterns to be determined by livelihood practices when distinguishing rice farming and pastoral communities in Tanzania and this proves true for the investigated wetland setting also.

Another aspect, which was deeply elaborated within the qualitative part of this study, plays an important role in terms of treating ill-health. The mere fact of people not seeking healthcare does not mean that they don't receive treatment whatsoever. On the contrary, the meaning of self-treatment can be extraordinary (Obrist et al. 2007, Ruebush et al. 1995). According to Nyamongo (2002), who investigated the care-seeking behaviour of rural Kenyans suffering from malaria, even as much as 83% of the target population applied self-treatment as their first choice of care, as it was the most cost-saving option. Although the numbers from the Ewaso Narok Swamp are lower, self-treatment is crucial related to all of the self-reported symptoms. More than half of the respondents of those claiming not to seek care treat themselves with medicinal plants or milk or with drugs. Here again, it is the pastoral group that stood out, with two thirds using traditional medicine from the wetland and the surroundings in order to cure their symptoms and diseases. They knew exactly which part of which plant to mix with which liquid, the suitable recipe in order to mash, chew or brew the right medicine for each symptom and even for specific diseases, including malaria, diarrhoeal diseases, typhoid and others. The same diseases were treated with traditional medicines in Uganda, as found by Namukobe et al. (2011). Mungunti (1998) found malaria to be widely treated with indigenous herbs in many malarious Kenyan areas, both attributed to the beliefs in the potency of the plants and on aetiology of the disease. In the Ewaso Narok Swamp, extensive knowledge on the traditional treatment of health conditions exists. This 'cultural' and 'health' capital provided by the Ewaso Narok Swamp is highly valued and appreciated by the respondents, given the medicinal plants significantly contributed in the treatment of ill-health in the wetland. According to the in-depth interviews, especially the pastoralists would rather use herbs, whose positive health effects had been taught to them by ancestors and handed down through generations, than trust conventional medicine. Geissler et al. (2000) also stress this importance of herbal medicines in Kenya, stating that there is perceived to exist a 'herb for every ache', as was found in Uganda also (Namukobe et al. 2011). Similar findings were elaborated by Sreeramareddy et al. (2006) from Nepal. This importance of traditional medicine has also been acknowledged by the WHO (2017<sup>45</sup>), who promotes such alternative care due to the fact that over one-third of the population in developing countries lack access to conventional medicine, which makes traditional plants critical in increasing access to care. A study from a rural region in

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<sup>45</sup> Further reading at <http://www.who.int/medicines/areas/traditional/en/>.

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Kenya found that people suffering from malaria usually have a high confidence in self-diagnosis and self-treatment (Nyamongo 2002).

Besides the named, the perceived quality of healthcare provision is also an aspect determining seeking or not seeking care, which might have mattered in the Ewaso Narok Swamp, as it was also described by numerous authors (Das and Ravindran 2010, Ergler et al. 2011, Gabrysch et al. 2009, Rahman et al. 2012, Shaik and Hatcher 2004).

Moreover, the switching of health-seeking behaviour was common in the Ewaso Narok Swamp. Those affected by ill-health would try multiple actions to get cured: in case self-treatment and the intake of herbs or drugs would remain ineffective, the patients would seek care from a facility or medical practitioner. Equally, those who would initially seek care from facilities but not be cured would switch to traditional medicine. Such decisions were driven by the severity of the self-reported symptom. Such behaviour involving several health-seeking stages supports evidence found in Kenya among pastoralists (Munguti 1998) and others (Nyamongo 2002, Ruebush et al. 1995), suffering from malaria. As reported by the same authors, the highest priority in times of ill-health in rural settings is getting well as soon as possible due to the need for physical productivity, income, and the need of minimizing the expenditure incurred due to sickness, which is why different treatment transitions are gone through.

Whether or not the health-seeking and self-treating behaviour in the Ewaso Narok Swamp indicate the severity of ill-health can only partly be answered based on the gathered data. Health-related behaviours in the wetland are determined by a wide range of factors, which do not only cover physical, socioeconomic and demographic aspects, but also traditional preferences rooting in health beliefs. What becomes apparent from the data is that very few symptoms really remain untreated in the first place, either by a service provider or by the patient himself: whether it is a hospital admission, the visit of a chemist, or the intake of drugs or medicinal herbs, some sort of treatment is usually being applied. A potential shortcoming in terms of healthcare coverage, on the other hand, is detected by the interpretation of the data. An undersupply of easy-to-reach healthcare options was mentioned by the respondents during the household survey and the in-depth interviews, by the experts and participants of the feedback meeting (Chapter 2.3.3). The self-treatment of symptoms might mirror such weaknesses of healthcare provision (Geissler et al. 2000). Given the fact that Rumurti and the area surrounding the Ewaso Narok Swamp have been subject to substantial in-migration throughout the past 30 years, which in the face of increased disease exposure arising from the wetland creates an increasing demand, it is no wonder that the healthcare services provided can hardly keep pace. This circumstance logically directs the attention back to the use of local options and the potential of self-treatment and traditional medicine in the wetland. Medicinal herbs, which, according to Turin (2010), are sometimes viewed as at odds with the adoption of a more modern health system, could instead be viewed as an opportunity to reach a wider portion of the

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population as suggested by WHO (2017<sup>46</sup>). As most cases of disease occur in rural villages, away from effective diagnostic and treatment facilities (Mboera et al. 2010), the use and effectiveness of traditional medicine available on-site in such a semiarid wetland as is the Ewaso Narok Swamp, should further be validated (Namukobe et al. 2011, Ruebush et al. 1995). The private retail sector could be strengthened also, since, according to Obrist et al. (2007) in the Tanzanias Kilombero Valley, it is increasingly recognized in its role of improving access to treatment, since self-treatment is often the first response to an illness. Moreover, as proved by Corley et al. (2016), the role of primary healthcare and community health workers becomes important in order to engage with underserved and hard-to-reach populations, also in response to the NTDs that are present in the wetland, since successful health management requires deep and meaningful engagement with local communities. Integrated into an overall health strategy, widely accepted (cultural) realities of healthcare behaviours could complement health service provision and be a promising solution in helping to close the service provision gap in wetlands as found in the Ewaso Narok Swamp.

### **6.5 Health risks and health-related behaviour among pastoralists: a special case**

As has been outlined, the water supply and storage, sanitation and personal hygiene conditions of the different user groups in Ewaso Narok Swamp vary greatly (Anthonj et al. 2016<sup>47</sup>). Out of all investigated groups, the pastoralists have the worst WASH conditions. Their water sources are generally scarce, predominately unimproved and unsafely stored. Factors perceived to cause unsafe water conditions include the limited access to improved sources, and the least available water quantities as compared to the other groups. Noticeable was that the vast majority of pastoral households surveyed had no sanitation on their premises. During the in-depth interviews, they were the group that was described and described themselves to have least access to sanitation facilities and to practice most open defecation, which corresponds to these quantitative results. By other groups, they were also perceived having the poorest personal hygiene. All has been mostly attributed to their nomadic lifestyle in water-scarce and remote areas and in close proximity to their livestock and to traditional habitual behaviour. Out of those pastoralists, most are lacking school education, have a low socioeconomic status, the largest family sizes, a relatively low level of health risk perception and undertake the fewest health-protective measures of all groups, mainly lacking interest or necessity, thus potentially knowledge.

Social and cultural factors mattered in the awareness and understanding of the ‘meaning’ of health and ill-health, the interactions with water and the wetland, exposure, transmission, prevention and treatment. According to MacKian (2002) and Ruebush et al. (1995), the cultural understanding of the ‘real’ causes of the illness goes far beyond the biomedical

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<sup>46</sup> Further reading at <http://www.who.int/medicines/areas/traditional/en/>.

<sup>47</sup> Parts of this chapter have been published.

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concept of health and diseases, and the same was observed in the investigated wetland. Numerous misconceived health beliefs were widely manifest and deeply rooted in the habits, routines and culture especially among the pastoral nomads, supporting the findings of Andersen (1995), Dunn et al. (2011), Geissler et al. (2000), Malisa and Ndukai (2009) and Rahman et al. (2012). These authors had earlier elaborated the influence of cultural background and ethnicity of individuals and communities, SES, education and place of residence. Pastoralists' health beliefs in the Ewaso Narok Swamp included, among others: malaria being caused by rain or by floods, pesticides and even by elephants; diarrhoea in children appearing as a consequence of them being teething; skin and eye diseases being caused by the weather; always staying healthy when eating healthy food; entire health protection by witchcraft or diseases caused by witchcraft; and sending wealth away when chasing away flies that occupy livestock. Widely perceived were also the spiritual value of river and wetland water for drinking, domestic use or bathing and the ineffectiveness of protective health measures. None of these beliefs had a direct causal relationship. However, some had indirect or secondary relationships, such as malaria occurring more often where farmers work in closer proximity to water, where also more pesticides are applied. Or not elephants causing malaria, but potentially creating breeding sites by their footprints for mosquitoes that could transmit malaria. Despite some distant relationships underlying such beliefs as found in the Ewaso Narok Swamp, they may be highly problematic because they do not implicate the actual disease causes' implications for prevention, treatment or control. As described by Dunn et al. (2011) and Munguti (1998), cultural health beliefs and practices might lead to inappropriate and/or inadequate preventive health measures, treatment and delays in seeking healthcare, all of which may result in complications. Moreover, misleading beliefs may limit the acceptance of 'healthy behaviour' due to lack of awareness.

As a logical consequence (Curtis et al. 2000), one would assume the pastoralists to be affected by the highest burden of disease in the Ewaso Narok Swamp. This assumption, however, does not at all hold true when comparing their self-reporting of symptoms to the other groups' respondents. The pastoralists report least abdominal complaints, least fever, least skin irritations as opposed to smallholder and commercial farmers and even service sector workers. This also explains the surprising findings in Chapters 4.3.1 to 4.3.4 revealing numerous theoretical high risk factors to be protective in the Ewaso Narok Swamp (such as low education levels, SES, poor WASH etc.): these are pastoralist characteristics, also (Chapter 1.3.3, Table 3).

The situation is different solely when it comes to eye conditions, which were reported by the pastoralists most commonly. So which reasons can explain this theoretically high exposure to risks on the one hand, but low reporting of symptoms on the other hand? Does it mean that pastoralists are healthier per se?

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There is vast evidence describing pastoral nomads as having stronger immune systems compared to other population groups, which is likely owed to the harsh environments they live in and conditions they face on a daily basis (Patz and Confalonieri 2005, Sumaye et al. 2013). Constantly moving from one place to the other, being used to travelling long distances in the semiarid heat, staying in particularly dry areas, being faced with water scarcity, a very one-sided diet that mainly consists of meat and milk, living in households with many others and deprived of any luxury goods and electricity, but instead sharing with livestock and struggling with mammals, the pastoralists' bodies adapt and are generally less susceptible to infection. Thus, one explanation for the lower number of reported symptoms among pastoralists may be a higher immunity compared to other groups. This was mentioned by several respondents of in-depth interviews, stating that '*the pastoralists' bodies are very strong*' (co3). Health indicators among pastoralists and other populations differ according to a publication on pastoralism on East Africa conducted by the ODI (2010). Their study showed infant mortality to be lower in children of pastoralists in Kenya, and pastoralists' life expectancy to be higher.

Another important aspect which could serve as an explanation was not mentioned by the respondents in the study, but described by Kaplan and Baron-Epel (2003). This author addresses the cultural and environmental surroundings and their influence on the subjective evaluation of health, concluding that individuals living in a community with many diseases and no healthcare system (as may be the case for pastoralists) may perceive their health as optimal even though in the same situation in a healthier community, this perception would be different. Moreover, culture, tradition and health beliefs may influence the sensitivity to symptoms, interpretation of their severity and significance, and thus, behaviours adopted to deal with prevention and treatment. As a consequence and as described by a chemist in the study area, certain diseases may go underreported in pastoralist communities.

Compared to the other groups, the pastoralists were least likely to consult a healthcare provider for cure from self-reported symptoms but mainly preferred self-treatment with herbal medicine, or advise by herbalists (Chapter 4.1.3).

Besides distance and access, socioeconomic status, educational background and health beliefs that drive health choices among pastoralists, another reason determining health-related decisions was provided by Rahman et al. (2012). The authors investigated the health-seeking behaviour of indigenous tribes in Bangladesh.

Accordingly, the choice also includes the level of respect by the provider paid to ethnic groups and tribes, the understanding of their anxieties and cultural differences, trust, communication barriers. Besides sociocultural rituals influence the choice of location for the process of healing and treatment. This could partly apply in the Ewaso Narok Swamp for pastoralists, also, but did not result from the data gathered.





a. Impression of a pastoral homestead in Mathera; b. livestock as integral part of live; c. living environment, no separation between humans and animals.

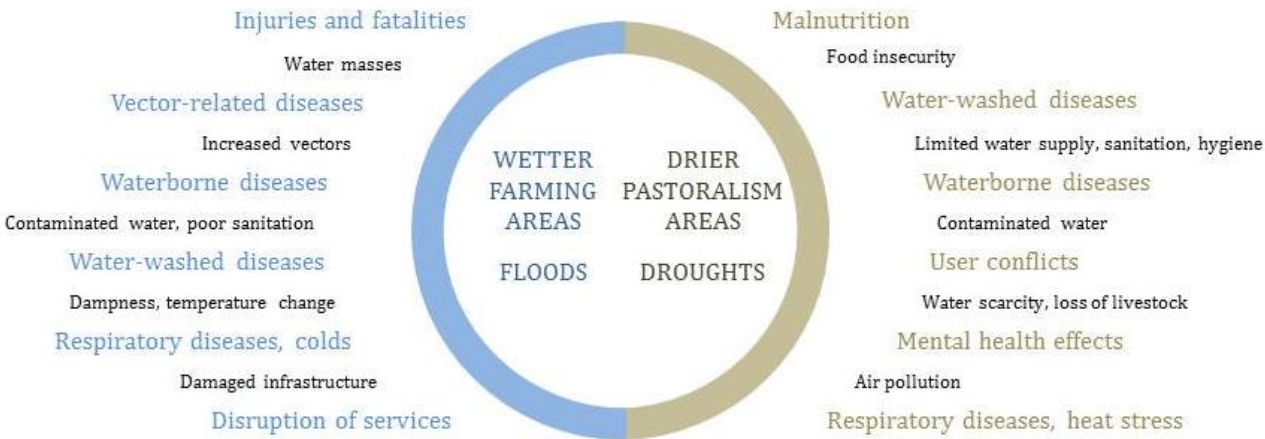
**Photo 10: The pastoralists in the Ewaso Narok Swamp: a special case**



Besides their remote lifestyle in dry areas and proximity to livestock (Photo 10), it is important to acknowledge and consider the pastoralists' differing cultural perceptions and health beliefs on the aetiology of water-related infectious disease and the importance of WASH. This underlines the previously formulated need to direct attention to the cultural understanding and metaphors of water and sanitation, the meanings, beliefs, values and taboos determining health practices and norms in order to integrate them into locally-informed health education programmes and holistic disease management (Akpabio 2012, Bisung et al. 2015, Halvorson et al. 2011, Paul 1958). Such practice could facilitate a more concrete reporting of ill-health, as well as the adoption of new behaviours especially among pastoralists (Geissler et al. 2000, Granich et al. 1999, Munguti 1998).

**6.6 Health effects in a semiarid wetland setting: a special case**

The risk perceptions of wetland users pointed to the Ewaso Narok Swamp as being a special case. The semiarid wetland forms the most important source of water in the region and is being used by different groups for different purposes, most importantly, for domestic and drinking water. The smallholder and commercial farmers live in close proximity to the swamp and use the provided water extensively for their agricultural activities, whereas the pastoralists, who live in the drier and more distant surroundings of the swamp, mainly herd their livestock to the water source. The different environments these groups of users live and work in expose them to different health risks. Under average wetland conditions, the health risks might be rather reasonable or manageable (Chapter 1.4.4 and Chapter 3.3, White et al. 1972), but they are exacerbated during seasonal extremes. The Figure 39 summarizes the possible health effects of these contrasting natural environments based on the study findings from the target population and experts in the Ewaso Narok Swamp.



**Figure 39: Health effects in a semiarid wetland. A special case. Graph based on findings**

In the wetter areas, where mainly the farmers accumulate, breeding sites are vastly available, favouring the reproduction of mosquito vectors, and thus increasing vector-related diseases such as malaria (Omukunda et al. 2012). The accumulation of wastewaters,

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sewage, faecal matter and other disease-causing agents in the swamp contaminates the wetlands' water. A decrease of water quality is accelerated by poor sanitation and sewage infrastructure and leads to the spread of waterborne diseases like diarrhoeal diseases, cholera and typhoid fever (Mayoke 2014). The contamination of wetland water, coupled with limited personal and environmental hygiene, increases water-washed diseases in these wet parts of the swamp.

All of these adverse health effects are significantly accelerated during heavy rains and flooding (Derne et al. 2015, Githeko et al. 2000, Patz et al. 2005, WHO 2016), as not only contaminants from the surrounding areas, but also from higher grounds accumulate in the low lying swamp. During the rainy season, the temperature declines, leading to respiratory diseases and flus among those that work in the dampness, making the hard physical farm labour even more difficult than under normal circumstances. Besides, especially during flooding, the water masses may cause injury and fatalities. The potentially increased burden of disease during flooding is then simultaneously facing the consequences of the natural hazard: damaged (WASH) infrastructure, disruption and inaccessibility of healthcare and other services putting an additional burden on the already strained health system capacities (Anthonj et al. 2015).

In the drier areas, where mainly the pastoralists live and work, the most pressing health challenge that the people are facing is the shortage of water, thus underlining the meaning of the wetland to those settling there. The water shortage is not due to absolute scarcity of water, however, but mainly due to the lack of access as a result of inadequate infrastructure provision (Bell 2015): in the Ewaso Narok Swamp, the water sources are usually located far from the pastoralists' homesteads, demanding the female family members to walk for hours to get just a small daily supply of water that stems from unsafe surface sources and may be contaminated. In such areas, water remains a scarce resource, both in terms of quantity and quality (Nyong and Kanaroglou 2001). According to the Bartram and Godfrey (2015), a reasonable basic access to water would require 20 litres per person per day from a source within one kilometer (see also Hunter et al. 2010) or less than thirty minutes collection time of the user's dwelling. In the pastoralist areas of the Ewaso Narok, this requirement is unrealistic to be met. Even the minimum drinking water requirement of 5.5 l per day (Howard and Bartram 2003) can hardly be met by the majority of the households, transforming healthy and hygienic living into a challenge. Such a shortage of drinking water makes a healthy nutrition difficult. Malnutrition and food insecurity<sup>48</sup> in such dry areas are real health threats to most of the pastoralists, already, particularly during times of drought which makes the soil even less fertile. The widespread shortage of water makes the limited hygiene of this user group well comprehensible, especially when keeping in mind that the limited water resources available need to be shared with the livestock, that the pastoralists

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<sup>48</sup> Within the GlobE Wetlands project, a Msc research project is currently being conducted by Mrs. Kagia that addresses aspects related to food insecurity and malnutrition in the semiarid Ewaso Narok Swamp. The findings will complement this study.

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share their homesteads with. Along with a lack of sanitation facilities, the limited water supply makes such arid areas conducive environments for the spread of water-washed diseases such as trachoma. During drought, seasonal streams dry up, leaving behind less water points than needed and due to overuse, these few sources may be contaminated, thus facilitating the spread of waterborne diarrhoeal diseases (Derne et al. 2015, Hunter et al. 2010). Other troubles that the rather arid pastoral area creates include the conflict of users over the scarce water sources – not only of different users or user groups, but also of conflicts between animals (livestock and mammals) and humans, for all of whom access to water becomes vital. These findings from in-depth interviews and expert opinions are supported by Bell (2015) and others (Heinichen 2015, Roden et al. 2016). The loss of livestock dying of thirst creates serious adverse mental health effects among the pastoralists, who solely depend upon their cattle for the maintenance of their livelihoods, as addressed also by Hongo and Masinki (2003). Other health threats during the dry season and during droughts include respiratory diseases and heat stress. Above all, the drier area of the pastoralists has very limited (health) infrastructure at its disposal, thus creating additional health challenges.

This compilation illustrates the contrasting adverse health effects and threats that the natural environments around the swamp provide, underlining the complexity and peculiarity of semiarid wetlands that host both risk linked to wet and dry conditions. It also draws the attention to the vulnerability of such ecosystems and their inhabitants, who depend upon them for the maintenance of their livelihoods, as well in in the rainy as in the dry seasons, both of which are likely to change in the future (Dale and Connelly 2012, Mungai et al. 2004, Mwita 2013, Smith et al. 2014). All these aspect need to receive consideration in an integrated health-based wetland management and among the responding care providers.

## **6.7 Awareness of neglected tropical diseases in the Ewaso Narok Swamp**

In this study, the presence of several neglected tropical diseases in wetlands was addressed in the course of a literature review, during a risk perception study and as part of a risk assessment in the Ewaso Narok Swamp. These included schistosomiasis, trachoma and onchocerciasis. According to the WHO (2015b), such diseases affect over one billion people worldwide, causing chronic disability and death, primarily among the disadvantaged of the world. Despite the critical importance to address such diseases, they remain widely unknown, underreported and untreated, even among many health professionals, which also becomes manifest in the official health data provided by the District Health Officer in Rumuruti. These circumstances make the findings from the Ewaso Narok Swamp quite remarkable: out of the three NTDs probed, two were very familiar to the wetlands' inhabitants, as revealed both by quantitative and qualitative data. Only onchocerciasis was unknown to the users, a disease, which, according to the health authorities in Rumuruti, is

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not prevalent in the swamp. Both schistosomiasis and trachoma were known, perceived as risks, and overall, the respondents were familiar with the transmission pathways of these diseases. The people interviewed were well-aware of the vital role of WASH in reducing the risk of contracting these neglected tropical diseases and are thus far ahead of the general public in terms of NTDs. They knew that WASH was of utmost importance in order to reduce the exposure to infection: the access to and use of sanitation facilities, the safe management of faecal waste to reduce human excreta in the environment; the safe water supply to prevent consumption of contaminated water, reduced contact with surface water, and enable personal hygiene practices; water resources, wastewater and solid waste management for vector control and contact prevention and hygiene measures such as handwashing with soap, food hygiene, and personal hygiene. This is in consistence with Esrey et al. (1991), who evidenced safe and sufficient water supply on the premises or near the house for personal and domestic hygiene (reduction in trachoma risk), as well as safe human excreta disposal (reduction in schistosomiasis risk) as main protective factors (see also Overbo et al. 2016). The knowledge on risk factors of trachoma was even present among the most vulnerable group in the wetland, namely the pastoralists: the same people who mostly lack access to even the most basic water and sanitation services and practice unhealthy behaviours. This is likely the result of community health workers' health education efforts and the awareness raising campaign which was run during a trachoma program in Rumuruti by AMREF in 2012, as was reported by health officials during expert interviews. According to Margaret Chan, the WHO Director General (WHO 2015b), *'NTDs thrive under conditions of poverty and filth. They tend to cluster together in places where housing is substandard, drinking water is unsafe, sanitation is poor, access to healthcare is limited or non-existent, and insect vectors are constant household and agricultural companions... This opens opportunities for integrated approaches, for simplification, cost-effectiveness, and streamlined efficiency.'*

The pastoralists being the high risk group for the NTD trachoma underlines and verifies Margaret Chan's statement and the often adopted use of NTDs as 'a proxy for poverty' (Nakagawa et al. 2015, WHO 2012), since as described before, the pastoralists live in rural, remote, water-scarce area, proximate to livestock, thus potentially environmentally unhygienic. Simultaneously, according to the data, they often face difficulties in accessing healthcare or prefer self-treatment, which makes them hard to reach in times of ill-health due to NTDs. This is tragic because according to Corley et al. (2016), NTDs would largely be preventable and oftentimes curable in case the infrastructure allowed for it.

The case study in the Ewaso Narok Swamp emphasizes the importance of social science research in terms of NTDs in special settings (Aagaard-Hansen et al. 2009). It also stresses the need to achieve universal access to WASH as formulated in the SDGs for those hardest to reach, who in the semiarid wetland setting are the pastoralists, usually the same groups mostly affected by NTDs, in order to prevent such diseases. However, the provision of safe

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WASH has so far received little attention in NTD control programmes (Grimes et al. 2014, Stocks et al. 2014). Given that WASH and NTDs are both significant challenges to global development, contributing to a circle of poverty and disease (WHO 2015c), increased household expenditure and reduced productivity, as well as adding a substantial burden on already stretched health systems, investments in WASH are not only a prerequisite, but also economically beneficial (Frick et al. 2003, Hutton 2013, Chapter 6.3): healthy people can contribute to the development, while sick people cannot, instead missing valuable lifetime, income, options, education etc. Therefore, joining NTD and WASH management as reflected by the Global Strategy 2015-2020 developed by WHO (2015c), developed for accelerating and achieving the NTD milestones formulated to improve the health status among the poorest and most vulnerable, proves highly relevant from this study's results.

### **6.8 Health effects arising from agrochemical use in the Ewaso Narok Swamp**

Although initially not planned to be part of this research which is focused on water-related infectious diseases, the adverse health effects of agrochemicals were largely thematised by the respondents in the Ewaso Narok Swamp. This revealed that there is no way getting around the impact of chemical fertilizers, pesticides, herbicides etc. when conducting a health risk assessment in an East African wetland or when capturing the users' health risk perceptions. This is due to the fact that the performance of hand-labour tasks in areas which have been treated with agrochemicals creates health risks (Rogers and Randolph 2015). Since other research projects<sup>49</sup> focus on such issues, they will only very briefly be discussed here.

The risk perceptions of the people in the Ewaso Narok Swamp revealed that they are well aware of the potential health risks that the application of loads of chemicals to the ecosystem while farming is creating. However still, this common practice done in order to increase the yield, particularly of the horticultures cultivated in the swamp (Photo 11). The quantitative part of this study uncovered that consequences concerning the agrochemical users' health mainly include eye and skin conditions, whereas in-depth and expert interviews pointed to severe respiratory and irreversible skin conditions. Moreover, adverse long-term health effects were mentioned as stemming from contact with chemicals and a neglect of preventive measures, hygiene or direct treatment after application. The mere fact that within this research so many statements of the respondents covered fertilizer-related health risks in the wetland, despite they not having been brought up the researcher, strongly underlines the importance of it being thematised in this discussion. Not only in the perception part of this study, but also in the risk assessment the use of pesticides and fertilizers play a significant role with regard to skin conditions.

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<sup>49</sup> The Swiss Federal Institute of Aquatic Science and Technology (Eawag), for example, is currently working on several research projects that address the health threats arising from the use of pesticides in agriculture. Further reading at <http://www.eawag.ch/en/department/uchem/projekte/pestrop-pesticide-use-in-tropical-settings/>.

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As was elaborated by Fuhrmann et al. (2015) who studied in the Nakuvibo wetland in Uganda, the chemical contamination stemming from agricultural practices can be hazardous for human health. However, one does not need a wetland focus in order to understand the adverse implications that the use of such chemicals can have on the human body. Health effects vary by the specific pesticide class and exposure level (Schwarzenbach et al. 2013, Smeester et al. 2015, Stauber and Casanova 2015, Villanueva et al. 2013), with exposure possibly being due to spills, splashes and inadequate worker protection during production, application and/or disposal of pesticides, handwashing with or bathing in contaminated water, and interaction with contaminated environments (Julian and Schwab 2015, Rogers and Randolph 2015). And as described here, it is especially the acute direct contact exposures that lead to the eye and skin irritations experienced by the farmers in the wetland. This is no wonder, given that farmers spend much time in the wetland and as revealed by the survey findings, mostly without any protective gears.



a. Farmer spraying pesticides; b. Tomato harvest in semiarid wetland; c. unsafe handling of agrochemicals in the Ewaso Narok Swamp (2015, 2016).

**Photo 11: The use of agrochemicals in the Ewaso Narok Swamp**

Besides, health risks could be real for those ingesting chemically loaded water or crops from the wetland, with consequences upon exposure including haematological and neurological effects, both cancer and non-cancer endpoints and particularly negative reproductive effects.

Here again, the presence and access to sufficient safe drinking water, sanitation facilities and handwashing facilities, as well as the application of protective health measures are crucial in the prevention of agrochemical-related health risks. One can easily imagine that if even the domestic domain has limited or no such facilities under its disposal in the Ewaso Narok Swamp, WASH will be difficult to be found in the occupational domain relevant in terms of agrochemicals: the farmers' shambas.

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The impacts of pesticides are not potentially harmful to human health only, but can be extremely harmful to ecosystem health, which is why many of these substances are restricted or banned from use (Julian and Schwab 2015). Although this is another cup of tea which other researchers elaborate<sup>50</sup>, the impacts on the environment are worthwhile being mentioned here, given the research project *GlobE Wetlands in East Africa's* overall focus on food production that goes hand in hand with environmental protection, all aspects relating to One Health. An overuse of such chemical substances degrades the soil, water quality, and all kinds of physical parameters that are necessary to ensure the foundation of the livelihoods that such wetlands provide, most importantly water and food production: the agricultural use that wetlands were targeted for in the first place. If this basis is destroyed, then subsequent food insecurity is an immense long-term health concern which even determines the survival of wetland communities. Thus, in order to meet the food security needs of the population without potentially harming their health, it is crucial to take up the concept of wise wetland use as suggested by Horwitz et al. (2012) and apply it also in terms of agrochemical use in the Ewaso Narok Swamp.

## **6.9 How to improve a health-based wetland management.**

### **Recommendations**

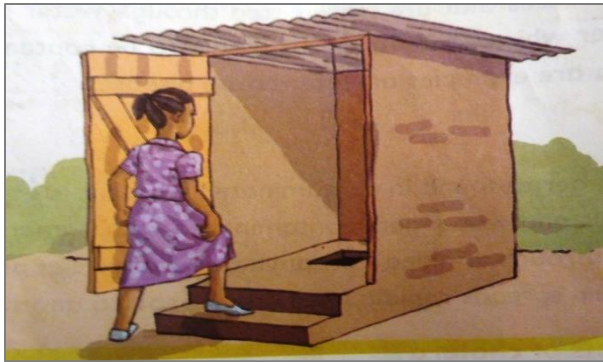
This study presented a range of occupational and domestic health risks that potentially expose wetland users to water-related infectious diseases, all of which are owed to the intense hydro-social interaction and change present in the highly fragile semiarid Ewaso Narok Swamp. Immense use of the water resource, particularly for agricultural production, but also pastoralism and domestic use, is coming along with severe environmental degradation and pollution reducing the quality and quantity of available water resources. At the same time, the deficient sanitation and sewage disposal infrastructure intensify the already existing health hazards (Derne et al. 2015). Thus, the application of protective health measures is indispensable for the promotion of human health, and so is a health-supporting water management and risk communication.

As the data reveal, the health-protective measures taken up by the wetland users are few compared to other contexts. The share of respondents using bed nets to prevent the risk of malaria is only 28% in the Ewaso Narok Swamp, and thus, much lower than in a Ugandan wetland, where 89% reported to do so (Isunju et al. 2016), or in rural Western Kenya, where Githinji et al. (2010) found 95% of the households possessing a bed net and 59% claiming to having slept under it the night before the survey.

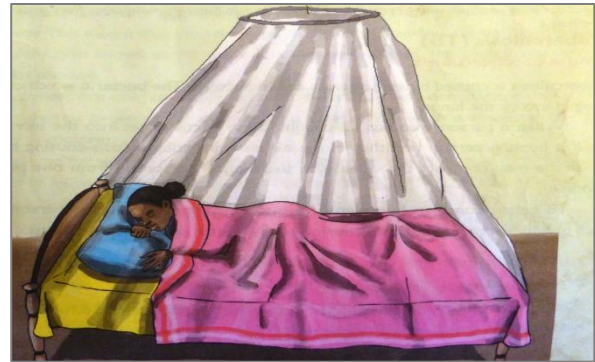
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<sup>50</sup> Within the GlobE Wetlands in East Africa project, Ms. Umulisa's PhD study deals with anthropogenic disturbances and the effects of agrochemicals in major wetlands of Rwanda.

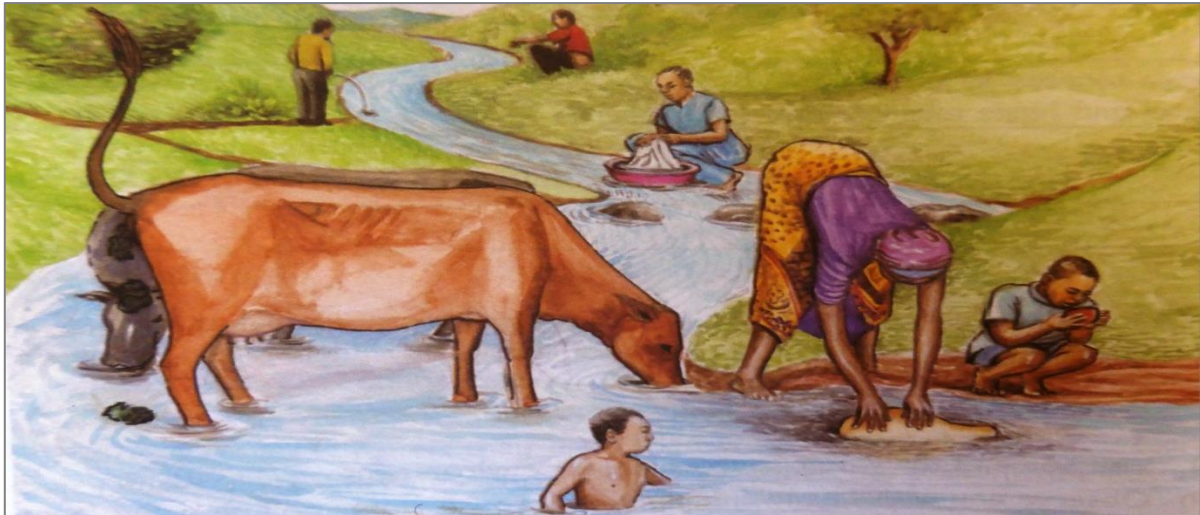




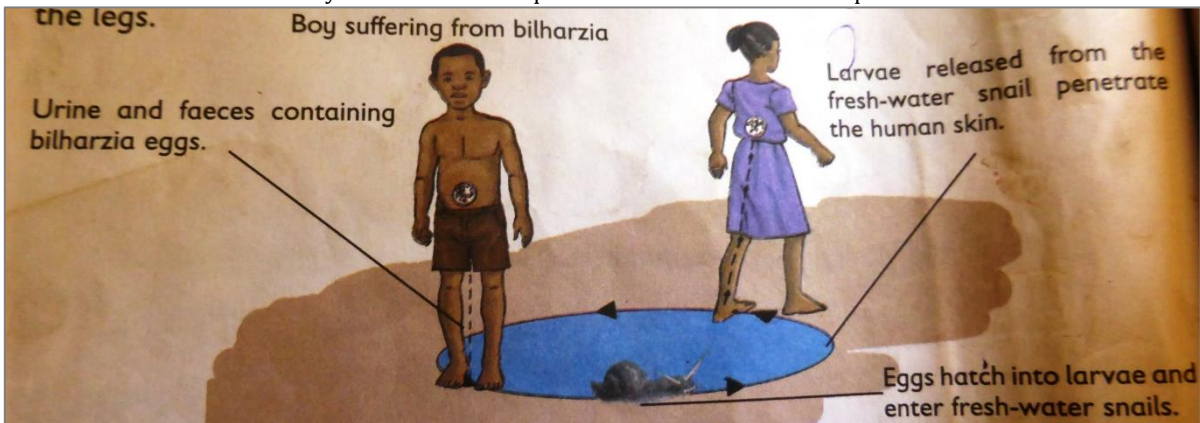
'Always make sure you and others use latrine or toilet.'



'Using a mosquito net keeps mosquitoes away.'



'Various ways in which water is polluted. Some causes of water pollution are:'



'Spread of bilharzia (swimmer's itch): Two types of bilharzia-causing worms affect the bladder or intestines.'



'Protective clothes should be worn when spraying crops.'



'Contaminated water can lead to the spread of typhoid.'

**Photo 12: Health education from Kenyan schoolbooks (Science Class)**

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Also, way less respondents (14% versus 43%) would prevent stagnant water near their home or regularly clean their sanitation facilities in the swamp (12% versus 35%) than was found in the Ugandan wetland by Isunju et al. (2016), just to list some examples.

This relatively lower uptake of protective health measures contrasts the awareness, health risk perceptions and the detailed knowledge on transmission pathways that many people in the Ewaso Narok Swamp possess. This study revealed, that there is a good understanding on the interlinkages of water, health, environment, human activity and wetland use, livestock interaction, and modes of disease prevention among the target population. As data from Kenyan primary schoolbooks showed, a lot of this knowledge is taught at schools (Photo 12). According to Few et al. (2013), such knowledge and perceptions are capable of driving human behaviour.

However, as was described already, the explanation for rather unhealthy behaviour seems to lie in the limited access to adequate WASH infrastructure rather than a knowledge-to-action-gap. Despite more health education and communication being highly necessary in the investigated wetland, a more healthy behaviour can only be achieved in conjunction with the overall prevention of contamination, the provision of adequate sanitation and the preservation of the ecosystem, since the strong reliance on the natural resources forces the people to make use of them (Derne et al. 2015). The described wetland-related diseases have wide-reaching adverse consequences for the humans and communities affected, as well as for the health systems<sup>51</sup>. The diseases could considerably be reduced by health-promoting interventions and efforts should be made to implement such, some of which are already being addressed in the study area. These health-based wetland management options will be listed in the following and conclude central findings and discussions from the study on water-related diseases, health risk perceptions and health-related behaviour in wetlands. The list includes concrete actions to be taken and recommendations by the experts and the target population in the Ewaso Narok Swamp (Table 35).

### **(1) Improving provision of safe drinking water**

The provision of improved drinking water, both in terms of quality and quantity, available and within reasonable reach from the households and work places, as well as the safe storage could significantly reduce the burden of all kinds of water-related infectious diseases. Therefore, action is required. Some of the targets have started being tackled, but several challenges remain: Several water pipes and storage tanks are currently in the process of being constructed by the government for the improvement of safe water drinking coverage in the Ewaso Narok Swamp. To overcome the shortcomings that the Rumuruti Water and Sanitation Company is facing, the management of this project was shifted to Nyahururu, where the respective Water and Sewerage Company has adequate management

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<sup>51</sup> Within the GlobE Wetlands project, a Msc research project is currently being conducted by Mr. Ng'etich that addresses the consequences of diarrhoeal diseases for farmers' households in the semiarid Ewaso Narok Swamp. The findings will complement this study.

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capabilities to supply water to Rumuruti and thus, improve the situation. Another initiative is the 'half half' programme which is currently being carried out by the Laikipia County Government. The programme refers to big plastic water tanks, to which the people in the Ewaso Narok Swamp contribute half of the cost, whereas the county government covers the cost for the other half. This programme, however, mainly serves those able to contribute, leaving behind the elderly and poor, who are unable to pay. Besides, once in a while, the government delivers a liquid water treatment solution called water guard to the people that helps to increase the quality of the drinking water. One intervention which would be recommendable also is solving the issue of domestic water storage safety by making such devices accessible to the people in need. Since the Government is aware of the need, but sets other priorities its allocations, donors could take the lead. And the delivery should be combined with teaching the target population in the best practice to cover containers in order to prevent mosquitos and contaminants from entering. In addition, it would be useful to teach rainwater harvesting (CHW, Rumuruti Water & Sanitation). As thematised by Halvorson et al. (2011) in a study in rural Mali, seasonal fluctuations and spatial variations should be considered also in the provision and accessibility of water, quality and quantity and water use, also, especially in areas with poor sanitation (Derne et al. 2015, Thenya 2001).

## **(2) Upscaling of sanitation coverage**

The sanitation conditions of most households in the Ewaso Narok Swamp are inadequate or deficient and sanitation behaviour, especially among those practicing open defecation, is described as highly problematic in terms of health outcomes: Thus, there is the pressing need to improve the sanitation coverage across the Ewaso Narok Swamp. After identifying those households in need through the CHW, the Government and donors should come and support the implementation of improvements. Already, awareness raising campaigns on flying toilets are in place for the prevention of faecal matter from entering the natural environment. This, however, is not a sustainable solution, given that waste management is inexistent and since the plastic bags will end up polluting the natural environment. Currently, CHW are encouraged to inform the Public Health Officer about people defecating in the open, and those people who are practicing such sanitation behaviour are being arrested. This, however also is not a long-term solution. Instead of harassing them, it would be better to educate them about the risks of faecal matter lying around, especially during the rainy season and to show them the benefits of sanitation. There is the need also to teach the responsible use of facilities and such sanitation-based education should be provided by the Public Health Officers, who reach the community in collaboration with community health workers (CHW, DHO, Rumuruti Water & Sanitation, WRMA). Coming back to Curtis et al. (2000), the transmission of faecal pathogens could be drastically reduced if the primary barriers were in place. Improved excreta disposal infrastructure can significantly contribute to preventing transmission but can, according to Cairncross (1990) only be fully effective if employed in conjunction with safe hygiene practices in the home.

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### **(3) Changing hygiene behaviour**

A good personal, domestic and environmental hygiene is very important in terms of disease prevention, in particular in the protection of water-washed diseases, and overall, for staying healthy. Besides improved water provision to improve the hygiene situation, a change in behaviour is required: Key to better hygiene among people in the Ewaso Narok Swamp is their education and their understanding of the precious good of their health, instead of taking it for granted. This could be achieved by tailoring health education programmes that show the target population risks and hygiene-related diseases. This requires close collaboration, interaction and participation. One previous intervention in the Ewaso Narok Swamp aimed at providing leaky cans by latrines to enhance the handwashing after the use of sanitation facilities. During the time the intervention was in place, the system worked well, but as soon it was over, the people would not continue. Thus, interventions should be coupled with sustainable education to make them longer last than does the intervention. Another suggestion concerning improvements in hygiene targeted the kind of housing: as the houses in the in the study area are mostly poorly constructed, not cemented, have open floors and poor ventilation, this would need to be changed in order to prevent diseases to be easily transmitted, e.g. by preventing mosquitoes from entering the homes. As was mentioned in a previous chapter, domestic hygiene is limited in households that are located far from the water source due to the setting of priorities when handling and using water: after hours of collecting water, the willingness of 'wasting' water on the floor for cleaning could be low. This must be changed. The pastoralists, who perform the worst as far as hygiene is concerns, are also hard to reach with hygiene education – due to distance and their cultural difference. A Trachoma Control Programme run by AMREF until 2014, which included hygiene education through the SAFE strategy<sup>52</sup>, successfully reached them. However, due to a reallocation of funds, the programme was withdrawn. In order to maintain hygiene education among pastoralists to prevent water-washed diseases such as trachoma, knowledge could be disseminated through their leaders and community health workers. Moreover, they should be shown the health risks that their traditional way of living entail and made aware on effective ways of preventing them (former PHO, CHW, sh4). These findings are supported by Cools et al. (2013), who evidenced a health-based wetland management in the Inner Niger Delta to critically depend on (environmental) hygiene behaviour. As described by Curtis et al. (2000), all of the water-related transmission routes shown in the F-Chart (Chapter 1.4.4, Figure 4) can be blocked by changes in domestic hygiene practices, which underlines the importance of behaviour change, once again, since the long-term of effect of respective interventions should not be underestimated (Cairncross et al. 2005). Moreover, Dale and Connelly (2012) designated the management of human behaviour as most effective approach in preventing diseases in wetlands.

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<sup>52</sup>SAFE is a WHO-developed community-targeted strategy which stands for surgery for trichiasis (S), antibiotics (A), facial cleanliness (F) and environmental improvement (E). Further reading at <http://www.who.int/blindness/causes/trachoma/en/>.

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#### **(4) Establishing a waste management system**

One big problem in the Ewaso Narok Swamp that poses significant health threats is the lack of an adequate waste management system. This contributes to a high level of contamination and water pollution. Considering the amount of people who use the wetland, who settle along it or in the surrounding area, and create domestic waste as well as agricultural by-products and waste which partly is poisonous, urgent action is required. The absence of such systems becomes especially apparent and highly problematic during the rainy season, when the water stagnates in the settlement areas, carrying wastewater, solid waste and faecal matter from upland, thus potentially increasing the risk of waterborne and water-washed diseases, in the lowest lying parts of the swamp, in particular. This lack of adequate waste and sewage systems is one immense challenge that requires urgent attention and a prompt solution (Rumuruti Water & Sanitation, former PHO, CHW, sh4). International guidelines on such exist (WHO 2006b) and need to be implemented.

#### **(5) Adopting simple environmental options**

Stagnant water, polluted environments, inadequate waste disposal and sanitation are all creating health risks – and can be counteracted with simple environmental measures at the household level in order to prevent adverse health effects. Action can be taken at the household level: preventing stagnant water, cutting grass and papyrus, clearing the bushes, planting trees, removing open water containers, burning cow dung to keep mosquitoes away and getting rid of the waste by digging pits. The traditional way to prevent mosquito bites involves the burning of cow dung, the smoke effectively chases away the mosquitoes and simultaneously, waste is eliminated, thus two birds are killed with one stone. The necessary resources can be found within the communities, the activities do not cost much and can therefore easily be applied. The respective health education messages should be spread in chiefs *barazas* [meetings] to make such information accessible to everybody. Interventions had been conducted in Rumuruti: A malaria control programme run by the government several years back proved to be very efficient. The provided and promoted insecticide-treated bed nets helped to reduce the numbers of malaria cases. When the follow-up assessment was done, the numbers of mosquitoes were reduced, which is why the project shifted elsewhere. However, usually, the risk of malaria is higher, therefore, the project should be revived (former PHO, CHW, se1, se4). Similar options as brought up by the experts in the Ewaso Narok Swamp were identified by Insunju et al. (2016) in an Ugandan wetland, including the use of mosquito bed nets, draining of water by the home, the household garbage removal and the cutting of bushes. The importance of such environmental health interventions was recommended in designing public and preventive health strategies was underlined by Prüss-Üstün and Corvalan (2006) and Curtis et al. (2011), also.



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## **(6) Reducing occupational health risks during farming**

The proximity to the wetland, irrigation activities, the application of agrochemicals to the fields: all of these occupational routines pose health risks that need to be reduced. The direct contact to water and thus, water-based disease exposure, should be reduced by providing farmers with affordable gum boots and protective gears and encourage them to wear those, but also, by an overall avoidance of water mismanagement. The same measures can reduce pesticide-related health risks, as well as precautions when applying the substances to the field, such as adequate spraying equipment instead of bare hands. Health education could target occupational health risks, thus drawing the farmers' attention to such relationships for avoiding the related problems. Also, such educational units should create awareness on the risks that chemicals are posing to the environment. They could be delivered through the agriculture extension officers in town, who are best connected to the farmers and have the leadership of the wetland. They can easily take certain information to the people through a respective forum that reaches them at their workplace and during their work. Health risks related to fishing should be communicated, trained and educated by the Fisheries Department Offices in Rumuruti (former PHO, CHW, Rumuruti Water & Sanitation). Considering Prüss-Üstün and Corvalan (2006), occupational health risks are directly related to physical, chemical and biological factors in the environment and related behaviours, which is why all need to be targeted in order to reduce risks.

## **(7) Targeting pastoralists**

The challenges that the pastoralists are facing include the dry and water-short areas that they inhabit and their proximity to livestock, both of which entail mainly water-washed health risks and related disease exposure. In order to providing the pastoralists with improved access to water, solutions could include the construction of dams, potentially through the County Government. This measure would also reduce or even solve the conflicts between farmers and pastoralists. The proximity to livestock is rooted in tradition and culture, hence difficult or impossible to be changed. An education forum to create awareness on the hygiene-related risks associated with the livestock could encourage pastoralist families to separate themselves from their livestock at least in the homestead. Here, health officers could play a role, as well as community health workers. Besides the risks they are exposed to, pastoralists do also contribute to increased disease risk in the wetland by herding their cattle in the same resource that is used for drinking (even though mainly by the pastoralists) and overall, in the domestic and occupational domain. Especially during market days in the rainy season, where the pastoralists offer huge bulks for sale, the cattle raises concerns in terms of deteriorating the water quality by their waste and faeces, regularly causing diarrhoeal disease outbreaks and affecting human health. Such challenges need to be addressed and solved, potentially by establishing areas for farmers or livestock only – although this would be difficult to implement, such a measure would significantly reduce human health risks (former PHO, CHW, Rumuruti Water & Sanitation). The need of

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targeting pastoralists and considering livestock in a proper watershed management to reduce the probability of source water contamination by zoonotic pathogens was addressed by Derne et al. (2015), Gannon and Laing (2015), Johnson and Paull (2011), and Patz et al. (2004). The latter proposed limiting the access of animals to watersheds through measures such as fencing waterways and providing alternative sources of drinking water to animals.

#### **(8) Acknowledging the CHW's role in health management & information dissemination**

As becomes clear from the case of the Ewaso Narok Swamp, it is not only infrastructural changes and the mobilization of resources that are necessary to reduce water-related health risks, but also intensified health education. The specialized education of the community is the best solution as far as diseases are concerned. It could help solving many of the problems that the people in the Ewaso Narok Swamp are facing. Community health workers could play a crucial role in spreading health-, risk-, and WASH-related knowledge and best practice behaviour to the community and thus complement the information dissemination from schools and churches. They are the ones who reach out farthest, even out to the remote pastoralist communities; who know the communities' languages, customs and contexts, thus capturing the health realities at the grassroots level. They report health challenges and conduct needs assessments for health-related activities at the household level through Public Health Officers and in charge of the Ministry of Public Health in Rumuruti. Their role in health management planning and in health education should thus be strengthened (former PHO, CHW, Manyatta Primary School teacher, se4). Such evidence has been also elaborated by Corley et al. (2016) from Sub-Saharan Africa, where the role of community health workers is important in order to engage with underserved and hard-to-reach populations in the provision of interventions against these maladies. Sometimes, they are even more important than health facilities, which also could effectively improve surveillance.

#### **(9) Improving collaboration to achieve a health-based wetland management**

This compilation shows that health risks and disease causes are already being addressed by the water, sanitation and health sectors in the Ewaso Narok Swamp – some challenges are still in the identification stage of the problem, whereas for others, solutions are currently being tailored or have been sought or implemented already. Obviously, the data from the investigated are reveals a high burden of self-reported symptoms, relatively few applied protective health measures, particularly as a consequence to inadequate WASH, facing a high level of health-related knowledge and disease awareness. The bottlenecks concerning the healthy use of and healthy behaviour in wetlands are not solely a question of infrastructure OR ecology OR occupation OR risk perception OR health systems: but a conglomerate out of all, which is why a health-based wetland management must address all of these aspects. The activities mentioned by the key informants and experts in the Ewaso Narok Swamp are far from exhaustive and could be complemented by others.

**Table 35: Recommendations to improve a health-based wetland management**

Recommendation	Summary of key points
1 Improving provision of safe drinking water	<ul style="list-style-type: none"> <li>- Provision of improved drinking water, available and within reasonable reach from the households and work places and safe water storage options.</li> <li>- Construction of water pipes and storage tanks by the government.</li> <li>- 'Half half' programme to help people finance their water tanks for safe storage.</li> <li>- Delivery of liquid water treatment solution.</li> <li>- <u>Teaching best practice in order to prevent mosquitos and contaminants.</u></li> </ul>
2 Upscaling of sanitation coverage	<ul style="list-style-type: none"> <li>- Improvement of sanitation coverage across the Ewaso Narok Swamp, identification of households in need through the CHW.</li> <li>- Awareness raising campaigns on flying toilets.</li> <li>- Education of communities that practice open defecation about the risks.</li> <li>- <u>Teaching of responsible sanitation provided by PHOs &amp; CHWs.</u></li> </ul>
3 Changing hygiene behaviour	<ul style="list-style-type: none"> <li>- Encouragement of a behaviour change by health education programmes on hygiene-related risks in close collaboration, interaction and participation.</li> <li>- Provision of better housing options, better constructed, well ventilated.</li> <li>- Special focus on the pastoralists, as they have the most limited options.</li> <li>- <u>Hygiene education through local leaders and community health workers.</u></li> </ul>
4 Establishing a waste management system	<ul style="list-style-type: none"> <li>- Need to establish an adequate waste management system for domestic waste, wastewater, and agricultural by-products.</li> </ul>
5 Adopting simple environmental options	<ul style="list-style-type: none"> <li>- Preventing stagnant water, cutting grass and papyrus, clearing the bushes, planting trees, removing open water containers, burning cow dung to keep mosquitoes away and getting rid of the waste by digging pits.</li> <li>- Going for local options with necessary resources found within the communities.</li> <li>- Spread health education messages to everybody in chiefs meetings to.</li> <li>- Provision and promotion of insecticide-treated bed.</li> <li>- <u>Include such considerations in public and preventive health strategies.</u></li> </ul>
6 Reducing occupational health risks during farming	<ul style="list-style-type: none"> <li>- Encouragement of farmers to wear protective gears, affordable provision.</li> <li>- Overall avoidance of water mismanagement.</li> <li>- Health education could target occupational health risks and precautions when applying agrochemical substances, and the risks to the environment. Dissemination through agriculture extension officers in the wetland.</li> </ul>
7 Targeting pastoralists	<ul style="list-style-type: none"> <li>- Provision of improved access to water for the pastoralists by construction of dams, e.g. through the County Government.</li> <li>- Education forum to create awareness on the hygiene-related risks to encourage a separation of animals and humans in the homestead.</li> <li>- Establishment of areas for farmers or livestock only to reduce user conflicts.</li> <li>- Limiting the access of animals to watersheds through measures such as fencing waterways and providing alternative sources of drinking water to animals.</li> </ul>
8 CHW's role in health management & information dissemination	<ul style="list-style-type: none"> <li>- Community health workers could play a crucial role in spreading health-, risk-, and WASH-related knowledge and best practice behaviour to the community.</li> <li>- Strengthening their role in health management and health education in order to <u>engage with underserved and hard-to-reach populations in wetlands.</u></li> </ul>
9 Improving collaboration to achieve a health-based wetland management	<ul style="list-style-type: none"> <li>- A multi-sectoral, multi-actor and multi-level One Health response is required, especially in view of increasing use and land use change reducing and polluting the already limited water resources and food productivity of wetlands.</li> <li>- Need for collaboration among wetland and water sectors, the health sector, education and training, gender, agriculture and fisheries, development, infrastructure, transport, housing, trade and tourism at different levels.</li> <li>- <u>The grassroots reality and participation of the target population is essential.</u></li> </ul>

\* This table refers to statements made during in-depth interviews with experts and the target population in the Ewaso Narok Swamp.

As so many different, relevant challenges are present in the unique and highly vulnerable ecological situation in the semiarid wetland, serving different interests and numerous stakeholders involved in the use and management of the Ewaso Narok Swamp all should be targeted to be represented in a health-based wetland management if it is to succeed. Health-promoting water and wetland management and health risk communication and education are tricky tasks, especially where so many are involved, and need a sensitive, integrative approach which will not leave behind any of the humans, ecology, and animals affected (=One Health). A multi-sectoral, multi-actor and multi-level response needs to be taken seriously, especially in view of increasing use and land use change reducing and polluting



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the already limited water resources and food productivity of the Ewaso Narok Swamp (WRMA, DHO, Rumuruti Water & Sanitation). And most importantly, to prevent water-related infectious diseases: the major roadblocks to sustainable development (Battermann et al. 2009). For a sustainable health-based wetland management, not only the wetland and water sectors and the health sector need to collaborate, but also education and training, gender, agriculture and fisheries, development, infrastructure, transport, housing, trade and tourism (Horwitz et al. 2015). Collaboration needs to take place at different levels and the grassroots reality and participation of the target population is essential to achieve a sustainable health-based wetland management (Finlayson and Horwitz 2015, Horwitz et al. 2012, Leemhuis et al. 2016, Maltby 1986, Mungai et al. 2004, Prothero 2000).

### **6.10 Methodological discussions and limitations**

This study pursued the overall target of contributing to fill the research gap on water-related disease exposure, health risk perception and health-related behaviour in a semiarid wetland in Kenya. A multi-step procedure was applied that first identified water-related infectious diseases that can be present in wetlands and associated them with different uses by the conduct of an analytical literature review which was informed by themes that had been collected during a prior exploratory field trip to East Africa (Chapter 2.1.1). The resulting grounded theoretical framework was then compared against a health risk assessment that included the burden of disease among wetland users, estimated by their self-reporting of symptoms and linked to health-related behaviour by a household survey and an observational assessment, in-depth interviews with the target population and expert interviews, as well as a feedback meeting (Chapter 4). The theoretical framework was also fed with empirical data from the Ewaso Narok Swamp in order to assess the level of health knowledge and health risk perception of wetland users by a household survey in-depth interviews with the target population, as well as interviews with experts and a feedback meeting (Chapter 5). Finally, all parts were brought together by triangulating and discussing theory against perception, behaviour and practice (Chapter 6.1). This multi-step mixed methods multi-level and partly explorative research approach proved to adequately achieve the aimed objectives and helped to answer the questions raised. Particularly the targeting of different wetland user (and exposure) groups (Fuhriemann et al. 2016) allowed for different inside and outside views both quantitatively and qualitatively, that helped to identify high risk factors and high risk groups for certain wetland-related infectious diseases from grassroots perspectives. These were complemented by the different uses probed among all of the respondents providing a study within the study, allowing for observations and insights from different angles. The findings could be supported and / or rejected by the expert opinions. Nevertheless, the approach to the research topic and its interpretation were limited by several methodological, organizational, context-related and other factors.

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This study adopted a cross-sectional study design in order to capture risk perceptions, behaviour and self-reported symptoms of 400 respondents and their households from the Ewaso Narok Swamp. As was described previously, cross-sectional studies are useful in capturing a snapshot of a health situation in a certain setting and associate disease outcomes with underlying risk factors. However, they are not able to fully uncover cause-effect relationships between the occurrences of symptoms and different factors. In specific, the factor time cannot be represented by a cross-sectional study at all, which is a shortcoming of this study, not allowing seasonal changes in risk perceptions and disease burden patterns to be displayed. Since no longitudinal study could be conducted in the wetland in the first place, this methodological deficiency was overcome by using perceptions and in-depth information from the target population and from experts on the seasonality of symptoms and diseases, health-seeking and WASH. Besides, the observational assessment of domestic water, sanitation and hygiene conditions contains potential limitations<sup>53</sup>. Although the index as developed and applied proved to be a helpful, rapid and efficient tool, previously applied by Herbst (2006) and Webb et al. (2006), such an instrument is only a proxy to behaviour presenting certain criteria defined by the researcher, rather than capturing actual behaviour or use. The predefined checklist aimed at making this tool as objective as possible and besides, the measurements were complemented by in-depth information concerning the WASH situation and behaviours raised by the respondents. This mixed method approach served as a valuable model to develop a multi-layered understanding of the domestic WASH situation in the Ewaso Narok Swamp as suggested by Ruel and Arimond (2002). Also, it must be pointed out that to fully capture WASH in wetlands, the public (Cairncross et al., 1996; Curtis et al., 2000) and occupational domains (Anchang et al., 2014; Derne et al., 2015) of wetland users need to be taken into consideration. As work environments and any related exposure to contaminants and infectious agents and therefore health risks vary between different groups, more investigation is required to draw a more complete picture.

The burden of disease among wetland users in this study was approached by using syndromic surveillance by self-reporting of symptoms. Such can entail several limitations. Self-reporting may differ between individuals, according to their subjective feelings and perceptions, their health beliefs and their understanding of disease. Thus, what might be worthy reporting for some might not even be considered being mentioned by others (MacKian 2002). However still, the value of syndromic surveillance has been acknowledged by several authors (Paterson and Durrheim 2013, Ziemann 2015), who described that the research interest in self-reporting has grown considerably since follow-up studies found it to predict a number of future health-related outcomes. A self-estimation of the health status includes a holistic picture and even undiagnosed diseases, judgement of severity of current diseases and family history. For these reasons, self-reporting can be used as a proxy in health-research. The interpretation of self-reported symptoms in order to approach wetland-related infectious diseases is another shortcoming of this study, since one symptom

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<sup>53</sup> Parts of this chapter have been published (Anthonj et al. 2016).

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alone cannot fully prove the occurrence of a disease and since a symptom does not indicate one specific health effect or disease. This non-specificity can lead to false alerts or the underreporting of health effects (Ziemann 2015, Kaydos-Daniels et al. 2013). However, as only diseases were approached that were reported to be prevalent, and since the symptoms used are plausible and complemented by official health data on hospital admission rates, risk perceptions by the target population and expert views, the method still gave some insight. It was the only way of approaching diseases at all, since the DHO data was limited and not detailed enough to verify the findings, not providing any information on relevant disease prevalence rates. However still, one should keep in mind potential co-occurrences of symptoms and water-related infectious diseases. In a similar setting, more detailed official health data could add a valuable benefit to similar empirical results. Besides the named, a recall bias could have confounded the study results. In this study, the self-reported symptoms were to be recalled for a four week period, a time span within which symptoms might have been forgotten or added. However, as described by Keller (1997), four weeks are minimal and thus not expected to bias the results substantially.

The sampling of respondents might also pose roadblocks to the study. Since the sample sizes of the four groups were limited to 100 per group only. Besides the targeted occupational differences in terms of potential use-related exposure, they were also quite heterogeneous in terms of socioeconomic status, education, cultural or tribal affiliation, household structure, lifestyle, habits, and household location, including distance to the swamp. Also, the sampling process was different according to the different groups, which was owed to the group sizes and the aforementioned group differences. However, still, representativity, generalizability and comparability was approached by the multiple methods used, the quantitative and qualitative nature of the data collected, the expert opinions and the feedback meeting that confirmed the results, as well as the triangulation of all. Also, the choice of the experts participating in in-depth interviews might have influenced the outcomes of the study. According to their specific background, their experiences and ideas on water-related disease in wetlands and related protective and health-seeking behaviours, the situation of water, sanitation and hygiene, water and wetland management and other important themes, their responses might differ significantly from other experts' experiences. By choosing a wide range of different stakeholders from different sectors for the interviews, working in very different disciplines and positions directly or indirectly wetlands and diseases, health education or management, a possible bias was minimized. Another potential methodological bias might stem from the data entry, analysis, transcription, and coding, which was done by several persons due to language barriers. However, the data were checked in close dialogue with the pre-existing knowledge and in the context of the theoretical framework at any time of the research, thus reducing this potential shortcoming.

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Organizational limitations arose from the limited time available for the preparation and conduct of the research in Kenya. The preparatory works and exploratory tour in other East African countries could only partly be used, which made the field phase in the Ewaso Narok Swamp very challenging. However, due to the collaboration with another working group from the GlobE Wetlands project, data collection was very efficient. Still, it was limited only to the situation in the dry season, biasing the result. The picture is likely different in the rainy season, in terms of risk perception, disease burden, health-seeking and WASH, due to water masses, inaccessibility of fields, workplaces and health-related services during flooding. Such ramifications were shown in other contexts (Anthonj et al. 2015). The involvement of the research assistants in the in-depth interviews might have influenced the outcomes of the study, as very sensitive topics were addressed. However, it would have been impossible without their involvement, given the researcher's different cultural background and language barriers in the area that hosted numerous different tribes. Without the assistants' familiarity with these relevant aspects, many might have remained undiscovered. However, during the translation process, information might have been lost, modified, or even misinterpreted. This potential limitation was controlled for by intensive training of the assistants. The risk of confounding due to socially desirable answers and the wish to fulfil the researcher's expectations is always there and can only be counteracted by an informed consent, which was done in this study.

The focus of this work is on water-related infectious disease exposure in wetlands. It is clear that transmission pathways are many, that pathogens can come from elsewhere than water and that risks for the self-reported symptoms lie in many more factors. These were not considered here as this would have gone beyond the scope of this study. However, this gives rise to several fields that could be investigated in similar settings in the future. Also, gender aspects were neglected in this study because no significant differences in terms of disease exposure could be identified between male- and female-headed households. This, however, does not mean that their health-related behaviour is similar, too. Neither does it mean that they have the same level of WASH conditions in their households, nor that they seek healthcare as men do or dispose over the same level of knowledge. This was not within the scope of this study, either, but could be analysed from the data in the future.

Finally, it must be said that another difficulty evolved from the research design and approach developed by the researcher intended to fill the research gap on water-related disease exposure, risk perceptions and health-related behaviour among wetland users: The large number and variety of methods applied in the multi-step procedure was not easy to handle in the limited amount of time. A huge array of health-based information in wetlands is included in this work, but some more information had to be excluded, because they would have gone beyond the scope of this thesis. They might, however, be put in writing elsewhere.

Despite these limitations, the study on water-related diseases, risk perceptions and health-related behaviour among wetland users in the Ewaso Narok Swamp makes a valuable

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contribution to the knowledge base on the wetland and health research. It provides the first broad overview on use-related disease exposure in wetlands by presenting a literature-based framework. It displays a detailed overview of wetland uses, related risk factors, transmission pathways and resulting diseases. Moreover, it includes the first extensive knowledge and risk perception study in terms of disease exposure from a wetland and from different wetland user groups, considering also neglected tropical diseases, which are generally under-researched, also in non-wetland settings. The study also shows for the first time the health-related behavioural decisions that wetland users take and identifies both commercial farmers and pastoralists at (opposing) high risk. The study provides the first investigation to assess and quantify the domestic WASH conditions of different wetland user groups and to identify the behavioural determinants in order to fully capture WASH in wetlands. Also, health-seeking behaviour was shed light on in the context of wetlands for the first time in such depth. Such research is valuable because to date, empirical data on the internal views of wetland inhabitants regarding health-related issues have been scarce (Horwitz et al. 2012). New is also the integration and triangulation of the theory with perception, behaviour and risk. Overall, this study facilitates a better understanding of the health risks and the health situation in wetlands from the grassroots perspectives. Both are good starting points for a health-adapted wetland management, which revealed to be of crucial importance, given the peculiarities of such fragile vulnerable ecosystems as are semiarid wetlands.

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## 7 CONCLUSIONS

This study aimed at helping to close the research gap on use-related disease exposure in East African wetlands by presenting the case of a semiarid highland floodplain in Kenya. Although the history of associating wetlands and infectious diseases has been long, providing a broad overview with specific information about use-related disease risks, considering occupational, as well as domestic features and behavioural aspects, is a novel approach.

The grounded theoretical model shows that different wetland uses entail different health risk factors. Exposure to infectious agents depends upon the type of use, occupational characteristics, time and duration spent in wetlands. Disease transmission is mostly driven by users' physical contact to water, characteristics of pathogens and vectors of disease. The available literature is scattered and the amount varies significantly. Whereas several publications have linked crop production to the contraction of diseases, fewer are available on health risks identified with the use of domestic water or with pastoralism in wetlands.

A health risk assessment relating self-reported abdominal conditions, fever, skin and eye conditions of wetland users to multiple occupational and domestic risk factors reveals that the contraction of diseases mainly takes place in the domestic domain, whereas the occupational risks play a minor role in the investigated population. Unsafe water source, little or discontinuous water supply, inadequate sanitation and poor hygiene, as well as poor environmental hygiene are high risk factors. Safe water supply, good sanitation and frequent cleaning of latrine, as well as frequent handwashing, on the other side, are the main protective factors, and so are the prevention of stagnant water near the home and the use of mosquito bed nets. Again, concurring with the current literature, it is not necessarily the occupational proximity to water and occupational characteristics that determine the contraction of diseases in marshes. Rather are the role of human behavioural practices in the domestic domain, most importantly water, sanitation and hygiene, as well as cultural aspects and health beliefs underlined in the exposure as well as the prevention of any sort of water-related infectious diseases.

Perceptions of wetland users revealed that the awareness level towards water-related health risks is generally high. The people in and around the Ewaso Narok Swamp strongly saw the connection between wetlands and adverse effects on human health. They were aware of the environment-animal-human health nexus. Especially unsafe water, inadequate sanitation, poor hygiene and environmental pollution were being regarded as responsible risk factors for diseases, in particular for diarrhoeal diseases and typhoid fever. Moreover, the wetlands' water resources providing mosquito breeding sites were rated as harmful and exposing users to malaria. The presence of neglected tropical diseases in such environments was perceived as a challenge to public health. Occupational factors, such as the use of pesticides in agricultural crop production and environment- and climate-related features

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were widely perceived risk factors as well, but perceived as way less hazardous than risks in the domestic domain.

Differences between different user groups become apparent in terms of health risk perceptions, health-related behaviour and in the actual health risks. Farmers rather find irrigation practices risky, fear mosquitoes on their fields, as well as the effects of agrochemicals used. As the statistical analyses reveal these concerns are justified, as they actually expose to diseases. Adapted to these perceptions and their occupational characteristics, the farmers are more likely to use protective gears during their field work. The pastoralists perceive unsafe and lacking WASH as risky, unhygienic environments and the presence of flies. All these factors are very pronounced in their nomadic living environments (which at the same is their workplace) due to the remoteness of their homesteads and the proximity to their livestock – and indeed increasing their risk of contracting eye conditions. The service sector workers have a comparably low perception on health risks arising from wetland use compared to the other groups, which is not surprising. Neither do they live close the Ewaso Narok Swamp, nor do they use or depend upon it for the maintenance of their livelihoods. Therefore, they lack experience of and exposure to risks associated with the wetland.

The relevance of this compilation is rather obvious: Wetlands are widely and increasingly used for different purposes in East Africa, with a tendency to increased exploitation and modification. The ongoing population growth is accompanied by higher density of populations living in closer proximity to wetlands, consequently increasing contamination of such ecosystems. The anthropogenic alteration, as well as human and livestock pollution drive the presence and proliferation of pathogens in wetlands, whilst human behaviour determines the users' exposure to these pathogens, as well as their risk of contracting diseases. As was described in detail, the most efficient way in breaking the transmission routes is the safe water, adequate sanitation and good personal and environmental hygiene.

The study from the Ewaso Narok Swamp, however, reveals that WASH is highly insufficient for large parts of the wetland users, lagging far behind the nationwide average for rural populations in the Republic of Kenya. Thus, even though the users understand the situation and risks that come along with inadequate WASH: as long as improved infrastructure and options are lacking, the prevention of diseases in wetlands will remain nearly impossible. Rather will the burden of disease continue to be high or even increase, as the lack of respective infrastructure will even accelerate the presence of infectious agents. And most of the diseases addressed in this study are very sensitive to the degradation of wetlands and to ecological, hydrological, seasonal and land use changes. This is problematic in view of the insufficient healthcare situation in the Ewaso Narok Swamp. Those falling ill are faced with an undersupply of easy-to-reach healthcare, making use of traditional herbal medicine as a cost-effective local alternative, but remaining underreported to the health system, and potentially not adequately cured.

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In a nutshell, this means that the contraction of diseases in marshes underlies temporal, environmental, ecological, anthropological and behavioural determinants. The Ewaso Narok Swamp exposes its users to different water-related infectious diseases, while at the same time not sufficiently providing the necessary infrastructure to stay healthy or get adequately treated. This transforms wetland use and disease exposure into an enhancing vicious circle with transmission routes difficult to be disrupted. Thus, whether or not the people perceive risks might only limitedly matter if they are underserved health-wise and have no options at hand to proactively act or to react.

This study points to what one might have figured already: the water provided by the wetland is a two-sided coin, acting as a driver for development, but also as an impediment in terms of health. The inhabitants of wetlands gain free water, nutrition and food security, but pay a high prize and ill-health in return, with water, sanitation and hygiene being high risk as well as protective factors, depending on their quality. Wetlands are not primarily made for human living, expose wetland users to health risks and diseases (if no adequate preventive measures are taken), while not being able to keep track in terms of health- and WASH-related infrastructure necessary to prevent and cure diseases. Naturally, still, given water and food scarcity, the benefits might outweigh the threats.

However, still, as this study shows, inhabitants of marshes are underserved. Common sense tells us that logical consequences for the protection of human health would call for improvements of domestic and communal water supply, sanitation and hygiene; as well as health-promoting water and environmental management and improvements in the healthcare infrastructure in wetland settlements. Besides, health education at different levels would be necessary in order to meet the health-related demands and the United Nations Sustainable Development Goal 6: Safe water and sanitation for all.

In-migration and overuse are already strongly challenging such fragile ecosystems, reducing and deteriorating their water resources, especially in semiarid regions, thus creating an increasingly hazardous environment, not only human health-wise, but also in terms of ecosystem health. For sure, improvements in wetlands' infrastructure could improve the situation; but also, they would be incentives to attract more settlers who could contribute to overstretch the natural resources, which would add an additional burden on the ecosystems. And which would then also result in reducing the soils' productivity and thus food security on the long run. This thought again reflects the questions on how to manage this competition between humans, animals and ecosystems and on how to realistically achieve the wise use and healthy wetlands as suggested by the Ramsar Convention while at the same time providing healthy conditions for people depending on wetlands. The sole provision of safe WASH would not be enough to meet all needs.

Health is the foundation for work productivity, food security, poverty reduction, growth, and long-term development and needs to be protected in the context of wetlands. Despite



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wetlands having been recognized by international agendas such as the United Nations Sustainable Development Goals, the World Health Organization, Ramsar or Wetlands International, global actions taken in order to achieve a health-based wetland management have been limited so far. This is owed to the entanglement of human health, ecosystem health and environmental protection: While wetlands could solve several challenges around the world related to water (SDG 6), food (SDG 2) and poverty reduction (SDG 1), such ecosystems should be protected, conserved, sustainably and healthily used (SDGs 14 and 15). Human settlements should be safe and sustainable (SDG 11), safe water access and sanitation should be allocated to all (SDG 6), and good health and well-being should be possible for everybody (SDG 3). This shows that wetlands may be regarded as microcosms and laboratories where all SDGs come together.

Given the high demand for water and food, it is impossible to achieve all of these targets at a time. What this compilation of targets underlines, however, is the need to view water-related disease exposure, risk perception, health-related behaviour and medical undersupply in wetlands from a holistic perspective. Since the trend of increasing wetland use is unlikely to be reversed but rather most likely to be exacerbated, increasing the health-related risks also, there is the need to capture the challenges that wetland communities are facing in order to facilitate healthy wetland use, decide on the way forward or on possible interventions.

It is essential that integrated health-based wetland management approaches are adopted, which incorporate health strategies based on risk assessments such as the one provided here. Approaches must be intersectoral, cutting across all wetland uses and stakeholders, and address health service deficiencies. And here, the role of wetland users as key informants should be acknowledged by wetland managers for a health-adapted sustainable wetland management that includes users as participants and actors with their grassroots perspectives. As falling ill impairs the users' (agricultural) productivity and quality of life, it is crucial to integrate the framework on use-related disease risks into health-sensitive wetland management activities, health education programmes and disease prevention and control strategies and last but not least, the concept of wise wetland use. Such would present good starting points for a health-adapted wetland management, which revealed to be of crucial importance, given the peculiarities of such fragile vulnerable ecosystems as are semiarid wetlands.

Along with findings from the other studies conducted within the *Globe Wetlands in East Africa* project, the results from this work are going to be integrated into a holistic Health Impact Assessment guidance document for wetlands. This HIA document is intended to serve to define wetland-specific health and disease conditions and link them with existing policies and good practices in the public health sector. Besides, the results contribute to the health and environmental sustainability targets of the United Nations Sustainable Development Agenda.

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## Annex 1: Glossary

Admission	The official acceptance into a health care service facility and the assignment of a bed to an individual requiring medical or health services on a time-limited basis.
Bilharzia	A human disease caused by various species of trematode worms that use snails as an intermediate host; also called schistosomiasis.
Burden of disease	The total significance of disease for society beyond the immediate cost of treatment. It is measured in years of life lost to ill health as the difference between total life expectancy and disability-adjusted life expectancy.
Diarrhoea	Diarrhea can be defined in absolute or relative terms based on either the frequency of bowel movements or the consistency (looseness) of stools.
Diarrhoea episode	A diarrhea episode is a single diarrhea incident. A new episode is defined as an interval of a symptom-free time span (often 3 days) before the next diarrhea incident.
Disease burden	Size of a health problem in an area, measured by cost, mortality, morbidity, or other indicators. Knowledge of the burden of disease can help determine where investment in health should be targeted.
Domestic hygiene	All activities to keep the house and people's clothes and bedding clean. This comprises sweeping and washing floors, cleaning the toilet, washing clothes and bedding as well as washing dishes and cooking utensils after meals.
Environmental management	The planning, organisation, carrying out and monitoring of activities for modification and or manipulation of environmental factors or their interaction with human beings with a view to preventing or minimising vector propagation and reducing human-vector pathogen contact.
Environmental modification	Measures aimed at creating a permanent or long-lasting effect on land, water or vegetation to reduce vector habitats.
Epidemiological study	A study design that investigates distribution and determinants of health conditions and health incidents in a defined population group and the resulting application for controlling health problems.
Equity	The absence of avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically, or geographically. Health inequities involve access to the resources needed to improve and maintain health or health outcomes and entail a failure to avoid or overcome inequalities that infringe on fairness and human rights norms.
Exposure	The condition of being subject to some detrimental effect or harm.
Exposure pathways	Exposure pathways are the means by which an individual comes into contact with the hazard. Exposure may or may not lead to adverse health effects and is determined by concurrent exposures to the same or different hazard, susceptibility and immunity of the individual. Exposure pathways can be primary (direct contact) or secondary (inhalation).
Gross domestic product	The GDP is the most widely used concept of national income defined in the System of National Accounts. It represents the total final output of goods and services produced by an economy during a given period, regardless of the allocation to domestic and foreign claims and is calculated without making deductions for depreciation.
Groundwater	The supply of freshwater found beneath the earth's surface, usually in aquifers, which supplies wells and springs.
Hazard	A hazard is something that does harm (e.g. agents such as pathogens). However, a hazard also includes the absence of protective measures and even the absence of controls over protective measures.
Health	A state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity (Constitution of the World Health Organization, 1946)
Health care facility	A building or group of buildings under a common corporate structure that houses health care personnel and health care equipment to provide health care services (e.g., diagnostic, surgical, acute care, chronic care, dental care, physiotherapy) on an in-patient or out-patient basis to the public in general or to a designated group of persons or residents.
Health indicator	An indicator applicable to a health or health-related situation.

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Health system	The people, institutions and resources, arranged together in accordance with established policies, to improve the health of the population they serve, while responding to people's legitimate expectations and protecting them against the cost of ill health through a variety of activities whose primary intent is to improve health. Health systems fulfil 3 main functions: health care delivery, fair treatment to all, and meeting non-health expectations of the population. These functions are performed in the pursuit of 3 goals: health, responsiveness and fair financing.
Homestead	A cluster of several houses belonging to one household. It includes other structures (animal sheds, granaries, utensils rack) adjacent to the houses.
Household	Individuals living together as a family unit and sharing a common budget. These may include domestic help and other members of the extended family.
Hygiene	Conditions and practices that help to maintain health and prevent the spread of diseases, including hand washing with soap or other agents, food hygiene, overall personal hygiene including laundry, and environmental cleaning. In healthcare settings, hygiene measures also include sterilization of equipment, safe disposal of medical waste and surface cleaning.
Improved sanitation	Improved sanitation comprises connection to a public sewer, connection to a septic system, pour flush latrine, simple pit latrine and ventilated improved pit latrine.
Improved water supply	Improved drinking water sources comprise household connection, public stand pipe, borehole, protected dug well, protected spring, and rainwater collection.
Incidence Indicator	The number of new cases of disease during a period of time. Variable susceptible of direct measurement that is assumed to be associated with a state that cannot be measured directly. Indicators are sometimes standardized by national or international authorities.
Latrine	A site or a structure, normally located normally outside the house or building, destined to receive and store excreta and sometimes to process them (composting).
Livelihoods	Capabilities, assets (incl. both material and social resources) and activities required for a means of living (Chambers & DFID). Livelihood strategies (i.e. the range and combination of activities and choices that people make in order to achieve desired livelihood outcomes) are influenced by the level and combination of the assets (or capital) to which an individual has access.
Malaria	A human disease caused by a protozoan that is transmitted by infected mosquitoes.
Marsh	Marshes are defined as wetlands frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions. Marshes receive most of their water from surface water, and many are also fed by groundwater. Marshes recharge groundwater supplies and moderate streamflow by providing water to streams. This is an especially important function during periods of drought.
Marura	Swahili word for wetland, in this study referring to the Ewaso Narok Swamp.
Mbu	Swahili word for mosquito.
Mortality rate	The number of deaths in a group of people usually expressed as deaths per thousand.
Odds ratio	A measure of effect size, describing the strength of association or non-independence between two binary data values. It is used as a descriptive statistic, and plays an important role in logistic regression.
Onchocerciasis	A human disease caused by nematode worms and transmitted by infected black flies; also known as river blindness.
Personal hygiene	Includes all activities to keep the body clean, such as washing hands after contact with fecal matter, showering, washing hair, brushing teeth.
Piped water	Drinking water supply with treated water, which is delivered by a water distribution system.
Prevalence rate	The number of people in a particular area who currently have a disease and have not been cured of it.
Resilience	Resilience has been defined from a number of perspectives, but its key elements include the ability of a social-ecological system to absorb disturbance, learn from it, and appropriately reorganize and adapt to minimize vulnerability.
Risk factor	Factor is a factor associated with an increase in the chances of getting a disease; it may be a cause or simply a risk marker. Factors associated with decreased risk are known as protective.
River blindness	A human disease caused by nematode worms and transmitted by infected black flies; also known as onchocerciasis.

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Safe drinking water supply	The water does not contain biological or chemical agents at concentration levels directly detrimental to health. 'Safe water' includes treated surface waters and untreated but uncontaminated water such as that from protected boreholes, springs, and sanitary wells. Untreated surface waters, such as streams and lakes, should be considered safe only if the water quality is regularly monitored and considered acceptable by public health officials.
Sanitation	The provision of facilities and services for the safe disposal of human excreta. It refers to the safe management of excreta from collection, emptying, transport, treatment and disposal or reuse.
Schistosomiasis	A human disease caused by various species of trematode worms that use snails as an intermediate host; also called bilharzia.
Shamba	Swahili word for field or plot in which agricultural production takes place.
Surface water	All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.).
Surveillance	Surveillance includes the collection of data and the review, analysis and dissemination of findings on incidence (new cases), prevalence, morbidity, survival and mortality. Surveillance also serves to collect information on the knowledge, attitudes and behaviours of the public with respect to practices that prevent cancer, facilitate screening, extend survival and improve quality of life.
Sustainable WASH	Sustainability of WASH services refers to the continued functioning and utilisation of water and sanitation services as well as lasting changes in human behaviour around hygiene and safe sanitation. Sustainability is about services that continue in use indefinitely and that consequently transform people's lives for good.
Trachoma	Eye disease caused by the bacterium <i>Chlamydia trachomatis</i> , closely connected with the presence and absence of water, sanitation and hygiene.
Transmission routes	Transmission routes are the ways in which an individual or group acquires the disease-causing pathogen. The transmission route could be, for example, through drinking contaminated water or through faecal-oral route. Transmission routes may be direct (through animal to animal, or human to animal physical contact) or indirect (through vectors, water, food, faecal-oral contact).
Typhoid fever	Disease caused by the bacterium <i>Salmonella</i> spp., transmitted through the ingestion of faecally contaminated water or food or by flies.
Unimproved sanitation	Unimproved sanitation comprises a public or shared latrine, open pit latrine and bucket latrine.
Unimproved water supply	Unimproved drinking water sources comprise unprotected well, unprotected spring, rivers or ponds, vendor-provided water, bottled water and tanker truck water.
Vector	The vector is the intermediary between the reservoir and the host. An organism, such as a biting fly, that transmits an infectious disease.
Water quality	Physical, chemical, biological and organoleptic (taste-related) properties of water.
Water supply	The provision of water by public utilities, commercial organisations, community endeavours or by individuals, usually via a system of pumps and pipes.
Wetland	Wetlands are broadly defined and include swamps and marshes, lakes and rivers, wet grasslands and peatlands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans (Ramsar 1971)

## Annex 2: Stakeholder mapping on wetlands & diseases based on expert IDIs

Expert & affiliation	Content of the interview	Focus wetlands & health
<b>Rwanda Environment Management Authority (REMA),</b> at 10 <sup>th</sup> March 2014 at 17 <sup>th</sup> March 2014	Wetland conservation activities of REMA included the mapping and classification of wetland use, community trainings on the sustainable use of wetlands for agriculture and artisanal use to create behaviour change ("healthy use"), as well as cross-cutting issues such as environmental awareness, gender, promotion of peace-building and youth programmes. Currently REMA works on district environmental management & protection, mainstreaming environmental protection, river bank restoration and the poverty environment. Health issues have been underrepresented up to now, only malaria and schistosomiasis are addressed. There is a lack of documents drafted by REMA on the links between environment and health. Environmental Health Officers (EHO) formulated the need for a baseline study on wetlands and health. Collaboration of multiple ministries, agencies, NGOs and using UMUGANDA for better land use and organization resulting in better health.	Water quality, pathogens, parasites, residuals. Health issues underrepresented. Cooperation with IWRM Department & Ministry of Health, Rwanda Biomedical Centre (RBC)
<b>Welthungerhilfe,</b> Meeting and field trip at 11 <sup>th</sup> March 2014 at 26 <sup>th</sup> March 2014	Involvement in marshland development projects aiming at the transformation of wetlands for agriculture, consolidation, farmer cooperatives, and protection of wetland erosion. Make wetlands usable for agricultural use in order to achieve food security and poverty alleviation for the poorest parts of the society, therefore close collaboration with the local governments of the respective regions took place. Fields were allocated and distributed among people living near marshlands by a categorization of poverty ranking of the addressed families made available from the sector offices. The interventions by WHH include trainings in cooperative management, marketing and rice cultivation, the construction of upstream dams for water storage and irrigation programmes with water users organizations.	Food security, income and indirect contribution to health by providing access to wetlands. Collaborate with BMZ, Viva con Agua on WASH
<b>USAID Rwanda,</b> at 12 <sup>th</sup> March 2014	USAID Rwanda supports multiple sectors, including health, agriculture, environment, education, democracy, government, capacity building. The health sector is supported in prevention and treatment of HIV, Malaria, TB, family planning, maternal healthcare, WASH, nutrition, strengthening of health services. Regarding the agriculture sector, USAID collaborates with the Ministry of Agriculture, Ministry of Water, Water Management Department, Natural conservation agencies, World Bank, etc. Especially in the Eastern province, water resources management activities are conducted, e.g. irrigation projects.	Improve access to WASH, health programmes, collaboration with cooperatives, environmental safeguarding
<b>Bugesera District Office, Access project</b> at 19 <sup>th</sup> March 2014	The EHO coordinates the activities related to water, sanitation, hygiene, supervises activities in health centres such as capacity building in waste management or public places WASH inspection, trains community health workers, besides other tasks. Each village has 4 CHW reporting certain diseases (pneumonia, malaria, diarrhoea), train communities on maternal & child health, and work on social affairs, including hygiene, sanitation, health insurance Mutuelles de Sante. There are CHW cooperatives, funded by Global Fund, GIZ, British Tech cooperative, UNICEF, EGPAF generating joint income projects to then buy activities they can make for earning money. Activities related to water are carried out with Water Aid on boreholes in wetlands and the reduction of the negative impact on health. In 2013, the top ten health threats included urinate diseases, eye infection, diarrhoea, dental diseases, gastritis, infectious diseases, malaria	Wetlands call for strategies to improve health, promote WASH & waste management. Collaboration with RBC, Access Project, Center for Global Safe Water at E. Monj University
<b>Protos,</b> at 20 <sup>th</sup> March 2014	Protos Rwanda aims at improving the water management in order to achieve economic and social development which is participatory, equitable and sustainable through local capacity building in cooperation with local communities, user organizations, local governments and authorities, local NGOs through a multi-stakeholder approach. A main focus is on IWRM and the allround functions of water (drinking, agriculture, industry, nature, ecology), different types of water users and their needs, impact on downstream neighbours, water conservation, water availability, habits, water and sanitation supplies, national policy & strategy, different actors and roles, threats, opportunities. Activities on drinking water, hygienic water storage and use, drainage of water, clean environment, waste disposal, hand washing, personal and food hygiene, pollution, water quality due to agriculture, chronic poverty and gender, partly in collaboration with health centres.	IWRM and focus on WASH, agricultural pollution, behaviour change → awareness rising Multiple collaborations: GIRE, GWP, HAMS, PHAST, WASCO
<b>Aegis Trust Gisozi Memorial,</b> at 21 <sup>th</sup> March 2014	During the genocide, wetlands served as refugee areas and became a home for some who lived in wetlands for months. In the countryside, people sought shelter in the wetlands. However, there, people were exposed to malnutrition and diseases. Due to the dangerous conditions, the perpetrators would not enter the wetlands, which offered some protection to those hiding there (part of the heroic story of some survivors). Rivers played a wetland-related role as well, receiving thousands of dead corpses. All wetlands around genocide memorials have a genocide-related history. <i>"If I stay on the hill, I am dead. In wetlands I can survive two or more days longer"</i> .	During the Genocide, wetlands and rivers played important roles regarding live and death, shelter, and disease
<b>Japan International Cooperation Agency,</b> at 28 <sup>th</sup> March 2014	The main foci of JICA Rwanda cover human resources development (education, technology, volunteers), rural development (water supply & sanitation, rural water supply, volunteers) and economic infrastructure & industry. JICA collaborates with the Ministry of Infrastructure and the Ministry of Natural Resources to develop WRM and water supply facilities by water quality, supply and demand assessments, the formulation of planning, recommendations on institutional structures, trainings and meetings with local administrators of water supply. The leading donor of water supply and sanitation in Rwanda works with health volunteers.	No clear wetland focus, but numerous activities carried out on WASH
<b>World Health Organization Country Office,</b> at 1 <sup>st</sup> April 2014	WHO Rwanda works on health-related technical support, policy and strategic planning and development considering the poverty reduction strategy, targeting the control of AIDS, TB, Malaria and non-communicable diseases, health systems, maternal and child health, as well as immunization, nutrition and ental health. With regard to environmental health, priorities include hygiene promotion, sanitation, water quality, food security, nutrition, disaster management controlling neglected tropical diseases, schistosomiasis and chemical pollution of water, development of strategies and policies in collaboration with Environmental Health Desk of MoH and Ministry of Infrastructure. WHO Rwanda conducts situation analyses and needs assessments, e.g. drinking water quality surveillance, in collaboration with UNHABITAT and UNICEF. There is no programme on wetlands and health, but recognized problems cover agricultural and industrial pollution. Two consultants work on environment and health. Collaboration with Rwanda Natural Resources Authority (RNRA) and WRM Department.	No programme on wetlands and health, awaiting a needs assessment. Recognized wetland-related health problems include agricultural and industrial pollution. Interest in assessment of water quality in wetlands

## Annex 3: Data Collection Tool: Survey questionnaire

### Globe Wetlands in East Africa Project - Household Survey

Dear participant,



we are part of a team at Kenya National Museums, Kenyatta University and other collaborators, who are studying aspects on how communities benefit from wetlands and how wetlands influence human health in the Laikipia County. You have been randomly selected to take part in this survey and therefore your participation in answering these questions would be very much appreciated. The participation is purely voluntary, requires your informed consent, and you free to withdraw anytime during the interview. Your responses will be completely confidential. They will be added to those of 400 other households and analysed together. If you indicate your voluntary consent by participating in this interview, may we begin?

Thank you very much for your participation.

#### SECTION A: PRELIMINARIES

Household identifying variables		
Survey Date	Enumerator	HHID
HH Name	<b>Wetland user group</b> (_____) <small>1 = smallholder, non-commercial farmer, 2 = commercial farmer 3 = pastoralist, 5 = service sector worker</small>	
Respondent(s)		
County		
Sub-county		
Ward		
Sub-Location	GPS coordinates	
Village	Northing _____' _____dd)	
Cell phone	Eastings _____' _____dd)	
	Altitude m.a.s.l (_____)	

#### SECTION B: WETLAND UTILIZATION

B1. When did you start using the wetland (year)? [\_\_\_\_\_]

B2. Which time of the day do you usually spend in wetlands? wetime [\_\_\_\_\_]

**Codes** wetime: 1=Morning (before 11 am) 2=Noon (11am-2pm) 3=Afternoon (2-6 Pm) 4=Evening (after 6 pm)

B3. For the different ways in which you use the wetland, please answer the following questions

**(ENUME: First probe for all uses then ask the questions that follow)**

Wetland use	Which year did you start using the wetland for this purpose?	Indicate the frequency of using the wetland for this purpose (see codes below)	
		times	period
Domestic Water			
Crop Production			
Irrigation water			
Application of manure			
Application of pesticides			
Livestock grazing, cut fodder			
Building materials, fuel			
Fishing			
Medicinal plants			
Other (specify) _____			

**Codes** period: 1 = day, 2 = week, 3 = month, 4 = semi-annually, 5 = annually, 6 = other (specify) \_\_\_\_\_



## SECTION C: HEALTH RISKS PERCEPTIONS AND KNOWLEDGE OF DISEASES

C1. Please indicate your opinion on the following statements, considering to what extent you either agree or disagree with the statements and specify.

(**ENUME:** If the response is either strongly agree, agree, disagree or strongly disagree, please ask the respondents to specify their answer and note their comments in the open space below the questionnaire)

Statement	1 = strongly agree	2 = agree	3 = neutral / don't know	4 = disagree	5 = strongly disagree
1. The use of the Ewaso Narok Swamp influences people's health					
2. The use of the Ewaso Narok Swamp causes diseases					
3. People spending much time in Ewaso Narok Swamp are exposed to higher health risks					
4. Health risks depend on the season					
5. There are more diseases in the rainy season					
6. There are more diseases during flooding					
7. There are more diseases in the dry season					
8. Compared to the past, diseases in the Ewaso Narok Swamp has increased					
9. Compared to the past, the quality of water in the Ewaso Narok Swamp has decreased					

C2. Which diseases do you know and are they common in this area/village?

(**ENUME:** please note all comments of the respondent regarding health issues in the open space below the questionnaire)

(**ENUME:** The question on affected household members is an anchor question that can qualify the respondent for an IDI)

Disease	Do you know the disease?  0 = no 1 = yes	If no, have you ever heard about the disease  0 = no 1 = yes	If you know the disease, how common is it in this area?  0 = not common 1 = very common 2 = don't know	Does the use of the Ewaso Narok Swamp expose people to this disease?  0 = no 1 = yes 2 = I don't know 3 = no answer
1. Malaria	[ ]	[ ]	[ ]	[ ]
2. Diarrhoea	[ ]	[ ]	[ ]	[ ]
3. Cholera	[ ]	[ ]	[ ]	[ ]
4. Typhoid fever	[ ]	[ ]	[ ]	[ ]
5. Bilharzia/Schistosomiasis	[ ]	[ ]	[ ]	[ ]
6. Eye diseases	[ ]	[ ]	[ ]	[ ]
7. Trachoma	[ ]	[ ]	[ ]	[ ]
8. Blindness	[ ]	[ ]	[ ]	[ ]
9. Skin diseases	[ ]	[ ]	[ ]	[ ]
10. Flu	[ ]	[ ]	[ ]	[ ]
11. Pneumonia	[ ]	[ ]	[ ]	[ ]
12. Tuberculosis	[ ]	[ ]	[ ]	[ ]
13. Malnutrition	[ ]	[ ]	[ ]	[ ]
14. HIV / AIDS	[ ]	[ ]	[ ]	[ ]
15. Mental diseases	[ ]	[ ]	[ ]	[ ]
16. Other, specify	[ ]	[ ]	[ ]	[ ]
17. Other, specify	[ ]	[ ]	[ ]	[ ]

C3. In your opinion, referring to wetlands, what causes these diseases? 0 = no, 1 = yes, 2 = I don't know

**(ENUME: First probe for diseases in general, then ask the other diseases that follow)**

**(ENUME: The following are anchor questions that can qualify the respondent for an IDI)**

Perceived disease cause		Diseases (general)	Malaria	Diarrhoea	Eye disease	Skin disease
1.	Unsafe wetland water					
2.	Inadequate sanitation					
3.	Poor hygiene					
4.	Environmental pollution					
5.	Mosquito habitats					
6.	Insect bites					
7.	Freshwater snails					
8.	Crop production					
9.	Irrigation canals					
10.	Use of pesticides					
11.	Proximity to livestock					
12.	Fishing					
13.	Collecting building materials					
14.	Fetching water					
15.	Washing clothes					
16.	Swimming					
17.	Proximity to river					
18.	Proximity to dam					
19.	Flooding					
20.	Rain					
21.	Drought					
22.	Poverty					
23.	Lack of education					
24.	Lack of social network					
25.	Lack of medical services					
26.	Other, specify					
27.	Other, specify					

C4. In your opinion, are the following aspects preconditions for health? 0 = no, 1 = yes, 2 = I don't know

Perceived health preconditions				
1.	Availability of clean water	[ ]	2. Sports / exercises	[ ]
3.	Hygiene	[ ]	4. Free time / leisure	[ ]
5.	Clean toilet / latrine	[ ]	6. Safe environment	[ ]
7.	Absence of disease	[ ]	8. Good infrastructure	[ ]
9.	Health education	[ ]	10. Availability of medication	[ ]
11.	Social network	[ ]	12. Availability of medicinal plants	[ ]
13.	Family & children	[ ]	14. Accessible health services	[ ]

Comments: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
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 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**SECTION D: SYNDROMIC SURVEILLANCE AND HEALTH-RELATED BEHAVIOUR**

D1. Have you suffered from the following symptoms during the previous month (February 2015) and have you sought medical consultation?

**(ENUME: Probe for all symptoms. Answering selected symptoms positively can qualify the respondent for an IDI)**

Self-reported symptom		Have you or any household member suffered the symptom in the reference period? 0 = no 1 = yes	If yes, did you seek medical consultation? 0 = no 1 = yes	If yes, where did you seek medical consultation? 1 = government hospital 2 = private doctor 3 = community health worker 4 = chemist 5 = traditional healer 6 = other (specify) _____	If you did not seek medical attention, give reasons  1 = took drugs 2 = took hebal medicine 3 = no money 4 = too far from facility 5 = other (specify) _____
1.	Abdominal complaints				
2.	Diarrhoea				
3.	Diarrhoea with blood				
4.	Dizziness				
5.	Dark urine				
6.	Bloody urine				
7.	Nausea				
8.	Vomiting				
9.	Fatigue				
10.	Headache				
11.	Fever				
12.	Skin itching				
13.	Skin lesion				
14.	Skin fungus				
15.	Eye lesions				
16.	Visual impairment				
17.	Cough				
18.	Flu				
19.	Insect bite				
20.	Joint pain				
21.	Other, specify				
22.	Other, specify				

D2. Do you regularly undertake any measures to protect yourself against water-related diseases? 0 = no, 1 = yes [\_\_\_\_\_]

D3. If no, why not? [\_\_\_\_][\_\_\_\_][\_\_\_\_][\_\_\_\_][\_\_\_\_]

**(ENUME: pick the first 5 in order of priority)**

**Codes** no measures: 1 = no necessity, 2 = no interest, 3 = no time, 4 = no money, 5 = other priorities, 6 = lack of knowledge, 7 = lack of possibilities, 8 = no access to health service provision, 9 = limited infrastructure, 10 = other, specify \_\_\_\_\_

D4. If yes, what are the measures that you usually take? [\_\_\_\_][\_\_\_\_][\_\_\_\_][\_\_\_\_][\_\_\_\_]

**(ENUME: pick the first 5 in order of priority)**

**Codes** measures: 1 = boil water before drinking, 2 = filter water before drinking, 3 = other water treatment measure, 4 = wash food before preparing, 5 = cook food before eating, 6 = frequent hand washing with soap, 7 = hand washing after using latrine or toilet, 8 = frequent bath taking, 9 = bath taking directly after farming, 10 = frequent cleaning of water storage container, 11 = Frequent cleaning of sanitation facility, 12 = wear protective gears (gloves / gum boots), 13 = use mosquito bed net, 14 = use insect repellent, 15 = stay away from wetland and rivers if not necessary, 16 = prevent stagnant water sources near house if possible, 17 = health education, 18 = preparing traditional medication, 19 = taking prescribed medication by doctor, 20 = spiritual practices, 21 = other, specify \_\_\_\_\_

## SECTION E: WATER SUPPLY AND HYGIENE

E1. What are the sources of drinking water for your household? [\_\_][\_\_][\_\_]

(ENUME: pick the first 3 in order of priority)

Codes drinking water source: 1 = private tap water, 2 = public tap, 3 = harvested rainwater, 4 = well, 5 = water kiosk / vendor, 6 = bottled water, 7 = water from river, 8 = wetland water, 9 = other, specify \_\_\_\_\_

E2. Which water source do you use for washing / bathing? [\_\_][\_\_][\_\_]

(ENUME: pick the first 3 in order of priority)

Codes bathing water source: 1 = private tap water, 2 = public tap, 3 = harvested rainwater, 4 = well, 5 = water from river or wetland, 6 = other, specify \_\_\_\_\_

E3. How was your water supply in the previous week? [\_\_\_\_\_]

Codes water supply: 1 = same as usual, 2 = discontinuous water supply, 3 = not enough water, 4 = more salty than usual, 5 = less salty than usual, 6 = other taste than usual, 7 = other colour than usual, 8 = high turbidity, 9 = other specify \_\_\_\_\_

E4. Where your water is usually stored? [\_\_][\_\_][\_\_]

(ENUME: pick the first 3 in order of priority)

Codes water storage: 1 = inside the house, 2 = outside the house, 3 = kitchen, 4 = bathroom, 5 = yard, 6 = other, specify \_\_\_\_\_

### E5. Hygiene Index

(ENUME: Assign a score on the following aspects based on your observations in the household)

(ENUME: By reaching a score >3 or <-3 the respondents can qualify for an IDI)

<b>Environment</b>		Score [_____]
-1	Faecal contamination / free roaming animals / stagnant water	
0	Some waste / restraint animals / significant number of flies	
+1	No sign of contamination / insignificant number of flies	
<b>Sanitation</b>		Score [_____]
-1	No sanitation facility on the premises	
0	Unimproved* sanitation facility on the premises	
+1	Improved* sanitation facility on the premises	
<b>Water</b>		Score [_____]
-1	Water storage container uncovered / visible signs of pollution	
0	Water storage container not covered / but no visible signs of pollution	
+1	Water storage container is covered, no visible signs of pollution	
<b>Food</b>		Score [_____]
-1	Food stored uncovered on the ground / significant flies	
0	Food stored uncovered / food stored on the ground / dirty dishes visible	
+1	Food stored covered and raised / clean dishes covered	
<b>Personal</b>		Score [_____]
-1	Visible sign of dirt on clothes, hands and body	
0	Few visible signs of dirt on clothes, hands or body	
+1	Neat appearance / no visible signs of dirt on clothes, hands or body	
<b>TOTAL HYGIENE SCORE:</b>		[_____]

\*Improved sanitation is defined as one that hygienically separates human excreta from human contact and includes flush toilet, pit latrine with slab, connection to septic system and others. Unimproved sanitation includes buckets, shared sanitation and others (WHO/UNICEF JMP, 2015).

## SECTION F: HOUSEHOLD DEMOGRAPHIC AND GENERAL INFORMATION

F1. Please indicate the following details for all the household members who were home for at least one month within the last one year (February 2014- March 2015).

ID	Name	In which year was this person born?	Gender 0=male 1=female	Relationship to current head ( <b>ENUME: See codes below</b> )	Is..... currently attending school? 0 = no 1 = yes	What is the highest level of education completed? ( <b>ENUME: See codes below</b> )
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

**Codes** relationship to household head: 1= head, 2 = spouse, 3 = own child, 4 = step child, 5 = parent, 6= brother / sister, 7 = nephew /niece, 8 = son/daughter-in-law, 9 = grandchild, 10 = other relative, 11 = unrelated, 12 = brother / sister-in-law, 13 = parent-in-law, 14 = worker, 15 = other, specify \_\_\_\_\_.

**Codes** education levels: -99 = don't know, -9 = none, 0 = pre-school, 1 = std 1, ..., 8 = std 8, 9 = form1, ..., 14 = form 6, 15 = college 1, ..., 18= college 4, 19= univ 1, ..., 23 = univ 5, 24=postgrad, 25 = other, specify \_\_\_\_\_.

F2. At present, do you own the following assets? How many do you possess?

Household assets					
1.	Radio	[ ]	6.	Bicycle	[ ]
2.	TV	[ ]	7.	Motorcycle	[ ]
3.	Solar panels, battery, generator	[ ]	8.	Car	[ ]
4.	Mobile Phone	[ ]	9.	Truck or tractor	[ ]
5.	Water tanks, borehole, well	[ ]	10.	Fridge	[ ]

F3. What is the distance from your home to the nearest of the following infrastructures?

Infrastructure	km
F.3.1: What is the distance from your home to the nearest shopping centre?	[ ]
F.3.2: What is the distance from your home to the nearest tarmac road?	[ ]
F.3.3: What is the distance from your home to the nearest health centre?	[ ]
F.3.4: What is the distance from your home to where you can tap electricity?	[ ]
F.3.5: What is the distance from your home to where you can get piped water?	[ ]
F.3.6: What is the distance from your home to the nearest river/stream?	[ ]
F.3.7: What is the distance from your home to the Ewaso Narok Swamp?	[ ]

## FOLLOW-UP: IN-DEPTH INTERVIEWS

Dear respondent,

thank you very much for your participation in this survey. The information you have provided in the health section of this study qualifies you for an in-depth interview (IDI). The IDI aims at gaining deeper information on your experience with regard to health knowledge, health risk perception and health-related behaviour. We would kindly like you to avail yourself for an IDI which can take about 15-45 minutes. In case you agree, we would contact you by phone to schedule a new date for this purpose.  I agree  I don't agree

Thank you very much.

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## Annex 4: Interview guide for in-depth interviews with target population

### Globe Wetlands in East Africa Project – Interview Guide Wetland Users



Dear participant,

you have participated in our household survey in 2015, and indicated an interest in the participation of an in-depth interview. It aims at gaining information on your experience with regard to health knowledge and health-related behaviour. You are invited to share your ideas and thoughts and contribute to issues on water-related disease exposure in wetlands. Your participation is purely voluntary, requires your informed consent, and you are free to withdraw anytime during the interview. Your responses will be completely confidential. If you indicate your voluntary consent, may we begin? Thank you very much for your participation

#### **Theme 1: Perceptions of wetland utilization, health benefits and health risks**

Do certain uses of the Ewaso Narok Swamp entail certain benefits or risks?

- Focus on farming versus pastoralism
- Focus on wetland water for drinking and domestic purposes
- Are health risks and benefits seasonal? In what way?
- Do you think the users are aware of potential health risks? In what way?

#### **Theme 2: Disease exposure in the Ewaso Narok Swamp**

What are the diseases affecting people in this area? (rank them in order of importance)

In what way are these diseases associated with wetlands?

What are their exact transmission routes?

Can you explain in detail for the following diseases? (ask only those known to respondent)

- Malaria
- Diarrhoeal diseases
- Typhoid fever
- Schistosomiasis
- Trachoma
- River Blindness

#### **Theme 3: The role of water, sanitation and hygiene**

How would you describe the situation of water, sanitation and hygiene in this area?

Which roles do water, sanitation and hygiene play in the Ewaso Narok Swamp in

- the prevention of diseases?
- the transmission of diseases?

#### **Theme 4: Health-related behaviour**

How do people prevent the named diseases? (rank the most common measures)

Which reasons might prevent them from adopting adequate health-protective measures?

If people feel ill, where do they seek treatment and care?

Which factors determine their choice of where and what to seek for treatment?

#### **Theme 5: Health-related knowledge and education**

How do people in the Ewaso Narok Swamp learn about health risks and diseases?

Which are the most important information channels?

#### **Theme 6: Recommendations**

How can health risks and the exposure to disease be reduced?

How can the transmission routes be disrupted?

How can the situation of water, sanitation and hygiene be improved?

How can the healthcare service provision be improved?

How can important health knowledge and education reach everyone?

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## Annex 5: Interview guide for in-depth interviews with experts

### Globe Wetlands in East Africa Project – Interview Guide Experts



Dear key informant / expert,

we are part of a team at Kenya National Museums, Kenyatta University and other collaborators, who are studying aspects on how wetlands influence their users' disease exposure in the Laikipia County. We are currently conducting a household survey in the area, as well as in-depth interviews with selected respondents. We would moreover like to complement the community members' perspectives by your valuable experience from the healthcare / wetland and water resources management / water and sanitation / education sector. We chose you as a potential key informant due to your wide-ranging experience in the topic of our interest and due to the responsibilities that your position brings along. Therefore your participation in answering these questions would be very much appreciated. You are invited to share your opinion and experience to issues on water-related disease exposure in and management of wetlands. Your participation is purely voluntary, requires your informed consent, and you free to withdraw anytime during the interview. Your responses will be completely confidential. If you indicate your voluntary consent, may we begin?

#### **Theme 1: The implications of wetland utilization on health risks and disease exposure**

Guiding question: Which wetland uses entail which health risks and disease exposures?

#### **Theme 2: Factors underlying the situation in theme 1**

Guiding questions:

- Which factors do you evaluate as problematic in terms of disease exposure?
- In what way do setting-specific peculiarities matter? (reference to semi-aridity)

#### **Theme 3: Wetland communities' response to health risks and ill-health**

Guiding question: Which measures do community members adopt to stay healthy or get cured?

#### **Theme 4: Healthcare service provision (for healthcare personnel)**

Guiding question: How does the health sector respond to the disease burden in the wetland?

#### **Theme 5: Health-related knowledge and awareness raising**

Guiding question: How do you inform the people in the Ewaso Narok Swamp about health risks?

#### **Theme 6: Responses and recommendations**

Guiding question:

- How can your sector best respond to the health risks in the Ewaso Narok Swamp?
- What would be the most effective measures to reduce risks and disease burden?
- Which actions / initiatives / practices have proven successful?
- How can a health-based wetland management be achieved?

Thank you very much for your participation.



**Globe Wetlands in East Africa  
Reconciling future food production with environment protection  
Research participant information sheet**

Globe Wetlands in East Africa is a project by German University Institutions and East African partners, the National Museums of Kenya and Kenyatta University. The project observes wetlands in East Africa and their significance regarding food security and their sustainable use. One topic of special importance within this project is human health. The use of wetlands can have implications on the human health, therefore the aim is to deliver an understanding about associated aspects.

Within this study we would like to learn from you about the meaning of wetlands, your behaviour with regard to wetland use and its impact on health, furthermore we would like to gain insights on your health risk perception and health risk behaviour using these ecosystems. Therefore we kindly ask you to participate in a household survey of about 15 minutes, a hygiene spot check of about 5 minutes and probably, in case you qualify as a candidate, in an in-depth interview of about 40 minutes.

All information given will be absolutely confidential and only the people working on the study will have access, all documents will be stored safely and securely locked in cabinets and password protected computers. The knowledge gained from this research will be shared in summary form, without revealing individuals' identities. If you decide that you do not want to participate in the study or decide to withdraw from the study at any time and for any reason, this will not affect you in any way.

You are free to ask any question about this research using the contacts below:

Dipl.-Geogr. Carmen Anthonj, Institute for Hygiene and Public Health Bonn

Mail: carmen.anthonj@ukb.uni-bonn.de, Tel: +254 703 533 535

Dr. Helida Oyieke, National Museums of Kenya

Mail: oyiekeh@gmail.com, Tel: +254 722 458 508

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**Research participant informed consent form**

I have had the study explained to me. I have understood all that has been read / explained and had my questions answered satisfactorily.

**Yes (please tick) I agree to take part in the study.**

**Yes (please tick) I agree to the audio-recording of the interview.**

I understand that I can change my mind at any stage and it will not affect me in any way.

Participant's signature: \_\_\_\_\_ Date \_\_\_\_\_

Participant's name: \_\_\_\_\_ (Please print name)

***If the participant cannot read, a witness may observe consent process and sign:***

I certify that I have followed all the study procedures described in the SOP for obtaining informed consent.

Designee/investigator's signature: \_\_\_\_\_ Date \_\_\_\_\_

Designee/investigator's name: \_\_\_\_\_ (Please print name)

**THE PARTICIPANT IS GIVEN A SIGNED COPY TO KEEP**



## Annex 7: Ethical clearance from the University of Bonn, Germany



### Rheinische Friedrich-Wilhelms-Universität

#### Medizinische Fakultät Ethik-Kommission

Ethik-Kommission - Medizinische Fakultät Bonn  
Biomedizinisches Zentrum, Sigmund-Freud-Str. 25, 53127 Bonn

Herrn  
Prof. Dr. med. Thomas Kistemann  
Institut für Hygiene und Öffentliche Gesundheit  
Sigmund-Freud-Straße 25  
**53105 Bonn / durch Boten**

53127 Bonn, 10.12.14

Sigmund-Freud-Str. 25  
Biomedizinisches Zentrum  
Zimmer 2G 029

Durchwahl: 287 - 51 282  
287 - 51 931  
Telefax: 287 - 51 932  
(Vorwahl national: 02 28-;  
international: + 49 -2 28- )  
e-mail: [ethik@uni-bonn.de](mailto:ethik@uni-bonn.de)  
Internet: <http://ethik.meb.uni-bonn.de>

KRa/BR

N / C. Anthonj  
Lfd. Nr. 246/14

**Reference:** Application to the Ethics Committee  
PhD research project Carmen Anthonj  
**Applicant:** Prof. Dr. med. Thomas Kistemann  
**Study Title:** The Implications of Wetlands on the Water-Health Nexus  
**Sponsor:** Doctoral Scholarship

**List of attached documents:**

- Checklist/ Application as of 06.08.2014
- Study protocol as of 31.07.2014 including Informed consent, Questionnaire, Interview guide
- Support letter by supervisor as of 31.07.2014
- Curriculum Vitae, University Certificate C. Anthonj

Dear Prof. Dr. Kistemann,  
Dear Ms. Anthonj,

at the meeting on 1 September 2014, the Ethics Committee reviewing clinical research involving human beings and epidemic research including personal data of the medical faculty of the Rheinische-Friedrichs-Wilhelms-University of Bonn came to the conclusion that, concerning your application for ethical clearance as named above, your research project is ethically and legally impeccable.

The Ethics Committee assumes that the adequacy of the informing documents provided will be proved by the responsible local Ethics Committee.

Furthermore, the Ethics Committee points out that the study protocol should outline how illiterates can sign the informed consent.

Changes to the study protocol should be communicated to the Ethics Committee and require a further consultation.

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In addition, the principle investigator must promptly inform further investigators of the Ethic Committee about changes within study protocol.

In accordance with the advisory function of the Ethics Committee, the medical and legal responsibility of the manager of the clinical trial and further participants of the clinical trial remains unaffected by the Committee's opinion.

The Ethics Committee of the medical faculty of the Rheinische-Friedrichs-Wilhelms-University of Bonn reviewing clinical research involving human beings and epidemic research including personal data adheres to the national legislation of the ICH-GCP guidelines. The Ethics Committee also advises in accordance with the latest revised version of the "World Medical Association Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects".

Yours sincerely,

A black rectangular redaction box covering the signature of Prof. Dr. K. Racké.

Prof. Dr. K. Racké  
Head of the Ethics Committee

## Annex 8: Ethical clearance from the Kenyatta University, Nairobi, Kenya



### KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE

Email: [chairman.kuerc@ku.ac.ke](mailto:chairman.kuerc@ku.ac.ke)  
[secretary.kuerc@ku.ac.ke](mailto:secretary.kuerc@ku.ac.ke)  
[ercku2008@gmail.com](mailto:ercku2008@gmail.com)  
Website: [www.ku.ac.ke](http://www.ku.ac.ke)

P. O. Box 43844 - 00100 Nairobi  
Tel: 8710901/12  
Fax: 8711242/8711575

Our Ref: KU/R/COMM/51/411

Date: 26<sup>th</sup> February, 2015

Carmen Anthonj  
Universitäts Klinikumbonn  
53113 Bonn, Germany.

Dear Carmen,

APPLICATION NUMBER PKU/303/E279- "THE IMPLICATIONS OF WETLANDS ON THE WATER-HEALTH NEXUS. THE CASE OF KENYA."

#### 1. IDENTIFICATION OF PROTOCOL

The application before the committee is with a research topic, "The Implications of Wetlands on the Water-Health Nexus. The case of Kenya". Received on 23<sup>rd</sup> January, 2015, discussed on 17<sup>th</sup> February, 2015.

#### 2. APPLICANT

Carmen Anthonj

#### 3. SITE

Narok, Rumuruti, Laikipia

#### 4. DECISION

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines AND APPROVED that the research may proceed for a period of ONE year from 26<sup>th</sup> February, 2015.

#### 5. ADVICE/CONDITIONS

- i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
- ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.
- iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
- iv. Submit an electronic copy of the protocol to KUERC.

When replying, kindly quote the application number above.

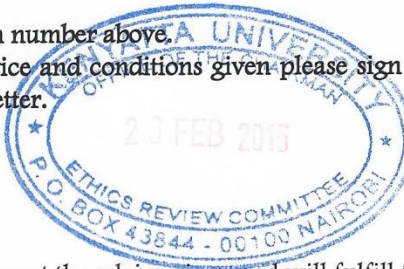
If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.

PROF. NICHOLAS K. GIKONYO  
CHAIRMAN ETHICS REVIEW COMMITTEE

I, Carmen Anthonj .....accept the advice given and will fulfill the conditions therein.

..... Dated this day of.....11. March..... 2015.

cc. Vice-Chancellor





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## **Annex 10: List of publications**

### **Publications**

- Anthonj, C., Rechenburg, A., Kistemann, T., 2016. Water, Sanitation and Hygiene in Wetlands. The Case of Ewaso Narok Swamp, Kenya. *International Journal of Hygiene and Environmental Health* 219 (7), 606-616.
- Anthonj, C., 2016. Wetland-related Diseases, Health Risk Perceptions and Behaviour in Ewaso Narok Swamp, Kenya. *WHO CC Newsletter Water & Risk* 24, 8-10.
- Anthonj C., Nkongolo O.T., Schmitz P., Hango J.N., Kistemann T., 2015. The Impact of Flooding on People living with HIV: a case study from the Ohangwena Region, Namibia, *Global Health Action* 8, 26441.
- Anthonj C., Beskow S., Dornelles F., Terumi Fushita A., et al., 2014. Water in Urban Regions: Building Future Knowledge to Integrate Land Use, Ecosystem Services and Human Health, Halle/Saale, Rio de Janeiro, Berlin, 32 pp.

### **Conference Presentations**

- Anthonj, C., Rechenburg, A., Kistemann, T.: The impact of water on health and ill-health in a Sub-Saharan African wetland: Exploring both sides of a coin presented at: 17<sup>th</sup> International Medical Geography Symposium in Angers, France, 2 – 7 July 2017.
- Anthonj, C., Rechenburg, A., Kistemann, T.: Can Health Risk Perception act as a Tool in Wetland Management? presented at: Society of Wetland Scientists European Chapter Meeting in Faro, Portugal, 4 – 6 May 2017.
- Anthonj, C., Rechenburg, A., Kistemann, T.: WASH in Wetlands. Where do we stand? presented at: 2016 UNC Water & Health Conference: Where Science meets Policy in Chapel Hill, USA, 10 – 14 October 2016.
- Anthonj, C.: Gesundheitsverhalten und Nutzung von Gesundheitsversorgung im Ewaso Narok Swamp, Kenia presented at: Annual Meeting of the Working Group Medical Geography in Remagen, Germany, 6 – 8 October 2016.
- Anthonj, C.: Water-related diseases, health risk perception and behaviour in Ewaso Narok Swamp, Kenya presented at the Water Resources Management Authority, Rumuruti, Kenya, 11 May 2016.
- Anthonj, C., Rechenburg, A., Kistemann, T.: Water-related diseases, health risk perception and behaviour in wetlands. The case of Ewaso Narok Swamp, Kenya presented at: University of Bonn, Germany, 16 December 2015.
- Anthonj, C., Rechenburg, A., Kistemann, T.: Die Auswirkungen von Feuchtgebieten auf den Nexus von Wasser und Gesundheit presented at: Deutscher Kongress für Geographie Stadt Land Schaf(f)t – Land Schaf(f)t Stadt in Berlin, Germany, 1-6 October 2015.

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Anthonj, C., Heinkel, S.-B., Rechenburg, A., Kistemann, T.: Feuchtgebiete in Ostafrika – Gesundheitsrisiko und Beitrag zum Wohlbefinden presented at: Deutscher Kongress für Geographie Stadt Land Schaf(f)t – Land Schaf(f)t Stadt in Berlin, Germany, 1-6 October 2015.

Anthonj, C., Rechenburg, A., Kistemann, T.: Estimating water-related health risks in East African wetland ecosystems presented at: 16<sup>th</sup> International Medical Geography Symposium in Vancouver, Canada, 5–10 July 2015.

Anthonj, C., Rechenburg, A., Kistemann, T.: Health risk assessment in wetlands – the case of a Kenyan floodplain presented at: 7<sup>th</sup> International Water and Health Seminar in Cannes, France, 29 June – 1 July 2015.

Anthonj, C.: Die Auswirkungen von Wetlands auf den Nexus von Wasser & Gesundheit Fallstudie aus Ruanda presented at: Annual Meeting of the Working Group Medical Geography in Remagen, Germany, 9-11 October 2014.

Anthonj, C.: The implications of fragile ecosystems on human health. Human health and health care delivery in the case of flooding presented at Workshop on Water Issues and Ecological Sustainability in Areas of Urbanization in Sao Carlos, Brazil, 5-8 May, 2014.

### **Public lectures**

Anthonj, C., Heinkel, S.-B.; Luther, S., Timm, C.: Wasser und Gesundheit als Forschungsschwerpunkte am GeoHealth Centre presented at: Forum Wissenschaftlicher Nachwuchs am Dies Academicus in Bonn, Germany, 25 May 2016.

### **Posters**

Rechenburg, A., Anthonj, C., Heinkel, S.-B., van Soest, M.: Human health in wetlands. Poster presented at: PLANT 2030 Status Seminar in Potsdam, Germany, 4 -6 March, 2015.

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## **Annex 11: Erklärung**

Hiermit erkläre ich, Carmen Anthonj, dass die vorliegende Doktorarbeit mit dem Titel „Mosquitoes, Malaria and Maladies among Men using Marshes. Is the Contraction of Diseases in Wetlands a Question of Use? Behaviours, Risk Assessments and Perceptions from the Ewaso Narok Swamp, Kenya“ im Sommersemester 2017 von mir selbständig und ohne jede unerlaubte Hilfe angefertigt wurde. Es wurden keine anderen Hilfsmittel als die im Literaturverzeichnis genannten benutzt. Alle aus den Quellen und der Literatur wörtlich oder sinngemäß übernommenen Stellen wurden als solche gekennzeichnet.

Ich habe bisher noch keinen Promotionsversuch unternommen. Die vorliegende Dissertation wurde nicht in gleicher oder ähnlicher Form bei einer anderen Stelle zur Erlangung eines akademischen Grades eingereicht.

Bonn, den 21.07.2017

Unterschrift