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A rapid impact assessment approach for decision support in food policy

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So then there is no difference between the sage's and the fool's condition; or, if there be, the fools have the advantage: first, in that their happiness costs them least, that is to say, only some small persuasion; next, that they enjoy it in common. And the possession of no good can be delightful without a companion.

Desiderius Erasmus Roterodamus
1509. *The Praise of Folly*

Alla mia famiglia

Acknowledgements and Disclaimer

Abstract

A rapid impact assessment approach for decision support in food policy

Under the pressure of many alternative stakeholders' demands, the food policy maker needs to consider regulatory decisions in order to grant a safe final product for the consumer, as well as to foster the improvement of the agro-food supply system. However, current ex-ante impact assessment systems present many evaluation shortcomings due to the intrinsic difficulty of: modelling impact phenomena, establishing reliable time-related parameters and predicting food supply network actors' behaviour. Considering these issues the present doctoral thesis proposes an alternative assessment approach, based on a mix of qualitative and quantitative elements, able to rapidly obtain impacts and display them in an intuitively comprehensible visualization. Main features of the created model are: the consequentiality between food sector enterprises' compliance with new policies and the calculation of potential macro impacts, the highly disaggregated multi-level government impacts data collection, the structured procedure in analysing the numerous impact categories and the indication of inputs uncertainty. Results from two case studies (Directive 2009/128/EC of the 21st of October 2009 'establishing a framework for Community action to achieve the sustainable use of pesticides' and European Commission Proposal of 30th January 2008 for a Regulation 'on the provision of food information to consumers – allergens focus'), a simulation and direct interviews to prospective users of the model (European Commission Departments members), revealed the complementary role of the rapid assessment approach in respect of part of the current impact assessment system. Finally a dedicated software illustrates how the rapid assessment approach could serve policy makers in supporting their decisions when dealing with food regulations' outcomes improvement.

Zusammenfassung

Eine effiziente Bewertungsmethode zur Unterstützung der Entscheidungsfindung in der Ernährungspolitik

Unter dem Druck der verschiedenen Ansprüche der Akteure der Lebensmittelwertschöpfungskette sind Entscheidungsträger der Ernährungspolitik gezwungen Entscheidungen zu treffen, die sowohl die Lebensmittelsicherheit der Endprodukte für den Verbraucher berücksichtigen als auch der Verbesserung der Wertschöpfungskette des Agribusiness Rechnung tragen. Bestehende ex-ante Bewertungssysteme weisen verschiedene Mängel auf, die auf Schwierigkeiten innerhalb des Systems zurückzuführen sind: Modellierung der Bewertungsphänomene, Etablierung verlässlicher zeit-bezogener Parameter und Vorhersage des Verhaltens von Akteuren der Wertschöpfungskette. Unter Berücksichtigung dieser Probleme beschäftigt sich diese Doktorarbeit mit möglichen Lösungsansätzen. Schwerpunkt bildet die Entwicklung eines alternativen, effizienten Bewertungsansatzes, welcher auf qualitativen als auch quantitativen Komponenten basiert. Dies ermöglicht es, Einflussfaktoren effizient und effektiv zu identifizieren und visualizieren. Im Mittelpunkt des erarbeiteten Modells stehen die Zusammenhänge zwischen der Compliance der Ernährungsindustrie und potentiellen Einflussfaktoren, disaggregierte Datenerhebung auf mehreren Ebenen, strukturierte Vorgehensweise in der Analyse potentieller Einflussfaktoren und Ausweisung von Unsicherheitsfaktoren. Ergebnisse liefern zwei Fallstudien (Richtlinie 2009/128/EG über, einen Aktionsrahmen der Gemeinschaft für die nachhaltige Verwendung von Pestiziden' und Vorschlag für eine Verordnung (2008) betreffend ‚die Information der Verbraucher über Lebensmittel – Fokus auf Allergene'), eine Simulation sowie Tiefeninterviews mit zukünftigen Nutzern der effizienten Bewertungsmethode (Generaldirektionen Mitglieder). Es zeigt sich, dass die effiziente Bewertungsmethode komplementär zum derzeitigen Bewertungsmechanismus gesehen werden kann. Abschließend illustriert eine Softwareanwendung, wie die effiziente Bewertungsmethode zukünftig politische Entscheidungsträger in ihrer Entscheidungsfindung bezüglich Lebensmittelgesetzen und –richtlinien unterstützen könnte.

Compendio

Un sistema rapido di valutazione degli impatti per il supporto alle decisioni nelle politiche agro-alimentari.

Sotto la spinta di diversi gruppi di pressione, quali i consumatori, le industrie manifatturiere agro-alimentari e l'opinione pubblica, il decisore politico si trova a prendere scelte atte a garantire sia la sanità del prodotto finale che lo sviluppo e l'innovazione delle reti di offerta agro-alimentari. Tuttavia gli odierni sistemi di valutazione ex-ante degli impatti delle politiche agro-alimentari presentano molteplici problemi di analisi legati alla modellizzazione delle particolarità dei fenomeni sottastanti gli impatti, alla determinazione di parametri con variabilità temporale e alla previsione dei comportamenti degli attori economici del settore. Considerando le difficoltà sopra elencate, il presente lavoro propone un approccio di valutazione alternativo; tale sistema, in parte basato su informazioni qualitative ed in parte su informazioni quantitative, permette di ottenere velocemente i potenziali impatti ex-ante presentandoli con un'interfaccia di facile ed intuitiva comprensibilità. Le caratteristiche principali del modello sottostante il sistema di valutazione creato sono: la consequenzialità tra la conformità delle imprese agro-alimentari alle norme di nuove politiche e il calcolo degli impatti a livello aggregato, la raccolta disaggregata dei dati di impatto a diversi livelli di governo del territorio, la procedura strutturata nel considerare le molteplici categorie di impatto e l'indicatore di incertezza connessa agli inputs immessi. Il test del sistema di valutazione attraverso due casi studio (Direttiva 2009/128/CE 'Istituzione di un quadro per l'azione comunitaria ai fini dell'utilizzo sostenibile dei pesticidi' e Proposta di Regolamento della Commissione (2008) 'relativo alla fornitura di informazioni alimentari ai consumatori – focus sugli allergeni'), una simulazione ed interviste dirette ad utilizzatori potenziali del modello (membri di specifici Direttorati Generali della Commissione Europea), hanno rivelato la complementarietà tra l'approccio di valutazione espresso in questo studio e i sistemi di valutazione di impatto esistenti. Un software dedicato dimostra infine come l'approccio di valutazione rapida possa servire il decisore politico aiutandolo nel miglioramento degli esiti delle politiche agro-alimentari.

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Abbreviations

CBA   Costs-Benefits Analysis

DG   Directorate General

DSS   Decision Support System

EC   European Commission

EU   European Union

FAO   Food and Agriculture Organization

IA   Impact Assessment

IAR   Impact Assessment Report

IAS   Impact Assessment System

NUTS   Nomenclature des Unités Territoriales Statistiques (Nomenclature of Territorial
        Units for Statistics)

RIA   Regulatory Impact Assessment

WTO   World Trade Organization

1   Introduction

Actors in the European food system face an unprecedented number of opportunities and challenges due to the new phase of international trade where goods and services exchanges increase in pace and scale (Lang, 1999). This results in a highly complex environment in which enterprises have to detect changes in time to adapt to trends which they cannot influence (Jurakovic, Cadum, & Fabris, 2006) (Deaconu, 2007) (Kaufmann & Tödtling, 2002) (Lang, 1999). Public authorities too have to face increasingly complex dilemmas concerning many fields: labour market (OECD, 2006), environment (FAO, 2006), public health (EC, 2007), growth and competitiveness of their productive system (EC, 2010). Civil society as well as the single individual is not immune from the same disorientation problems (Mazzarella, 2004) with a consequent natural need for information clarity and transparency (Systems Dynamics and Innovation in Food Networks, 2010).

The growing problem that all above mentioned actors are confronted with is how to take actions leading to intended effects without occurring in unintended ones (Sterman, 2000). Taking actions or intervening involves a prior decision. The latter is not the responsibility of or influenced by single individuals. Generally a decision is the product of an interaction among individuals' preferences and/or entities' preferences, namely the stakeholders' preferences. As a result the decision develops in a chaotic way, evolving from on-going confrontations among stakeholders (Roy, 1996).

Decision aiding methods have been created in order to find a rational, a logical path to be followed during stakeholders' confrontations. A decision aiding system corresponds to a procedure that, through the use of explicit but not necessarily completed formalized models, helps obtain elements of responses to the questions posed by a stakeholder of a decision process (Roy, 1996). Therefore if a stakeholder's question corresponds to '*the identification of future consequences of a current or proposed action*' (Becker, 2001), we could comprehend in the decision aiding term the series of evaluation procedures falling under the big umbrella of the ex-ante Impact Assessment Systems (hereafter IASs).

In this study I intend for impact assessment the process that prepares evidence for political decision-makers on the advantages and disadvantages of possible policy options by assessing their potential impacts (EC, 2009). More specifically, the impact assessment system

investigated through this work addresses the impacts evaluation of European food sector policies with a particular focus on food safety.

IASs are especially relevant to the public policy maker as the way the market functions has deficiencies for what concerns equity, distributional effects and negative externalities; these problems are commonly referred to as market failures (Rosen, 2003). Markets failures concern mainly public goods (e.g. environment), but can also involve private goods as result of market related problems as firms' competition state, information failures and asymmetry. A specific example of the latter is the food safety. Given its characteristics of rivalry and excludability in consumption, the food is considered a private good; nevertheless, the strictly related feature of food safety enters the domain of market failures for many reasons (Calvin, Avendaño, & Schwentesius, 2004) (Mitchell, 2003):

- the subjective risk perception of the food consumers;

- the asymmetric information between producers and consumers;

- the social distribution of the risks.

To protect society from food safety risks, international institutions (e.g. FAO, WTO) and governments promote risk analysis (Henson & Caswell, 1999); the latter can be divided in a three stages-process: risk assessment, risk management and risk communication. IASs are used in order to measure the effectiveness of policies proposed during the risk management stage with the aim of evaluating ex-ante whether the likely benefits, often not measurable, overcome the intervention's costs.

As the focus of this study is on the evaluation method of European food policies I used as main analysis framework reference the European Commission Impact Assessment Guidelines (2009). The latter suggest the following analytical steps in order to obtain an Impact Assessment Report (IAR) for EU policies:

1. defining the problem;
2. defining the policy objectives;
3. defining the policy options;
4. identifying the likely economic, social and environmental impact of every policy options;
5. compare the impacts of the options to choose the more appropriate policy.

The fourth step of the procedure includes other three sub-steps necessary to obtain the likely economic, social and environmental impacts:

1.   identification of economic, social and environmental impact;

2.   qualitative assessment of the more significant impacts;

3.   in-depth qualitative and quantitative analysis of the most significant impacts.

In the first sub-step, the analyst in charge of the IA should highlight both the intentional and unintentional impacts that are likely to occur as consequence of the policy implementation. Through the other two sub-steps the analyst should understand whether the quantitative balance between positive impacts and negative impacts lead to a final benefit deriving from the policy.

This work refers particularly to the impact identification and assessment steps of the IA process. Both can be operated through different methods; the European Commission suggests three main methods in the IA Guidelines: cost-benefit analysis, cost-effectiveness analysis and cost-benefit thinking through multi-criteria analysis. Within these methods and focusing on food safety regulatory impact assessment, specific benefits indicators (cost of illness, forgone income, averting illness, disutility of illness, value of statistical life, wage differences, willingness to pay) as well as costs (fixed and variables compliance costs) can be used (Antle, 1999). Nevertheless many authors stress that often the field in which the impact occurs, or domain of impact, raises intrinsic appraisal problems of different nature (Antle, 1999) (Henson & Caswell, 1999) (Ragona, Mazzocchi, Zanoli, Alldrick, Solfrizzo, & Van Egmond, 2011).

1.1   Present Food Safety Policies Impact Assessment Issues and Research Problem Statement

From the analysis of the existing literature on food safety policies impact assessment and from opinions of key stakeholders, as EC members, one can isolate four main appraisal problems: impact phenomena modelling, comprehensibility of both evaluation procedure and impacts results, completeness of the impacts spectrum and length of the evaluation procedure.

1.   *Impact phenomena modelling*. Ragona, Mazzocchi et al. (2011) highlight how, 'despite the wide body of quantitative methods for monetization of policy impacts, complete and reliable cost-benefit analysis are an exception rather than the rule in Regulatory Impact Assessments of food safety regulations. Some of the reasons the authors elicit from their research experience are:

a) difficulty in isolating confounding factors (e.g. market forces, weather, etc.);

b) probabilistic outcome of some actions, as food hazards may still occur with lower risks;

c) uncertainty in compliance levels (as example see Unnevehr & Jensen, 1999 and Mora & Menozzi, 2003);

d) different timing in the occurrence and discounting of costs and benefits (e.g. short-term costs for firms versus long-term health outcomes).

Similarly Henson and Caswell (1999) and Giorgi (in Mazzocchi, 2010) assert that knowledge base and scientific evidences are too weak to allow a quantitative assessment. The fore-mentioned reasons clearly demonstrate how knowledge gaps and food system dynamics weaken the results of the evaluator work.

2. *Impacts results and evaluation procedure comprehensibility.* By looking through the impact categories recommended by the Impact Assessment Guidelines in its Annexes, one realizes the problem the policy maker is often confronted with: sort and process a big amount of complex information to give a final statement on the acceptance or rejection of the legislative proposal. Usually members of the European Commission find themselves with detailed reports from several knowledge fields and they have problems in filtering all the impact information while maintaining an objective, transparent decision path (Mazzocchi, 2010). Keeping consistency in the evaluation and following a precise logic to reach the final decision in such a contest, contrasts with human cognitive limits (Miller, 1956 in Mintzberg, Ahlstrand and Lampel 1998) and it is a typical information management and organization problem for which supporting tools are needed. To the impact results comprehensibility adds the evaluation procedure issue. Often impact results are used to set up production standards or agreed legislative limits among many stakeholders (e.g. European institutional bodies internal debates, international discussion rounds as WTO agreements), but the absence of transparency in the way impacts are calculated leads to long-lasting discussions on appropriateness of the impact assessment procedures. The final consequence is the difficulty in reaching consensus and the subsequent postponement of the decision (Giorgi in Mazzocchi, 2010).

3. *Completeness of the impacts spectrum.* Although EC IA Guidelines provide a complete set of economic, social and environmental impacts, current European food policies IAs

lack in reporting certain type of impacts (e.g. public health and administrative burdens) mainly because of the poor data availability (Ragona, Mazzocchi et al., 2011). Moreover, the over-reliance on micro-economics models (gravity models) tapping on trade effects and CBA for the industry, leads to an economics-driven analysis limited in scope and with no baseline about environmental effects and circumstantial effects in terms of job creation and loss (Giorgi in Mazzocchi, 2010).

4. *Length of the evaluation procedure*. Often evaluators need to run an IA within a short time period since market and society require food policy makers to provide rapid signals of change through new policy proposals (FAO, 2009). Moreover, in the case of a new policy option formulation, an impact assessment reiterative process of long duration would undermine the possibility of direct experts' discussion on mitigation measures for negative impacts. In fact the possibility to organize, analyze and present the results of a holistic IA is strictly dependent on the time necessary to run the evaluation. As stated by Pastakia and Jensen (1998) for the specific field of the Environmental Impact Assessment, the time frame provided for data acquisition and analysis, is one of the causes leading to the criticism of subjectivity in the evaluation.

An overall consideration of the evaluation issues of current European procedures identifying and evaluating impacts caused by food safety regulations, prompted me to question whether a new IAS, based on targeted solutions addressing the specific problems aforementioned, could be used alternatively to the existing one.

As the four evaluation issues highlighted can have negative self-reinforcing loop feedbacks on the length of the evaluation time and on the assessment procedure transparency, they should be tackled as a whole.

With the intent of reducing the degree of complexity, naturally part of food safety regulation impacts assessments, the contribution of this work is the creation of an IAS, where, multiple targeted solutions, some of which of new conception, are integrated into a single system.

1.2   Research Objectives and Research Design

The study focuses on the creation of a new potential Impact Assessment System (IAS) tailored for the public decision maker of the European food sector arena. The model, on which the new IAS relies, proposes solutions for what concern the '*Impact phenomena modelling*', the '*Impacts results and evaluation procedure comprehensibility*', the '*Completeness of the impacts spectrum*' and the '*Length of the evaluation procedure*' (figure 1.2.1). This is done through the combination of qualitative, as well as, quantitative evaluation elements in the impact analysis.

Many authors, in the case of a complex system modelling with decisional aspects involved, suggest the use of a qualitative type of evaluation, where use of not-continuous variables are more suitable (Giorgi in Mazzocchi, 2010) (Ragona, Mazzocchi et al., 2011) (Henson, Caswell et al, 2007). Under this view, the same authors recognize the use of Multi-Criteria Decision Aid systems a powerful and appropriate tool, able, at the same time, to deal with domain of impacts of diverse measure units and to develop consensus. Relying on these considerations, I base the new IAS on a Multi-Criteria Decision Aid system with dedicated features.

The first of these features is the possibility to gather the impact information on variables' complex interactions, from specialized experts and on a highly disaggregated scale. The final objective is to let emerge the local existing impacts knowledge or reducing the number of variables for the single evaluator approaching the impact analysis problem. The second feature consists in the causal relation between the enterprises new regulation's requirements compliance and the impacts' direction and magnitude calculation. The specificity of such a feature is that it considers enterprises' convenience in complying from a management perspective. The third feature is the presence of an uncertainty scale linked to experts' impacts judgements. The objective of these three features is to reduce the '*Impact phenomena modelling*' complexity.

The use of discrete values and ordinal scales to evaluate impacts, instead, supports experts in reading out the type of impact, its direction and its magnitude; the same is valid for the policy maker that has to read and comprehend specific multi-disciplinary impact analysis. In doing this the latter is supported by an extremely graphically intuitive impacts output table and an impacts map. Moreover the '*Impacts results and evaluation procedure comprehensibility*' can

improve substantially by making the whole IA interactive for the user, hence by allowing him to check the creation of impacts results through the single steps of the evaluation procedure. This feature, allowing the IAS user to access also evaluation method reports and definitions, increases the transparency of the evaluation process.

By means of structured impact categories, result of an updated food sector-oriented literature research, I address instead the criticism concerning the '*Completeness of the impacts spectrum*'. The same feature, together with the impact analysis framing flexibility can lead to faster impact results, therefore reducing the '*Length of the evaluation procedure*'.

The IAS here proposed focuses on the possibility of computing the impact in a short time facilitating the process, for the policy maker, of deciding on regulations approval; a natural consequence is that the final output could result in a lower accuracy level. Nevertheless, an uncertainty indicator helps the client in deciding whether to consider the impacts outputs trustworthy enough to draw conclusions on the validity of the proposal evaluated. Main fundamental principles of the model are: the transparency of the evaluation process, the consideration of food sector stakeholders' perspective, the structured impacts categorization for a step by step evaluation approach, the final impact sustainability view and the disaggregated level of information collection.

The general hypothesis of the study is that, by creating an alternative IAS that is both rapid and capable of delivering the impact information in a transparent, complete and comprehensible way, the current food safety regulations' impacts identification and assessment step, could be improved, with consequent positive outcomes for the policy maker. Therefore my thesis is that the IAS proposed here aids the policy maker in rapidly visualizing the likely consequences of his choices when dealing with a decision concerning European food safety measures.

Operatively, the support provided by means of the new IAS, consists in the rapid and user-friendly displaying of conflicting impacts results, within a transparent evaluation procedure allowed by the interactivity of the IAS. Through these features, the policy maker can discuss, in a first drafting stage, about potential improvements of the legislative proposal; in the case of unavoidable conflicting impacts, the use of the new IAS could serve as a basis for the establishment of mitigation measures.
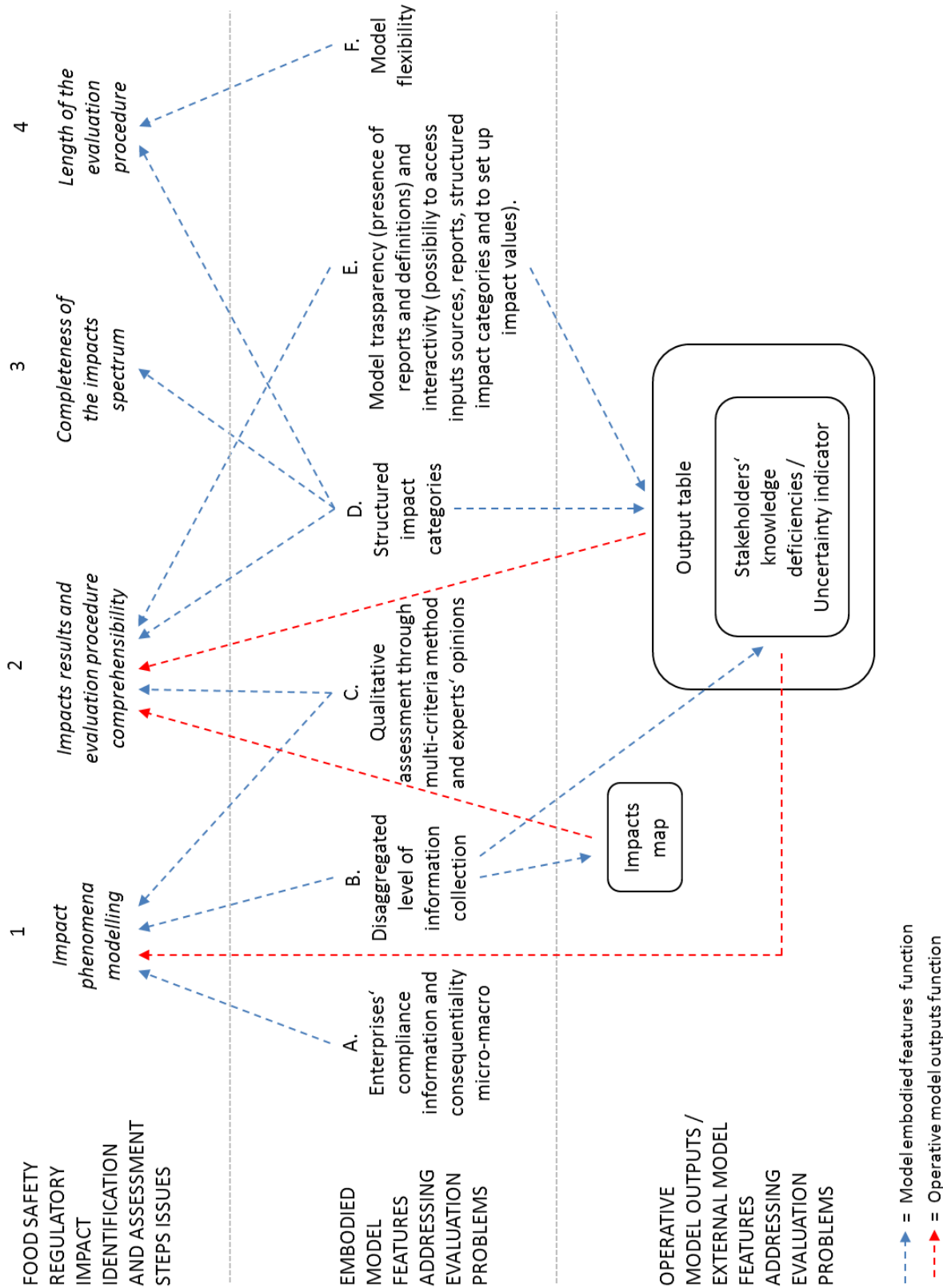
Figure 1.2.1 – Food safety regulatory impact assessment issues, model targeted features/solutions and operative model outputs.

To demonstrate my argumentation I first describe in chapter 'Method' all features of the model built for the new IAS. Every feature addresses one of the specific problems that have been listed in the previous paragraph. In the second part of the same chapter, I shortly describe how we want to proof the validity of our model in respect of its final goals. In doing so, I test the operability of the IAS by means of two case studies (pesticides and allergens regulations) and a simulation. Finally, I interview members of specific DGs of the European Commission in an IAS potential user capacity.

The largest part of chapter 'Results' concerns the case study, from the preparation to the final impacts output tables. In this chapter I report also the simulation results and the European experts' interviews outcomes.

Chapter 4, 'Discussion', analyses the results from the case studies' output table in order to draw considerations on the validity of the model, its limits and side features discovered through the case studies. Here the information obtained from European experts is compared to the evidences of the model testing. Moreover, I report direct opinions from the European experts concerning the IAS. In this chapter I draw also indications on the model functioning and potential improvements deriving from the simulation. Finally, I discuss and analyse supporting and contrasting argumentations in respect of the main thesis.

In chapter 'Conclusions' the major discoveries of this whole study are essentially described together with potential future directions necessary to improve the new IAS or adapt it for decision makers of different spheres of activity.

The present study has been carried out within the European project MoniQA. MoniQA stands for Monitoring and Quality Assurance in the Food Supply Chain and it corresponds to one of the Network of Excellence financed by the European Commission through the 6th Research Framework Program. The responsibility for a new model based on qualitative as well as quantitative elements and with a micro actors' perspective has been assigned by the leader of the Bonn University research group. The latter, together with Bologna University and the International Centre for Comparative Research in Social Sciences (ICCR), is part of the socio-economic assessment group of MoniQA.

The Bonn University group's outcome corresponds to the impacts calculating model illustrated in this work. The model can be divided in two large parts with different but complementary foci: the 'horizontal part' and the 'vertical part' (see figure 2.1.1.2). The 'horizontal part' addresses the problem of the food companies' compliance when new legislative acts have been approved by the decision maker; the 'vertical part' of the model instead uses the enterprises' compliance information to predict potential impacts on the European society level.

As the author of this study concentrated on the 'vertical part' of the model, only a paragraph in chapter 'Method' summarizes shortly the concepts of the 'horizontal part'. The paragraph intentionally limits itself to the 'horizontal part' essentials necessary for the understanding of the thesis' argumentation line.

For further information concerning the horizontal part of the model I suggest the reading of the following work: 'Modelling enterprise behaviour in a food regulation environment – a decision support system for policy makers' (Krapp, 2011).

2 Method

The chapter 'Method' can be divided in two main parts: the creation of a new IAS and the procedure necessary to analyse whether the new IAS allows the thesis confirmation. While the first section explains in details the logic behind the functioning of the new IAS, the second part elucidates which criteria are used to evaluate the new IAS and the steps of the evaluation procedure.

2.1 The New Impact Assessment System

The sub-chapter 2.1 is divided in four main sections. In the first section the theoretical framework of the IAS is explained by means of its fundamental principles, its operative outputs, its algebra, its specific features addressing the problems highlighted in the introduction and the output table functioning. In the second section I display the structure of the software based on the new IAS. The section provides a first orientation to potential model users by describing files' functions and their directories. In the third section, a step by step approach guides the potential user through the evaluation procedure. At the end of this paragraph reading, the user will be able to execute an impact assessment analysis, namely to produce the outputs displayed in figure 2.1.1.3.

2.1.1 The impact assessment theoretical framework

Figure 2.1.1.1 schematizes a simplified impact assessment process constituted of few steps. Initially the public authority drafts up a new legislative proposal affecting the food sector. Subsequently an analyst, namely a specialist performing the aid by making the model explicit (Roy, 1996), carries out an analysis of quantitative and/or qualitative type by using existing knowledge or by performing new investigations. The results of the analysis highlight the final positive or negative impacts of the proposal on specific aspects of interest, or domains. The review of Ragona and Mazzocchi (Ragona & Mazzocchi, Food Safety Regulation, economic impact assessment and quantitative methods, 2008) identify thirteen main domains in which impacts deriving from food safety policies have been considered in recent years.
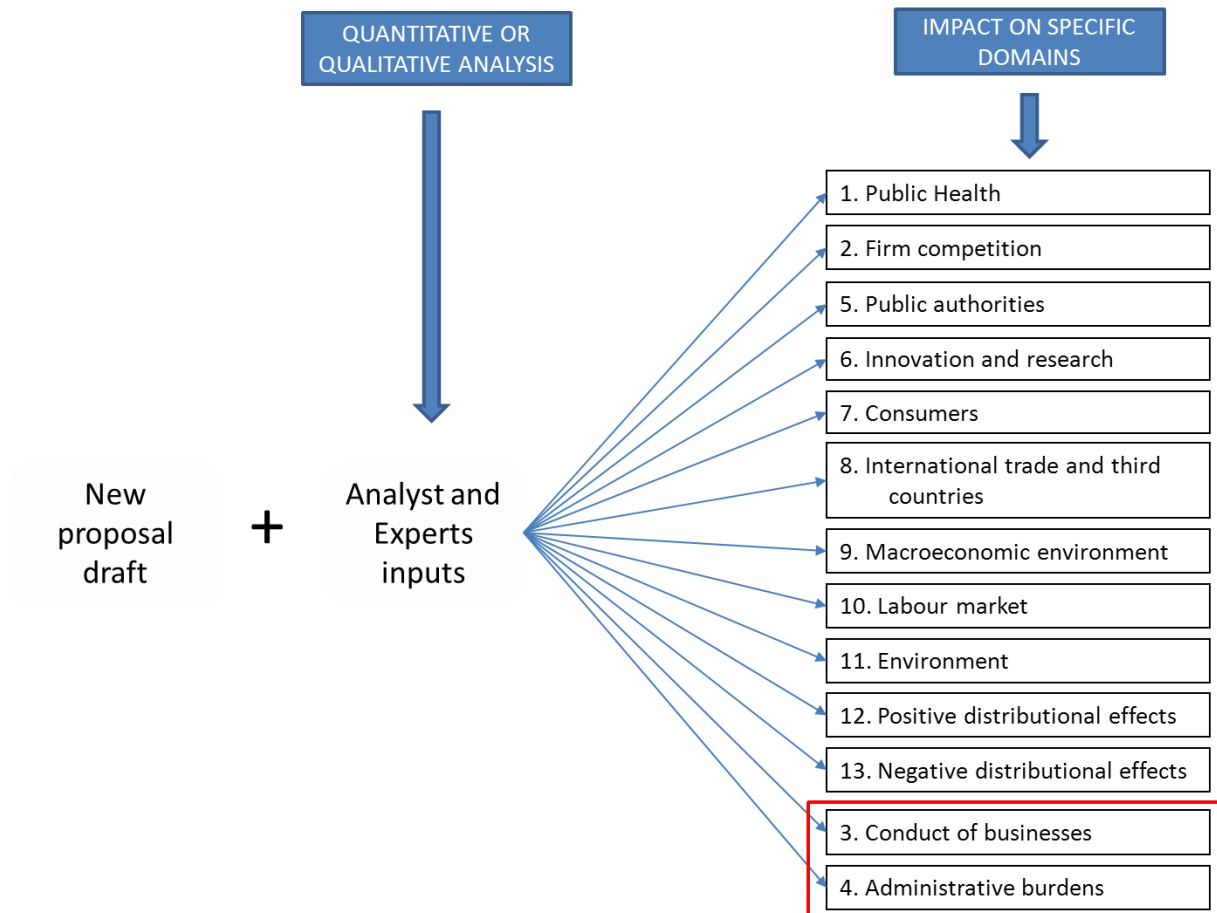
Figure 2.1.1.1 – Impact assessment process basic representation.

The model presented in this thesis reports impacts on the following domains:

1. public health;
2. labour;
3. public authorities;
4. innovation and research;
5. firm competition;
6. environment.

Given the particular structure of the model I did not consider the domains 'consumers', 'international trade and third countries' and 'macroeconomic environment'. Differently, a specific part of the model embodies the domains 'conduct of business' and 'administrative burdens'; although not displayed in the final output table, information on the latter two aspects can be extracted from the IAS. The twelfth and thirteenth domains indicated in figure

2.1.1.1, 'positive and negative distributional effects', are as well embodied in a specific part of the model that from now on I call 'horizontal part' referring to figure 2.1.1.2.
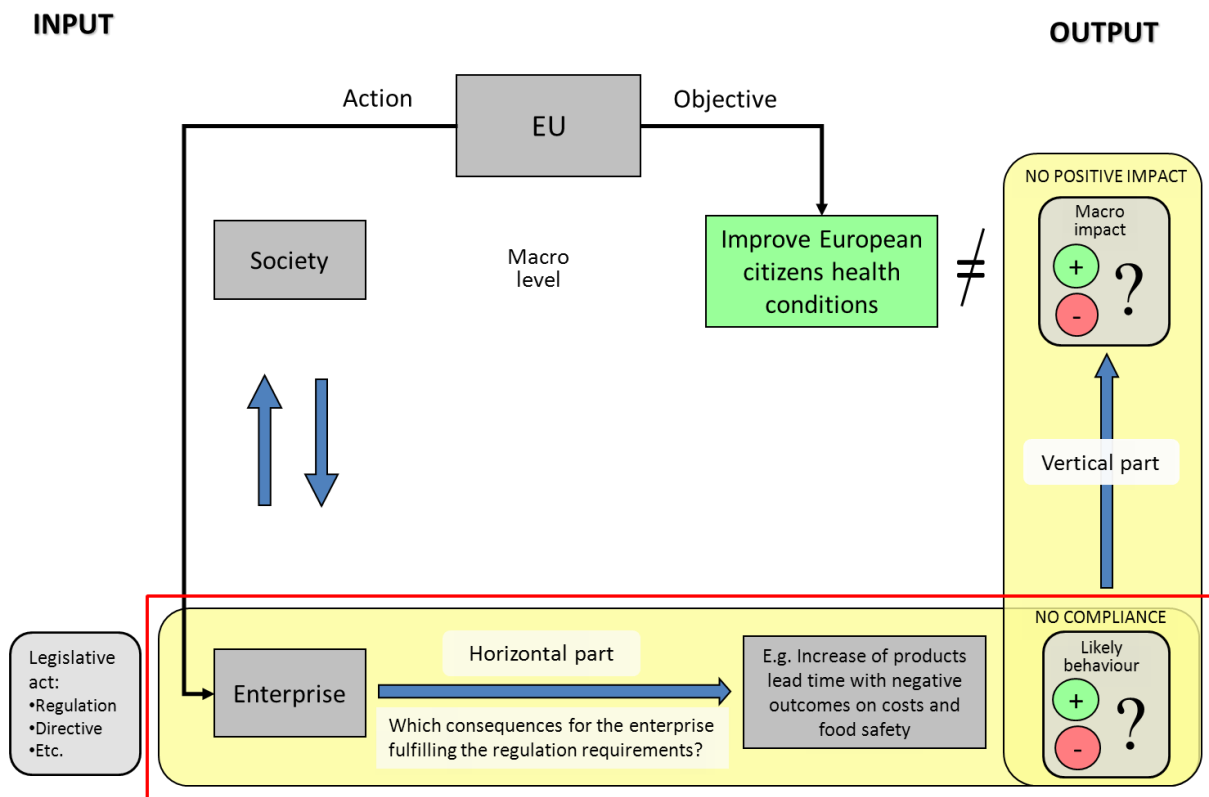
Figure 2.1.1.2 – Impact assessment system model general overview.

In figure 2.1.1.2 I displayed the general overview of the new IAS model. The European Union, through its main governmental bodies, aims at the achievement of specific objectives (e.g. the improvement of its citizens' health conditions). In order to achieve the objective the responsible European institutions take action by enacting legislative proposals that apply to many society actors; among the many actors one deserves particular attention: the enterprise. This focus is due to the fact that, in the food chain, where the consumer close the circle by consuming the product, the enterprise comes on an earlier stage; as a consequence if a problem occurs on this level of the food chain it automatically affects the consumer as well. Moreover in the past has been highlighted how for new legislative acts' effectiveness it should be considered enterprises ability in affording new investments necessary for the regulation's requirements compliance (Fritz & Schiefer, 2008). In other words, high compliance costs or organizational issues could be unaffordable for special categories of enterprises; they would be therefore unable of delivering the changes expected through new regulations, with subsequent ineffective or non-existing impacts on the European society level.

The model here proposed embodies the information about enterprises' compliance. As illustrated in figure 2.1.1.2 through the 'horizontal part' there is a first assessment of the proposal consequences on enterprises' performances. By taking in account compliance scenarios I elaborate the potential impacts on the macro level through the vertical process. The red rectangular shape of figure 2.1.1.2 highlights how the two domains of figure 2.1.1.1 are incorporated in the 'horizontal part'; in fact both 'conduct of business' and 'administrative burdens' are sub-elements of enterprises' compliance evaluation. Moreover, the final information concerning enterprises likely behaviour is grouped by enterprise size; as a consequence the analyst, or model user, if requested by the policy maker, can extrapolate indicators on the proposal's distributional positive and negative effects.

The whole model, hence the latter information too, has a supply view, as mainly the information derive from the productive system; however I demonstrate how the consideration of experts' opinions in the evaluation process could inform about the interaction between supply and demand in the final impacts visualization.

2.1.1.1   The impact assessment system operative outputs

The final objective of the IAS is to overcome specific impact evaluation issues to aid the policy maker in better visualizing his choices' consequences. Some of the solutions proposed in this thesis are embodied in the assessment method; hence the user does not directly perceive them. Differently, others model features as the output table, the impact map and the uncertainty indicator, are more operative from a user perspective; through the latter I aim at:

1. reducing the time necessary to obtain impact results so that impacts conflicts among different domains could be mitigated and remaining resources can be used to deepen the analysis concerning problematic impacts evaluation outcomes;
2. obtaining visual information on the dispersion and severity of the impacts across the European regions/ countries;
3. highlighting European stakeholders special knowledge deficiencies.

In achieving these operative goals I take into consideration the issues described in paragraph 1.1 grouped as '*Impact phenomena modelling*', '*Impacts results and evaluation procedure comprehensibility*', '*Completeness of the impacts spectrum*' and '*Length of the evaluation procedure*'.
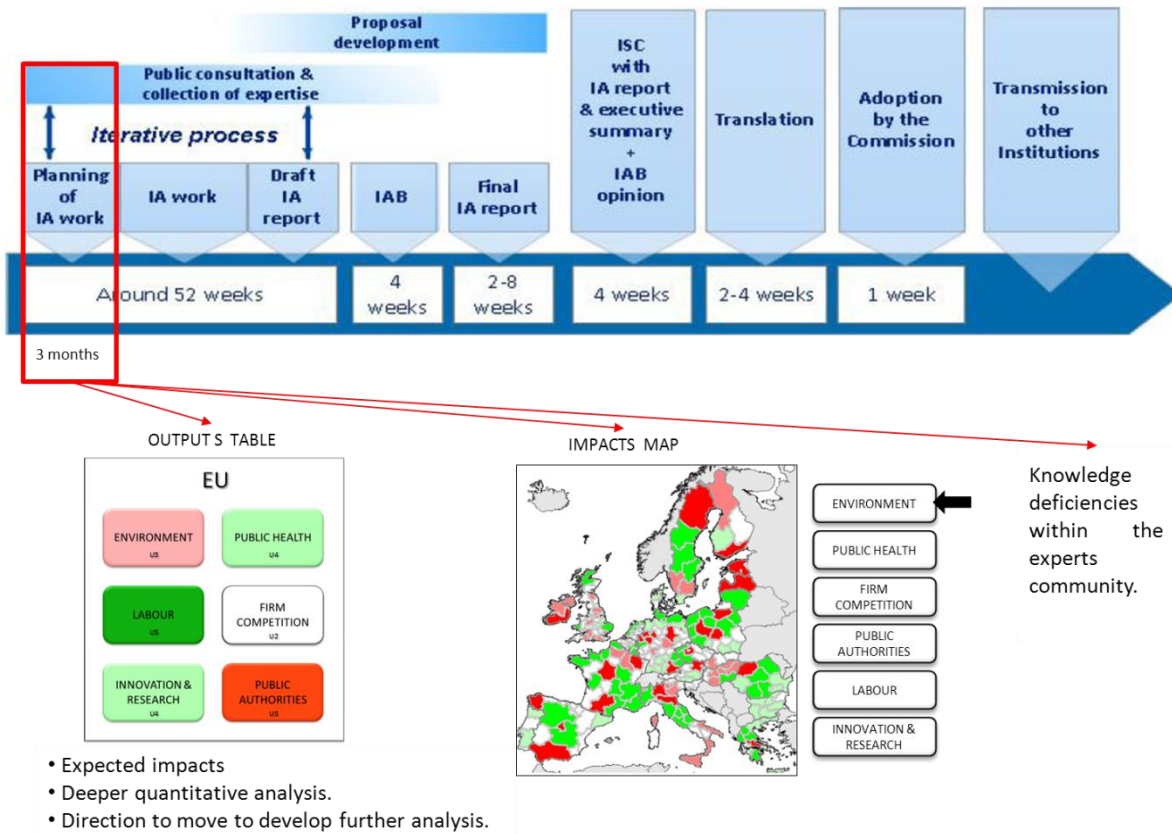
Figure 2.1.1.3 - Final outputs of the impact assessment system.

The top part of figure 2.1.1.3 reports from the EC IA guidelines 2009 the typical countdown indicative of an impact assessment report drafting. Normally, to arrive to a final impact assessment report draft, are necessary thirteen months. By means of the new IAS I intend to obtain the first impact information in three months. Through an output table the user will be able to visualize proposals' impacts on many domains; as the output table reveals conflicting impacts among domains and regions, or a risk for a potential negative impact, the analyst, in accord with the policy maker, can concentrate further quantitative analysis on the understandings of those specific problems, without binding further resources for unproblematic impacts. Moreover the map of the impact dispersion allows the policy maker to consider potential issues arising from particular regions; underestimating the latter could lead to expensive and delicate problems emerging during the implementation phase of a new potential policy. This information as well could be useful to readdress resources needed only on defined territories of the European Union already in a first stage of the proposal creation. Finally, the effectiveness of a new policy depends largely from the acceptance and the awareness of key actors in charge of delivering the execution of the European system change: public authorities as health or environmental agencies, or institutions monitoring the market. As the model relies partly on experts' opinions of these institutions, it is able to show whether

key stakeholders have enough knowledge to deal with the problems treated in the new proposal.

In the next part of the chapter I describe the features of the model that are necessary to achieve the objectives above mentioned.

2.1.1.2 Model output, algebra and impact results meaning

As the first goal is to rapidly obtain a first approximate result on potential impacts of a new proposal, an appropriate form of impact communication is needed. The main feature of such a media should be the readability easiness for a clear and fast comprehension of the information. From the latter consideration I propose an output table using colours and special formatting for the impacts reporting (figure 2.1.1.4).
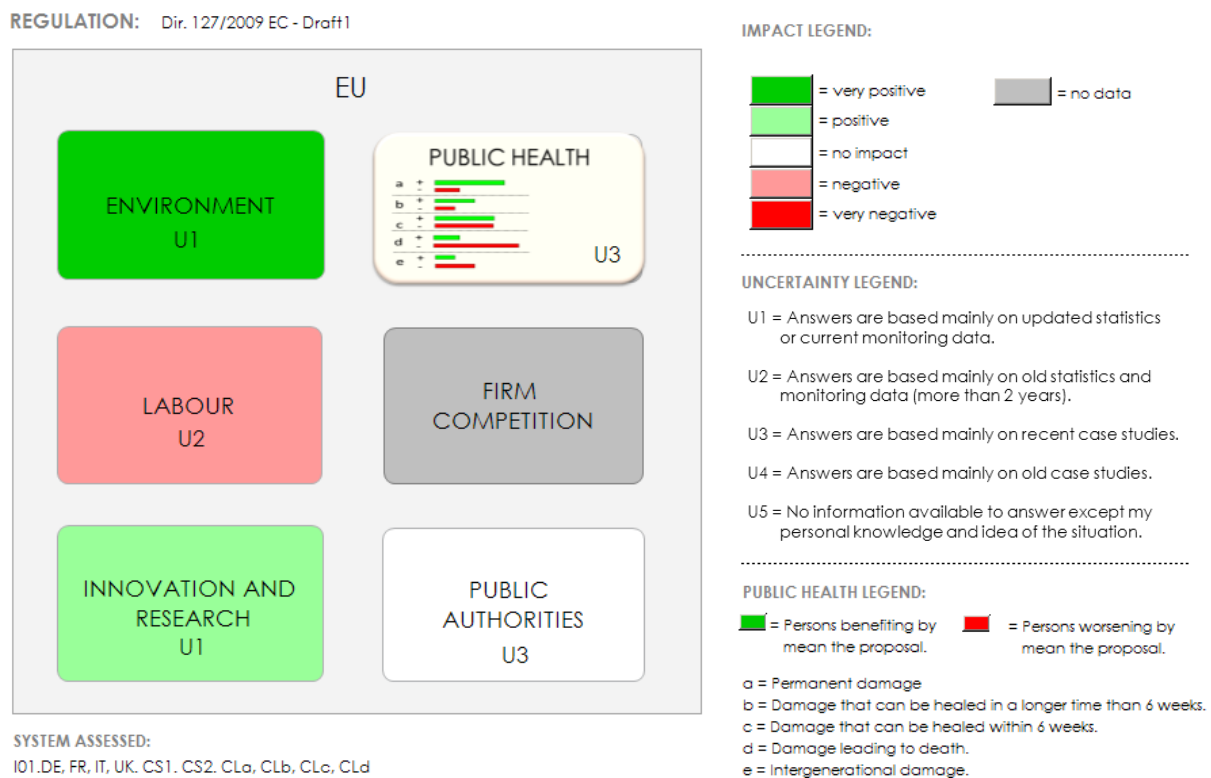
Figure 2.1.1.4 - Model output table.

In the output table colours correspond to impact attributes, namely 'very positive', 'positive', 'no impact', 'negative' and 'very negative'. These attributes provide as final information a statement on the future situation of every domain in respect of the moment during which the analysis is carried out.

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The impact attributes are linked to a chromatic scale by means of a conversion table where numerical impact values are divided in classes and labeled by impact denomination and colour (2.1.1.5).
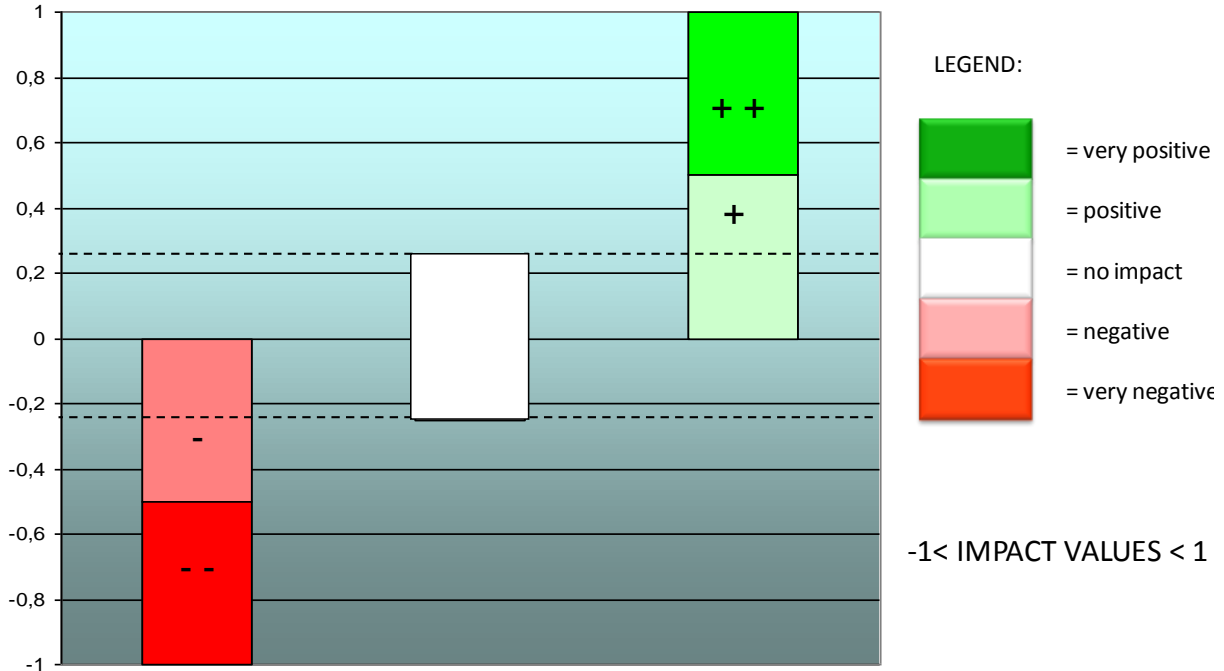
Figure 2.1.1.5 - Conversion between model's outputs' numerical values and impact labels.

The calculation procedure of the numerical value describes the model functioning. The numerical value of the impact is the result of a weighted sum obtained through qualitative answers provided by experts and quantitative information related to the horizontal part of the model. The final impact value for every domain varies between -1 and +1 (with the exception of Public Health Domain). Given the qualitative contribution to the formation of the final impact information, a large buffer with the label 'no impact' has been left. This give more robustness to model results as extreme impact values are displayed only for certain negative or positive experts' opinions.

In the coming pages I report the algebraic expressions to obtain domains' impacts. Depending on the boundaries of the system evaluated, the domain's impact can be obtained on a regional level, on a national level (in the specific case of this study a Member State level) and on an international level (in the specific case of this study a European level); the IAS here presented offers many possibilities also for what concerns the inputs collection level: the European impact for a specific domain could derive from inputs provided by a single European expert interview as well as from inputs provided by many national or regional experts' interviews.

The specificity of each domain, in addition to the calculation procedure of the impact, determines the level of inputs collection.

IMPACT OUTPUT FROM A SINGLE INPUT SOURCE OF THE SAME SYSTEM
BOUNDARIES LEVEL:

The formulas displayed in the following page allow me to determine a final impact value from an input source of the same output's system's boundaries level; the source of the single input could be an expert as well as a pool of experts.

If I want to obtain a European impact as output of equation (1) (see next page), I have to provide a European level of expertise as input; the same applies for the Member State and the regional levels. In order to display the combinations between the outputs and inputs source levels of (1), I use a legend as it follows:

O: EU – I: EU
O: MS – I: MS
O: REG – I: REG

In the legend O stands for output level and I for input level. As noticeable from the legend, in (1) there is no possibility to obtain an impact value from lower levels of input sources. In order to do that, one needs an aggregation criteria to proportion the impacts of several geographical entities when summarizing them in a single superior output level (e.g. from the Member State outputs level to the European one, or from the regional outputs level to the Member State one). In the model this aggregation criteria is indicated as 'Scale' or magnitude and corresponds to enteprises' compliance information.

The latter input is a quantitative information and it is not required in (1); this means that the equation (1) allows the model to provide an impact assessment also when the Scale factor is missing.

(1) $\quad Id = \displaystyle\sum_{k=1}^{X_k} Se_{i_{Cd_k}} * \left(\sum_{t=1}^{X_t} Se_{i_{SCd_{kt}}} * \left(\sum_{m=1}^{X_m} Se_{i_{SSCd_{ktm}}} * i_{SSCd_{ktm}} \right) \right)$

Conditions:

$k, t, m \in N$

$Se_{i_{Cd_k}}$ and $Se_{i_{SCd_{kt}}}$ and $Se_{i_{SSCd_{ktm}}} \in 0 \leq R^+ \leq 1$

$\displaystyle\sum_{k=1}^{X_k} Se_{i_{Cd_k}} = 1 \quad ; \quad \sum_{t=1}^{X_t} Se_{i_{SCd_{kt}}} = 1 \quad ; \quad \sum_{m=1}^{X_m} Se_{i_{SSCd_{ktm}}} = 1$

$i_{SSCd_{ktm}} : \{1; 0; -1\}$

$d = \{L; PA; IR; FC; E\}$

Where:

Id   = Impact of the domain d.

L   = Labour domain.
PA = Public Authorities domain.
IR   = Innovation and Research domain.
FC = Firm Competition domain.
E   = Environment Domain.

k = Parameter indicating the number of categories C of the specific domain d.
t = Parameter indicating the number of sub-categories SC of the specific category C and domain d.
m = Parameter indicating the number of sub-sub-categories SSC of the specific sub-category SC, category C and domain d.

$Se_{i_{Cd_k}}$ = Severity of the impact of the category k of the specific domain d.

$Se_{i_{SCd_{kt}}}$ = Severity of the impact of the sub-category t of the specific category k and domain d.

$Se_{i_{SSCd_{ktm}}}$ = Severity of the impact of the sub-sub-category m of the specific sub-category t, category k and domain d.

$i_{SSCd_{ktm}}$ = Impact direction for the sub-sub-category m of the specific sub-category t, category k and domain d.

For categories, sub-categories and sub-sub categories I intend those multiple and interconnected aspects a domain can be divided in, because of his broadness and complexity. One can imagine the categorization system as the skeleton of the domain; by means of it experts have an orderly frame to express a judgment depending on the domain current state of the art situation and future likely legislative act's effects. The last order of categories of the domain's frame, namely the sub-sub-categories, is the level of the primary classified impact causes: here the expert provides, for every specific aspect, the impact direction (i) or his opinion concerning the proposal effect.

The latter is obtained through closed-ended questions allowing three answers options (usually 'increases', 'no influence' and 'decreases'). The answer 'no influence' corresponds always to the value zero. In this case no change occurred for the category evaluated. Differently both answers 'increases' and 'decreases', depending on the question formulation, could correspond to 1 or -1: if the proposal's effect on the judged category will be positive the value corresponds to 1, if the proposal's effect will be negative the value is -1. In any case both answers signal that the proposal causes changes in the system evaluated.

The severity (Se) of the impact describes the relative importance of a single category among others leading to the domain's impact. The numerical value of this factor is obtained through questions whose corresponding answers assign percentages of relevance of a single category in respect of others of the same domain; in this way I can ascribe a weight to the proposal impact consequences (i) for that specific category. The weight ranges from 0 to 1 and the sum of all k categories' weights or t sub-categories weights or m sub-sub-categories weights should always add-up to 1. The factor severity is a measure of impact intensity.

IMPACT OUTPUT FROM SEVERAL INPUT SOURCES OF A LOWER SYSTEM
BOUNDARIES LEVEL:

The formulas displayed below allow me to determine a final impact value from input sources
of a lower output's system's boundaries levels; the sources of the inputs are several experts or
pools of experts expressing opinions on countries or regions.

If I want to obtain a European impact as output of equation (2), I have to provide a European
and national level of expertises as inputs values; the same applies for the Member State; hence
if one want to obtain a national impact as output of (2), one have to provide a national and
regional level of expertise as inputs. Below there are combinations between outputs and
inputs source levels of (2):

O: EU − I: EU + MS
O: MS − I: MS + REG

Below I report the equation to calculate the impact under the conditions above described:

$$(2) \quad \mathrm{Id} = \sum_{k=1}^{X_k} \mathrm{Se}_{\mathrm{i}_{Cd_k}} * \left(\sum_{t=1}^{X_t} \mathrm{Se}_{\mathrm{i}_{SCd_{kt}}} * \left(\sum_{n=1}^{X_n} \mathrm{Sc}_{\mathrm{i}_{SCd_n}} * \left(\sum_{m=1}^{X_m} \mathrm{Se}_{\mathrm{i}_{SSCd_{ktnm}}} * \mathrm{i}_{SSCd_{ktnm}} \right) \right) \right)$$

$$\mathrm{Sc}_{\mathrm{i}_{SCd_n}} = \frac{\displaystyle\sum_{g=1}^{4} \mathrm{E}_{gn} * \mathrm{L}_{\mathrm{E}_{gn}}}{\displaystyle\sum_{n=1}^{X_n} \sum_{g=1}^{4} \mathrm{E}_{gn} * \mathrm{L}_{\mathrm{E}_{gn}}}$$

Conditions:

$$k, t, n, m \in N$$

$$Se_{iCd_k} \text{ and } Se_{iSCd_{kt}} \text{ and } Sc_{iSCd_n} \text{ and } Se_{iSSCd_{ktnm}} \in \quad 0 \leqq R^+ \leqq 1$$

$$\sum_{k=1}^{x_k} Se_{iCd_k} = 1 \; ; \; \sum_{t=1}^{x_t} Se_{iSCd_{kt}} = 1 \; ; \; \sum_{n=1}^{x_n} Sc_{iSCd_n} = 1 \; ; \; \sum_{m=1}^{x_m} Se_{iSSCd_{ktnm}} = 1$$

$$i_{SSCd_{ktnm}} : \{1; 0; -1\}$$

$$Id = \{L; IR; FC; E\}$$

if g = 1
$$L_{E_g} = \frac{L_{E_g} \max}{2} \longrightarrow L_{E_1} = 4,5$$

if g = 2 or 3
$$L_{E_g} = \frac{(L_{E_g} \max - L_{E_{g-1}} \max)}{2} + L_{E_{g-1}} \max \nearrow L_{E_2} = 30 \searrow L_{E_3} = 150$$

if g = 4
$$L_{E_g} = \frac{(700 - L_{E_{g-1}} \max)}{2} + L_{E_{g-1}} \max \longrightarrow L_{E_4} = 474,5$$

$$1 \leqq L_{E_1} \leqq 9$$
$$10 \leqq L_{E_2} \leqq 49$$
$$50 \leqq L_{E_3} \leqq 249$$
$$250 \leqq L_{E_4} \leqq 700$$

Where:

Id = Impact of the domain d.

L = Labour domain.
IR = Innovation and Research domain.
FC = Firm Competition domain.
E = Environment Domain.

k = Parameter indicating the number of categories C of the specific domain d.

t = Parameter indicating the number of sub-categories SC of the specific category C and domain d.

n = Parameter indicating the number of countries considered for the impact assessment.

m = Parameter indicating the number of sub-sub-categories SSC of the specific sub-category SC, category C and domain d.

E_g = Number of enterprises of group g complying with the legislative proposal requirements.

L_{E_g} = Number of workers of enterprises group E_g.

g = 1 : micro enterprises.

g = 2 : small enterprises.

g = 3 : medium enterprises.

g = 4 : large enterprises[1].

$i_{SSCd_{ktnm}}$ = Impact direction for the sub-sub-category m, of the specific nation n, contributing to the specific sub-category t, of the specific category k and domain d.

$Se_{i_{SSCd_{ktnm}}}$ = Severity of the impact of the sub-sub-category m of the specific nation n, contributing to the specific sub-category t, of the specific category k and domain d.

$Sc_{i_{SCd_n}}$ = Scale or magnitude of the impact of the sub-sub-category m of the specific nation n, contributing to the specific sub-category t, of the specific category k and domain d.

One of the basic assumptions of the model is that one cannot consider proposals' future macro impacts if actors responsible to deliver the changes, in this case enterprises of the European food sector, do not comply with the proposal's requirements. Hence, enterprises' compliance information should be among the relevant variables for the impact calculation. Enterprises' compliance information enters the calculation procedure of the model in two ways, implicitly through the expert mindfulness while giving the impact judgment or explicitly as calculation element.

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[1] The upper limit of this enterprise group has been taken arbitrarily by the author as it is not indicated by Eurostat classification. Enterprises in the European cereal industry accounting for more than 1000 workers in a European region are generally rare; that is why it has been decided, as average upper class boundary, a lower number of workers corresponding to 700.

In the first case enterprises' compliance information, in regard of a specific geographical boundary, has the function of supporting the expert opinion providing him an anchor to frame a more trustworthy answer concerning a specific impact category; by knowing the amount of companies performing specific actions and their dimensions, a regional expert of environmental or health impacts could have a clearer picture of future proposal's outcomes.

In the second case I use enterprises' compliance information to proportion or weigh sub-categories' and sub-sub-categories' impacts of different geographical boundaries of the same level in the process of obtaining a single impact value. I can describe the problem as follows: given a country C composed of a region A and a region B, what is the proposal's impact on C if region A has a positive impact outcome and region B has a negative impact outcome? I need a rule to aggregate region A and region B impact results in a single value. As the impact evaluation of region A has been given by considering the compliance effects of enterprises of region A on region A, and the same has been done for region B, I have a direct connection between the impact evaluated through local experts knowledge and the quantitative measure cause of those impacts.

Then, I assume that, given the part of C's value added influenced by the proposal as the total value added generated by all enterprises complying with the new proposal in C in a specific year, the bigger the share of total value added generated by the complying enterprises of A in respect to the one generated by the complying enterprises of B, the more likely is that impacts from A will be more relevant in influencing the final impact of C. The principle is that the impact of a region is proportional to the enterprises' ability and possibility to influence the market of that region.

In this light a better measure unit than the value added at factor cost would be the market share of enterprises complying with the proposal evaluated. Unfortunately this indicator is not always available on public statistics. Differently, the value added, measure unit directly connectable with the physical production of goods or services, can be approximated by means of a substitute indicator based on input, namely the number of staff involved in the different economic activities of an enterprise (Eurostat, 2008); for the latter public statistics are widely available. From above and as displayed by (2), it follows why I chose as final scale measure unit, for impact aggregation purposes, the indicator 'number of workers of enterprises

complying with the new proposal's requirements'. This measure unit indicates the magnitude of the compliance effect and more specifically it is calculated as percentage (see equation 2), hence the value is comprehended between 0 and 1.

Although a direct proportionality between production units scale level and impact scale level is not always proofed, I decided to use this criteria as aggregation starting rule because of the data availability, the easiness of comprehension and the possibility of representing through it the meeting of supply (the productive system) and demand (the consumer) influenced by a new legislative proposal.

The scale factor could be in the future further tailored on the type of domain, the type of industry and the type of chain stage. As example I could use for the Environment Domain the amount of produced items whose production processes have negative externalities for the environment; in respect of the chain stages I could use for the first chain stage (the farmers in the model) the amount of agricultural land owned by the enterprises.

The scale factor does not vary from category to category of the same domain. It has the function of aggregation criterion for impacts of the same category and system boundaries level but deriving from different regions, or countries. Since this factor embodies the enterprises likely behaviour and since it contributes through the aggregation in shaping the final domain impact result, the scale factor is the connection between the micro level of the model (the enterprise) and the macro level (the final effect for the European society). In other words, the scale demonstrates the consequentiality between micro-macro in reporting proposals' impacts through the output table.

The procedure to calculate enterprises' compliance consists of the following operative steps:
  1. regulation analysis and selection of the productive system affected;
  2. enterprise behaviour prediction.

The first step is necessary to identify which types of enterprises are affected by the regulation. For the purposes of the model the horizontal part identifies and simplifies the enterprises in four groups or classes: micro, small, medium, large (EC,DG Enterprise and Industry, 2003). Moreover the classes of enterprises are separated for chain stages as actors operating different

production functions can have different behaviours in complying or not. The chain stages are specific for each food industry but in the model I focus only on the cereals industry.

In the second step I try to elicit the behaviour of a class of enterprises through the use of regulation requirements classification and key performance indicators; this is possible by means of the use of an expert checklist or matrix (example of the matrix in figure 2.1.1.6).

EXPERT CHECK LIST						
BUSINESS AREAS	ENTERPRISE KEY PERFORMANCE INDICATORS					Probability of compliance
	Financial		Costumer		Internal business process	
	Sales revenue	Production costs	Product appearence	Lead time	Product safety	
Production processes						HIGH
Shipment	0	-	0	+	+	
Labeling						
Management processes						
Complaints management						
Documentation						LOW
Product characteristcs						
Safety	+	+	0	-	0	
Infrastructure						
Technical measures						

Figure 2.1.1.6 - Example of expert check list.

The matrix is filled by enterprises representatives with a sector/ chain stage strategic view. While in the column of the matrix I display the different types of regulation requirements clustered by enterprise activity area, in the row I report key performance indicators.

The expert should first read the new proposal and then mark enterprises' areas affected by the regulation requirements. Successively he has to judge requirements' effects on the enterprise activity by stating for each performance indicator (PI) the type of impact:

Score +   positive estimated impact on the PI.

Score 0   no estimated impact on the PI.

Score -   negative estimated impact on the PI.

Score --   ruinous estimated impact on the PI.

Score ?   the estimated impact cannot be given.

Below I report the list of key performance indicators used in the matrix:

- o sales,
- o production costs,
- o lead time,
- o product appearance,
- o product safety.

Once the expert filled the matrix he has to give his opinion on the likely compliance of the enterprises class. The whole method serves as basis for the expert to consider all potential proposals' impacts on the enterprises activities before expressing his judgment on the enterprises' class behaviour.

The analyst responsible for the horizontal part collects then the compliance information for every enterprises class affected by the new proposal. By means of the enterprises classification he is able to connect the compliance to a defined number of enterprises. Unfortunately the latter value is not enough to find a proportion between compliance and compliance effects as required by the vertical part of the model; in fact an enterprise referring to the same chain stage could be small and produce rather little impacts or it could be big with major positive or negative effects. Consequently, I use the information concerning the size of the enterprises, given by the parameter number of workers, to express the proportionality between compliance and impact dimension.

For more details concerning the logic underlying the enterprise's compliance information look Krapp (2011).

IMPACT OUTPUT FROM SEVERAL INPUT SOURCES OF TWO LOWER SYSTEM BOUNDARIES LEVEL:

The formulas displayed in below allow me to determine a final impact value from input sources of two lower system boundaries levels; the source of the inputs are several experts or pools of experts giving opinions on Europe, countries or regions.

If I want to obtain a European impact as output of (3) I have to provide a European, a national and a regional level of expertise as inputs. Below the combinations between the outputs and the inputs source levels of (3):

O: EU − I: EU + MS + REG

Below I report the equation to calculate the impact with the conditions afore described:

$$(3) \quad Id = \sum_{k=1}^{x_k} Se_{i_{Cd_k}} * \left(\sum_{t=1}^{x_t} Se_{i_{SCd_{kt}}} * \left(\sum_{n=1}^{x_n} Sc_{i_{SCd_n}} * \left(\sum_{r=1}^{x_r} Sc_{i_{SCd_r}} * \left(\sum_{m=1}^{x_m} Se_{i_{SSCd_{ktnrm}}} * i_{SSCd_{ktnrm}} \right) \right) \right) \right)$$

With:

$$Sc_{i_{SCd_n}} = \frac{\displaystyle\sum_{g=1}^{4} E_{gn} * L_{E_{gn}}}{\displaystyle\sum_{n=1}^{X_n} \sum_{g=1}^{4} E_{gn} * L_{E_{gn}}} \qquad \text{and} \qquad Sc_{i_{SCd_r}} = \frac{\displaystyle\sum_{g=1}^{4} E_{gr} * L_{E_{gr}}}{\displaystyle\sum_{r=1}^{X_r} \sum_{g=1}^{4} E_{gr} * L_{E_{gr}}}$$

Conditions:

$$\sum_{r=1}^{X_r} \sum_{g=1}^{4} E_{gr} * L_{e_{gr}} = \sum_{g=1}^{4} E_{gn} * L_{E_{gn}}$$

$k, t, n, m, r \in \mathbb{N}$

$Se_{i_{Cd_k}}$ and $Se_{i_{SCd_{kt}}}$ and $Sc_{i_{SCd_n}}$ and $Sc_{i_{SCd_r}}$ and $Se_{i_{SSCd_{ktnrm}}}$ $\in$ $0 \leqq R^+ \leqq 1$

$$\sum_{k=1}^{x_k} Se_{i_{Cd_k}} = 1 \; ; \; \sum_{t=1}^{x_t} Se_{i_{SCd_{kt}}} = 1; \; \sum_{n=1}^{x_n} Sc_{i_{SCd_n}} = 1; \; \sum_{r=1}^{x_r} Sc_{i_{SCd_r}} = 1; \; \sum_{m=1}^{x_m} Se_{i_{SSCd_{ktnrm}}} = 1$$

$i_{SSCd_{ktnrm}} : \{1; 0; -1\}$

$Id = \{L; IR; FC; E\}$

Where:

Id, L, IR, FC, E, k, t, n, m, g, E$_g$, L$_{Eg}$ same as in (2)

r = Parameter indicating the number of regions considered for the impact assessment.

$i_{SSCd_{ktnrm}}$ = Impact direction for the sub-sub-category m, of the specific region r, of the specific nation n, contributing to the specific sub-category t, of the specific category k and domain d.

$Se_{i_{SSCd_{ktnrm}}}$ = Severity of the impact of the sub-sub-category m of the specific region r, of the specific nation n, contributing to the specific sub-category t, of the specific category k and domain d.

$Sc_{i_{SCd_r}}$ = Scale or magnitude of the impact of the sub-sub-category m of the specific region r, contributing to the specific sub-category t, of the specific category k and domain d.

PUBLIC HEALTH DOMAIN OUTPUT:

Differently than other domains, where the final impact is provided through a qualitative indicator, the Public Health Domain impact is reported as 'number of individuals affected positively or negatively by the new proposal'. The choice of using a countable indicator, displaying separately positive and negative impacts, is due to the ethical difficulty of stating whether positive health impacts overbalance negative health impacts and the other way round.

In health economics literature there are many measurement methods addressing such a problem, nevertheless they cannot be used in this impact evaluation system because of the tight modelling frame based on rapidity of the assessment and easiness of impact communication. Consequently I decided to display separately positive and negative health consequences for class of impact severity; severity as well originates from experts' opinions.

The formulas displayed below allow me to determine a final impact value from input sources of the same system boundaries levels; the source of the input can be a single expert or a pool of experts.

If I want to obtain a European impact as output of (4) I have to provide a European level of expertise as input; the same applies for the Member States and Regions. Below there are combinations between the outputs and the inputs source levels of (4):

O: EU – I: EU

O: MS – I: MS

O:REG – I: REG

Below I report the equation to calculate the impact under the conditions above described:

$$(4) \quad I_{PH} = \left(\sum_{k=1}^{X_k} i_k^{\pm} \; * \; \left(\sum_{s=1}^{X_s} Sc_{sk} \; * \; P_s \right) \right)_{Se_y}$$

Conditions:

$$i_k^{\pm} : \{1; -1\}$$

$$k, n, r, P_s \in \mathbb{N}$$

$$Sc_{sk} \in \quad 0 \leqq R^+ \leqq 1$$

Where:

Se_y = Type of impact severity category.

If $y = 1 \rightarrow Se = a$: Permanent damage;
If $y = 2 \rightarrow Se = b$: Damage that can be healed in a longer time than 6 weeks.

If $y = 3 \rightarrow Se = c$: Damage that can be healed within 6 weeks.
If $y = 4 \rightarrow Se = d$: Damage leading to death.
If $y = 5 \rightarrow Se = e$: Intergenerational damage.

$i_k^{\pm}$ = Positive and negative health impacts caused by the k impact category.

s = Type of population groups potentially affected by health impacts.

$s = 1$: newborns < 3 years old.
$s = 2$: 3 years old $\leqq$ children $\leqq$ 15 years old.
$s = 3$: 15 years old $\leqq$ adults $\leqq$ 65 years old.
$s = 4$: senior citizens $\geqq$ 65 years old.

Sc_{sk} = Percentage or scale of the population groups affected by the k impact category.
P_s = Number of individuals of the population group s.
k = Impact category; in the IAS $X_k = 24$

The same set of conditions is valid for the following outputs – inputs combinations:

O: MS – I: REG

$$(5) \quad I_{PH} = \left(\sum_{r=1}^{X_r} \left(\sum_{k=1}^{X_k} i_k^{\pm} * \left(\sum_{s=1}^{X_s} Sc_{sk} * P_s \right) \right)_r \right)_{Se_y}$$

O: EU – I: MS

$$(6) \quad I_{PH} = \left(\sum_{n=1}^{X_n} \left(\sum_{k=1}^{X_k} i_k^{\pm} * \left(\sum_{s=1}^{X_s} Sc_{sk} * P_s \right) \right)_n \right)_{Se_y}$$

O:EU – I: MS + REG

$$(7) \quad I_{PH} = \left(\sum_{n=1}^{X_n} \sum_{r=1}^{X_r} \left(\sum_{k=1}^{X_k} i_k^{\pm} * \left(\sum_{s=1}^{X_s} Sc_{sk} * P_s \right) \right)_{nr} \right)_{Se_y}$$

Where:

r = Parameter indicating the number of regions considered for the impact assessment.

n   = Parameter indicating the number of countries considered for the impact assessment.

As stated at the beginning of the chapter the time for the impacts evaluation is of key-importance in the IAS. By asking information about impact direction, severity and scale through closed-ended questions experts can provide more rapid answers. Closed-ended questions are easy to code and level differences between articulate and inarticulate respondents (EC, 2009) and in addition, the use values easily associable to close-ended question, as discrete values or ordinal scales, is more suitable to let the decision maker visualize the gradation of impact/effect/concern (Henson S. , Caswell, Cranfield, & Al., 2007).

Since the observed system and the judged phenomena can assume extremely large dimensions, I decided to do not use a method providing information on the appropriateness of the system's state itself as this would lead to a time consuming type of analysis. The meaning of the domains' impact of this model should not be considered in absolute value; more precisely, a 'positive impact' output, concerning consequences of a regulation on a specific domain, does not mean that changes happening in the productive system will lead to a positive state of the latter. Differently, 'positive impact' means that, in respect of the previous state of the system, something has improved; nevertheless the model does not indicate if the 'positive impact' is enough as permanent condition of the system state (figure 2.1.1.7).
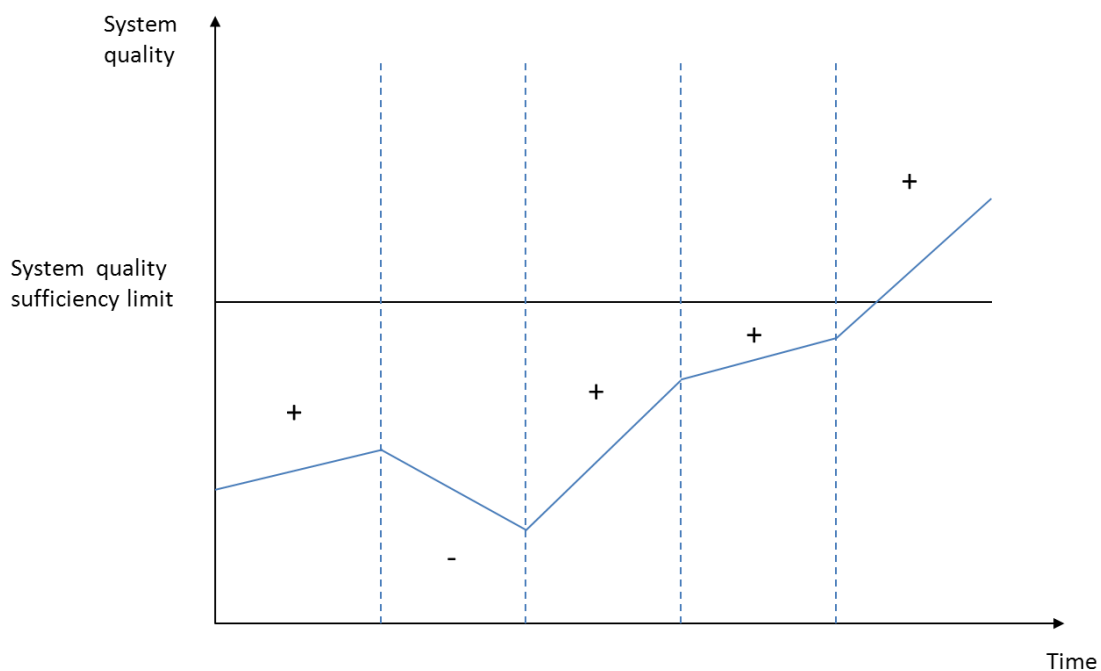
Figure 2.1.1.7 - Impact information obtained through the impact assessment system.

The information I obtain through the output concerns positive or negative pressures on the system and not its optimum level state. By considering impacts coming only from changes in the productive system, I say only if there will be improvements in respect of the current situation (ex-ante evaluation).
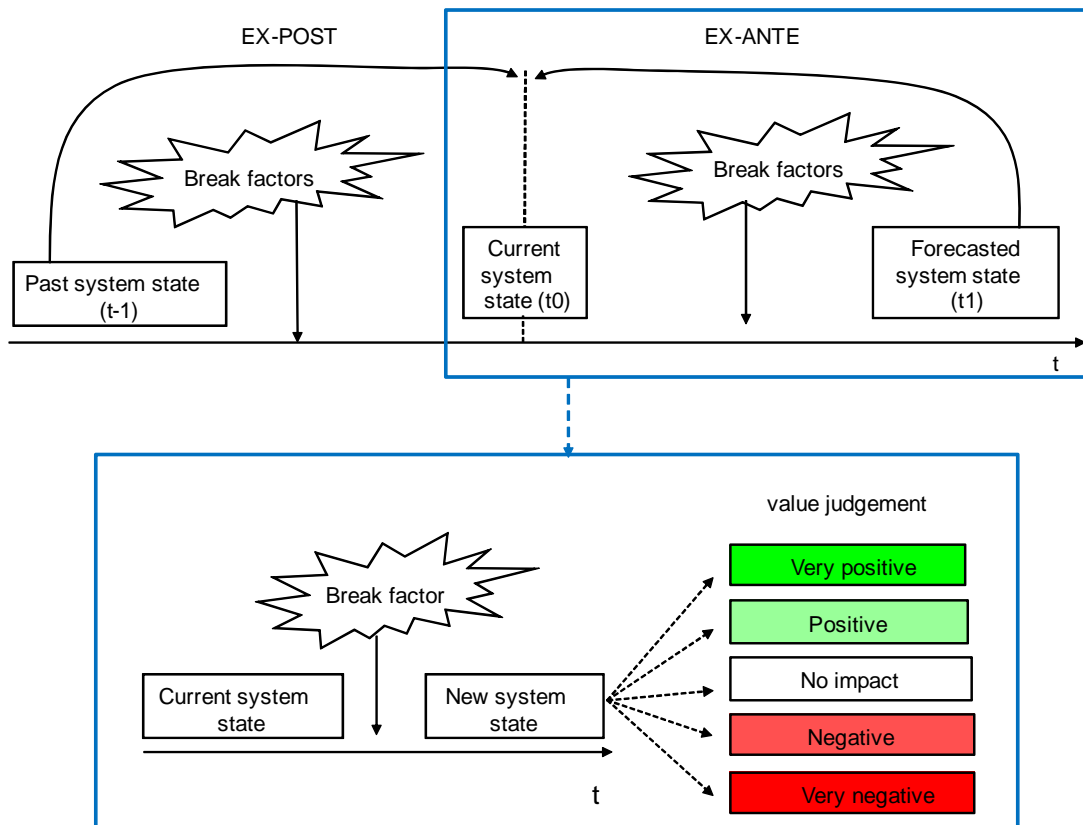
Figure 2.1.1.8 - Evaluation system frame and type of output information.

In figure 2.1.1.8 one sees that this assessment procedure requires a picture of the current state of the observed system and the likely future picture of the same system. I consider that experts providing answers already have a picture of the current situation; moreover, I provide them with further knowledge supporting their judgments; in fact to calculate the output, I provide experts with information on changes caused by the regulation (break factor changing the state of the observed system). Consequently experts can consider a future state of the productive system and can answer to specific questions necessary to build the final output.

Using the information from actors' behaviour at a micro level in order to calculate impact on the macro raises problems of data homogeneity in inputs collection and elaboration. Therefore precise system boundaries should frame the evaluation. On this point I refer to figure 2.1.1.9; in the evaluation system here presented, there are two types of system boundaries: one for the input collection and another for the output visualization. The domains using the enterprises'

compliance information for aggregation purposes (feature of the model called 'consequentiality micro-macro') have the following potential input collection boundaries: classes of enterprises, chain stages, regions, countries or Member States and Europe. These domains are Labour, Innovation and Research, Firm Competition and Environment. The first three domains above mentioned display the output at a country and a European level; this happens because information concerning the productive system cannot be collected and allocated by regions as the European food supply chain overpasses mainly regional and sometimes national borders. The other domains, namely Public health, Public Authorities and Environment display the impact outputs at a regional, at a national and at a European level. While Environment domain uses enterprises' compliance information as aggregation principle to pass from regional values to European ones, the Public Health Domain aggregates impacts through experts' opinions on impact scale values. Last, the Public Authorities domain does not operate any aggregation: this is the only domain that neglects the consequentiality micro-macro of the model; this is due to the diversity and variety of public authorities and agencies proper of every Member State. Consequently a common aggregation principle or criterion among regions or countries cannot be used in order to obtain a European aggregated value. The latter would require a too specific analysis; the natural consequence is that the evaluation system can still display results on the three levels region, Member State, Europe but as independent elaboration of inputs. In any case the compliance information remains a supporting information for every expert independently from the type of domain.

DOMAINS

INPUT COLLECTION LEVELS	PUBLIC HEALTH	LABOUR	PUBLIC AUTHORITIES	INNOVATION AND RESEARCH	FIRM COMPETITION	ENVIRONMENT
ENTEPRISES CLASS		x		x	x	x
CHAIN STAGE		x		x	x	x
REGION (NUTS 1 or 2)	x	x	x	x	x	x
MEMBER STATE	x	x	x	x	x	x
EUROPE	x	x	x	x	x	x

OUTPUT VISUALIZATION LEVELS	PUBLIC HEALTH	LABOUR	PUBLIC AUTHORITIES	INNOVATION AND RESEARCH	FIRM COMPETITION	ENVIRONMENT
REGION (NUTS 1 or 2)	x		x			x
MEMBER STATE	x	x	x	x	x	x
EUROPE	x	x	x	x	x	x
	Enterprises' compliance only for expert support use	Enterprises' compliance for aggregation function	No aggregation among different levels	Enterprises' compliance for aggregation function	Enterprises' compliance for aggregation function	Enterprises' compliance for aggregation function

Figure 2.1.1.9 - Multi-level inputs collection frame and multi-level outputs visualization frame.

2.1.1.3 Main impact assessment system model features

The first main model feature here explained corresponds to the consequentiality micro-macro; with this term I intend the use of information describing the behaviour of micro actors (e.g. enterprises) to reach the impact on the aggregated European level. By means of equations (2) and (3) (previous paragraph) one sees how the number of enterprises complying with a new proposal play a major role as impacts aggregation factor; moreover, experts are provided with the same information in order to support their territory-based impact opinion.

To explain both second and third model features, namely the 'structured knowledge of complex phenomena' and the 'disaggregated information collection', I describe the general approach used for the information collection of every domain and then I refer to the specific domain 'Environment'. The procedure necessary to formulate appropriate questions, which should be answered by external experts, is the same for every domain and it is reported in figure 2.1.1.10.
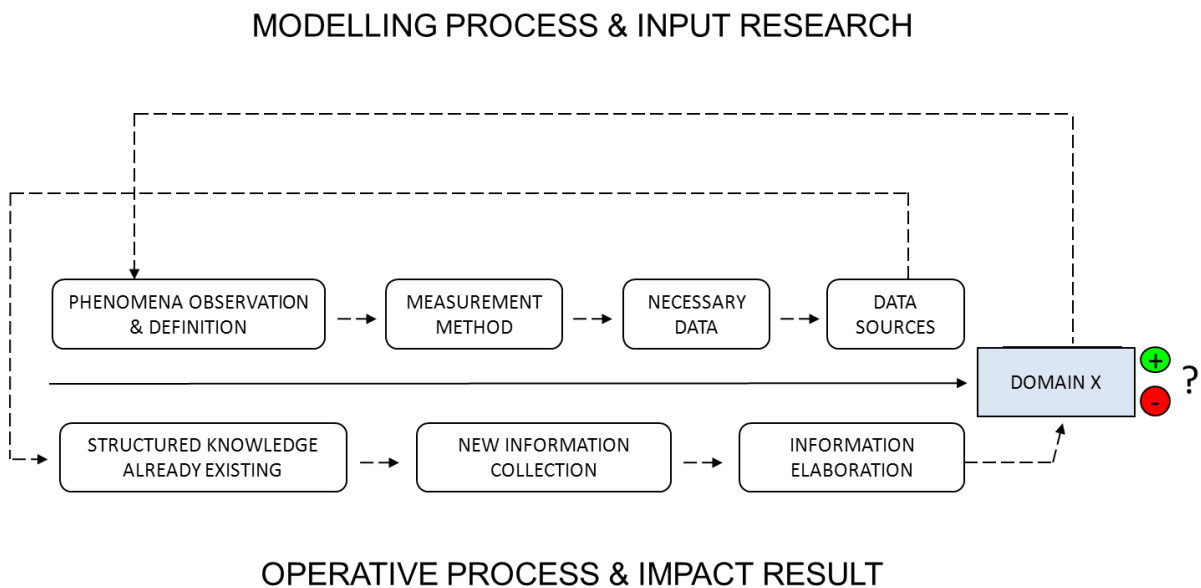
Figure 2.1.1.10 - Domains modelling and operational processes to obtain domains' impacts.

For every domain I did a first literature research in order to find a definition and to adapt the model logic to the specific phenomenon. From the definition I broke down measurement methods or indicators used in literature to quantify the phenomenon dynamic. The indicators give information on the necessary data and consequently the potential sources.

After this first modelling process followed the operative steps based on the research of data already available, the research of data not available and finally the elaboration of the information to obtain the impact.

Focusing on the creation process of the Environment domain impact, I refer to Goedkoop and Spriensma (2001); they define the environment as a '*set of biological physical and chemical parameters influenced by man, which are conditions to the functioning of man and nature'*. The complexity of such a system requires multiple analyses in several fields to obtain a complete impact assessment. I aim at reducing such a complexity by structuring the knowledge of the specific topic in precise questions posed to specialized experts; moreover, I reduce the size of the system under evaluation, hence the expert has a small system to consider in addressing evaluation issues on potential environmental impacts.

Environmental impact assessments are particularly time consuming processes because of the complexity and the number of analyses necessary to give a final statement on the negativity or positivity of an impact for the human being. Common analysis concerns the way the harmful pollutants spread in the environment (fate analysis), the type and length of contact pollutants have with the species under observation (exposure analysis), the causal relation between a defined exposure and the onset of damages for species under observation (effect analysis) and finally the reporting of the damage on a common scale of comparison in order to evaluate whether or not the damage has a high relevance for those species.

In figure 2.1.1.11 I report a regional simplified agri-food supply chain. It consists of three stages, namely producers, processors and retailers. Enterprises of different sizes are present in every chain stage. In the single enterprise there are two inputs: 'x' or operational capital goods and 'n' or natural resources. By means of the three internal production factors, 'L' for labour, 'R' for Ricardian natural resources or land and 'K' for capital goods, the enterprise generates as outputs wasted matter or pollutants and consumable products.
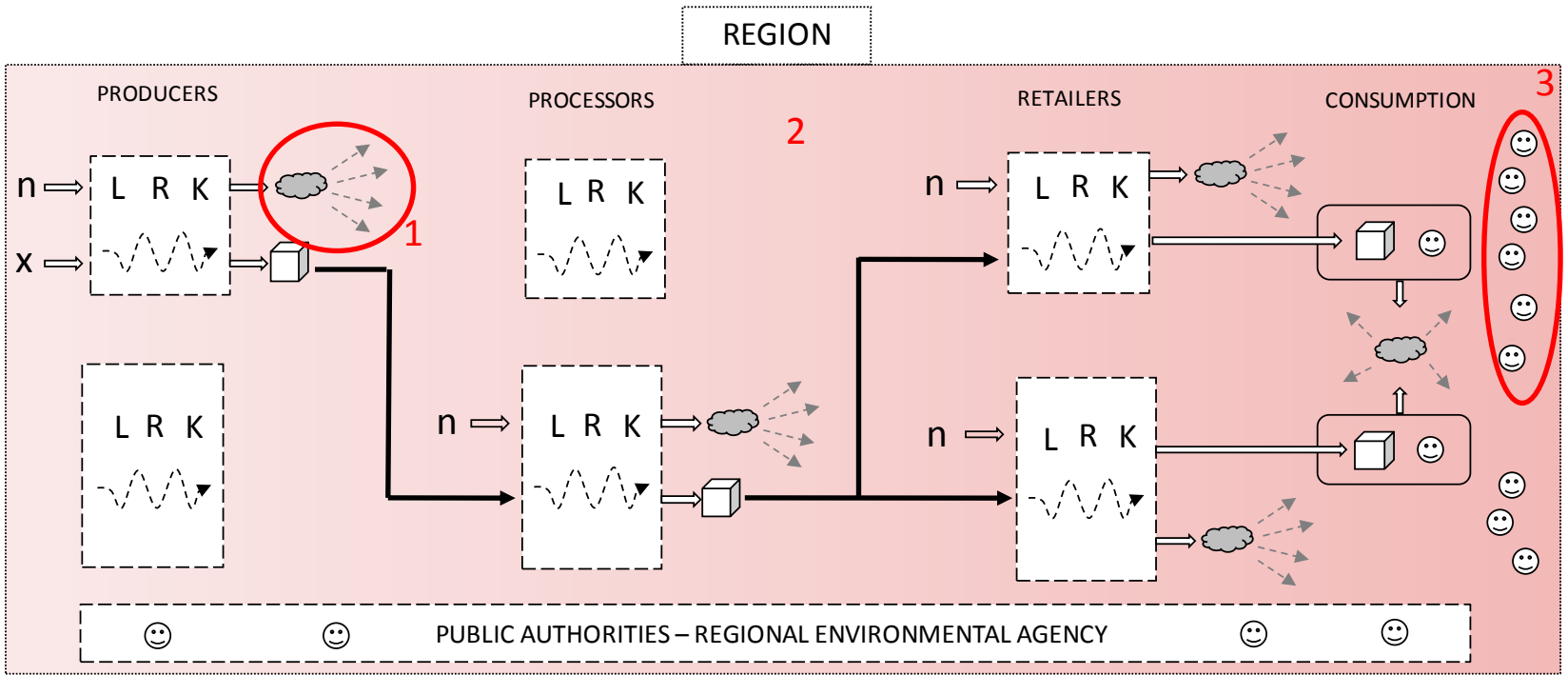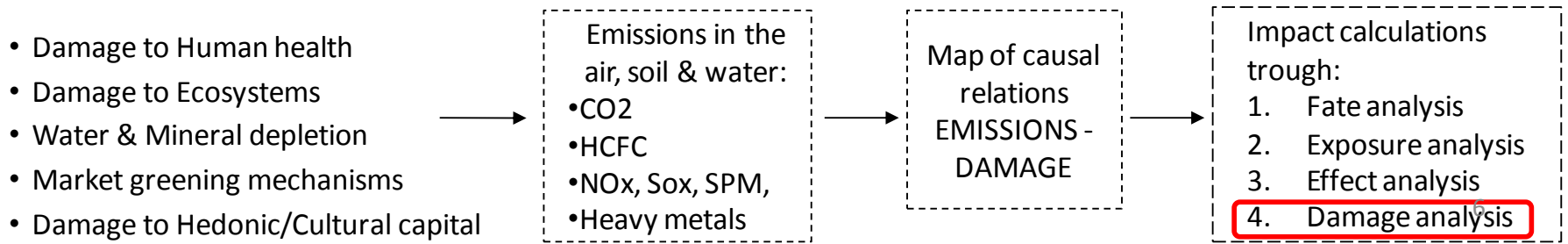
Figure 2.1.1.11 - Representation of the complex system 'environment-human activities' and related analysis for the impact calculations.

The information on pollutants emissions can be obtained at an enterprise level (point number one). Information on the exposure depends highly on the territory morphology, therefore from a specific knowledge of the region under observation (point number two). Information on effects and damages are provided by experts with specific knowledge for the field of inquiry (chemical contaminants experts, microbiological experts, etc.). The latter usually work in public specialized agencies distributed on the territory of the country.

By focusing on the data sources I can isolate the actors I need to address in order to obtain all information above mentioned. By addressing already enterprises for the compliance information, I can ask them further information concerning the production process changes deriving from the fulfillment of the new proposal requirements. These changes, when detailed and referred to the functional unit of one item, can be easily related to upcoming environmental impacts by environmental agencies experts.

If the territorial system under evaluation is too big the expert faces difficulties in understanding interactions between pollutants dynamics and related species damages. In my model I propose to reduce the size of the system so that the expert can provide a more reliable judgment.

In Europe a network of environmental agencies already exists. These agencies normally collect data and monitor the environmental state of a region; as a consequence they already have knowledge of regional areas particularly sensitive to specific pollutants. Moreover, given the reduced size of the territorial system under evaluation, regional agencies employees responsible for the Strategic Environmental Assessment are able to locate the group of enterprises complying; the latter are classified by size and by type of production stage within the food sector, therefore through their specificity they can be easily identified (figure 2.1.1.12).

1. Info on **number** and **type of enterprises** affected by the regulation in a specific region.

Before the proposal

After the proposal

$a + b = c$

$a + b + d = c + e$

2. Info on what the proposal will **change in the production process** of the enterprise.

TERRITORY OF REGION X

Flat with problem of nitrates in groundwater	Area with already polluted river
Metropolitan area with air pollution problems	Natural park area

3. Expert knowledge of the **current regional environmental state**.

TERRITORY OF REGION X

Flat with problem of nitrates in groundwater	Area with already polluted river
Metropolitan area with air pollution problems	Natural park area

4. Expert ability **in locating the enterprises** of point 1 **in the regional territory**.

TERRITORY OF REGION X

Flat with problem of nitrates in groundwater	Area with already polluted river
Metropolitan area with air pollution problems	Natural park area

5. **Positive or negative impacts** likely to be caused by the proposal **in the region**.

IMPACTS IN EU

Region X +++	Region b +	Region c +
Region d +	Region e - -	Region f - - -
Region g - - -	Region h + +	Region I - -
Region l - -	Region m - -	Region a + +

Figure 2.1.1.12- Procedure to obtain experts' opinions on new proposals' impacts.
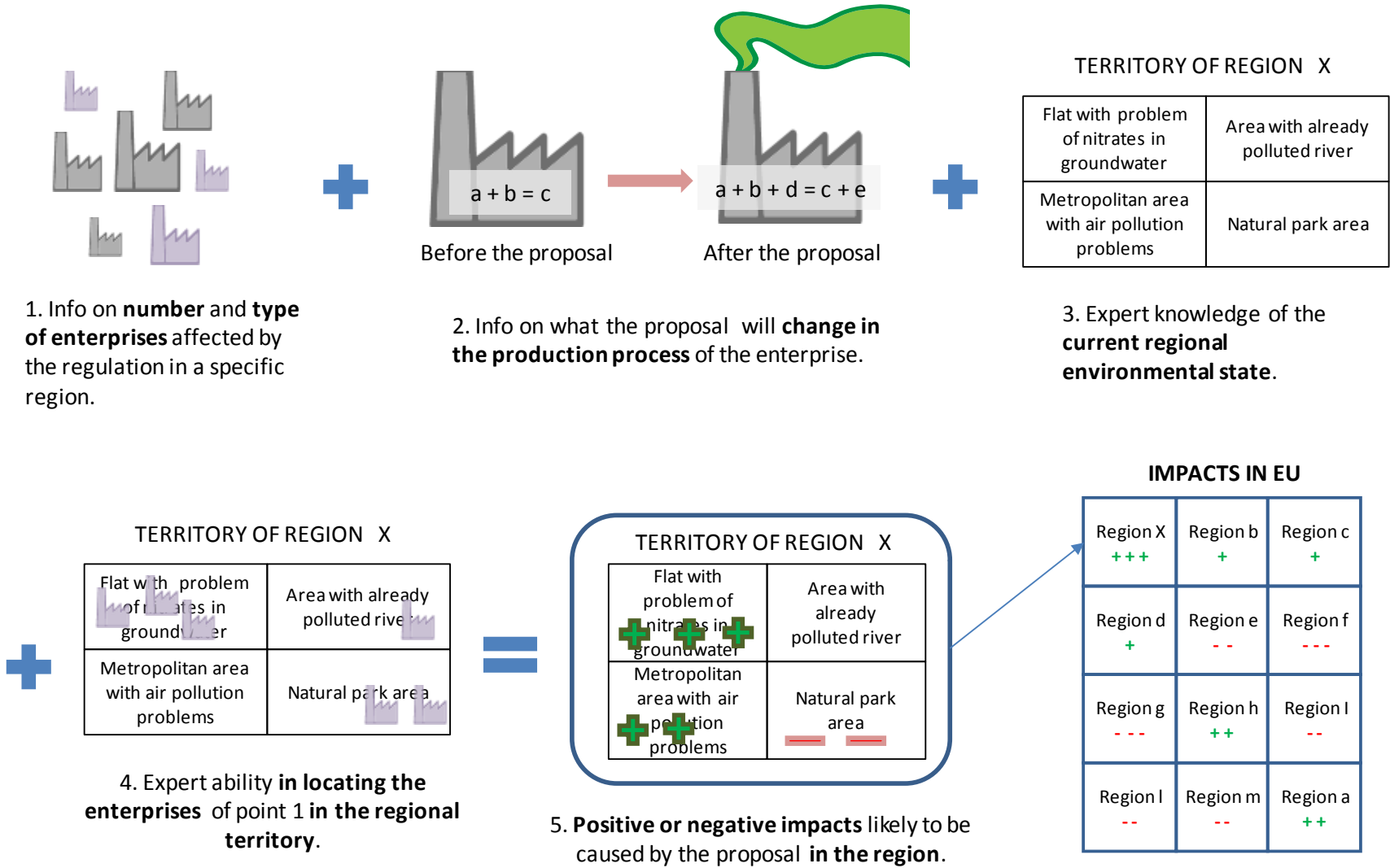
As displayed by means of figure 2.1.1.13, a disaggregated information collection can lead to a more reliable expert opinion, because the system size is smaller, the variables it contains are less and there is already knowledge of the system responsiveness and sensitivity to particular pollutants.
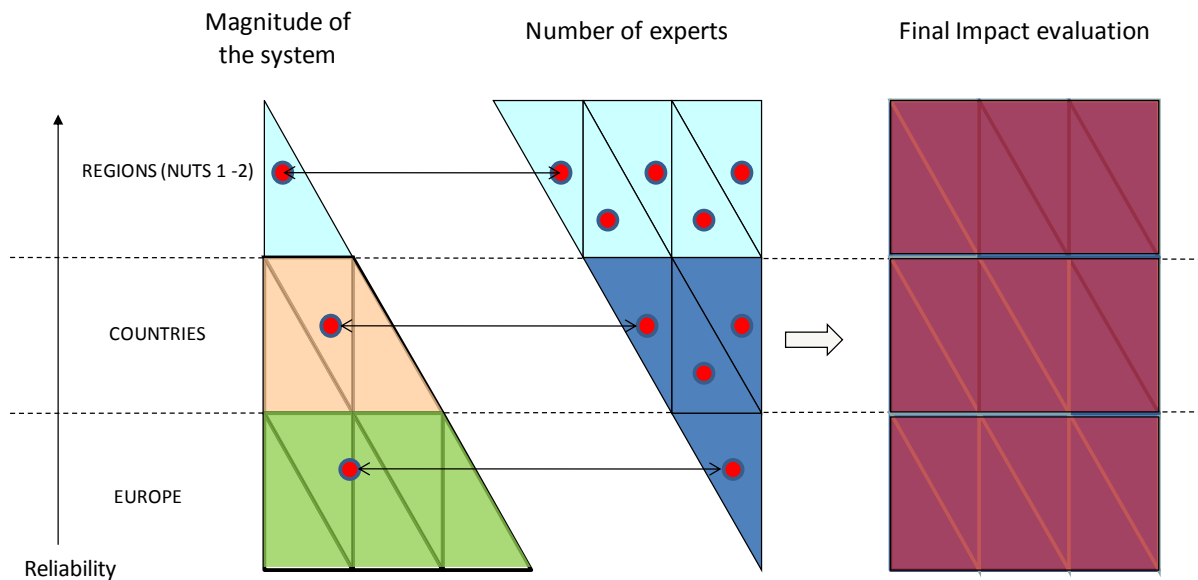
Figure 2.1.1.13 - Relation between size of the system evaluated and reliability of the impact information.

As regional agencies monitor constantly specific impact aspects, I can collect information at the regional level obtaining reliable experts opinions on potential impacts. This model feature works for domains as the 'Environment', the 'Public Health' and the 'Public Authorities'. For the first two domains the regional impact can be aggregated in order to obtain the European impact. I call this feature of the model 'disaggregated level of information collection'.

Another relevant model feature is the 'structured knowledge of complex phenomena'. The idea underlying this attribute is that the expert, in providing answers or opinions on potential impacts, has to follow a step by step approach. By structuring the relevant impact categories for every domain, the expert will not neglect side aspects linked to potential underestimated impacts. The expert judgment should follow a set of rules so that comparisons of evaluation differing in time or in geographical boundaries can be executed. Structured categories of impact allow different analysts to replicate the impact calculation procedures reducing the subjectivity bias.

The domains' impacts categorization proposed in this model is based on a domain-tailored literature research. However lack of specific knowledge aspects might still be present in the model since the subject broached are broad and complex. What is of relevance for the model is the presence of a logic structure for categories on which the expert has to extern his opinion. In other words the impact calculation and the related elaboration files are set in a way that allows the expert to tackle one aspect per time and the analyst to input the expertise outcome independently from the category label. On the latter I suggest updating the domain categorization on a regular base every two years.

By means of figure 2.1.1.14 I display how domain categories are structured. First I identify the causes leading to an impact. Then I group this causes in possible categories of impact.

Below, figure 2.1.1.15 exhibits how the feature 'structured knowledge' matches a simplified expression of the model algebra. In the example of figure 2.1.1.15 the expert has to answer two types of questions:

1) Which category has more relevance in respect of the others in creating a negative impact given the current state of the regional environment?

2) Do you think that a proposal X will lead to an *increase, a decrease or not influence* the damage cause Y?

By assigning experts 'answers to question 2 a score (impact direction: 'i' = 1 or 0 or -1) and by assigning experts 'answers to question 1 a weight ($0 \leqq$ Severity: $Se_i \leqq 1$) I can obtain through a weighted sum an impact value ranging between -1 and 1.

Domain reports present a more detailed view on the categorization process and on the impact results calculation. As every domain addresses particular knowledge fields and stakeholders, the impact calculation procedure is tailored on the domain specificity; however, with the exception of the Public Health Domain, the algebraic rules work in the same way for all domains.

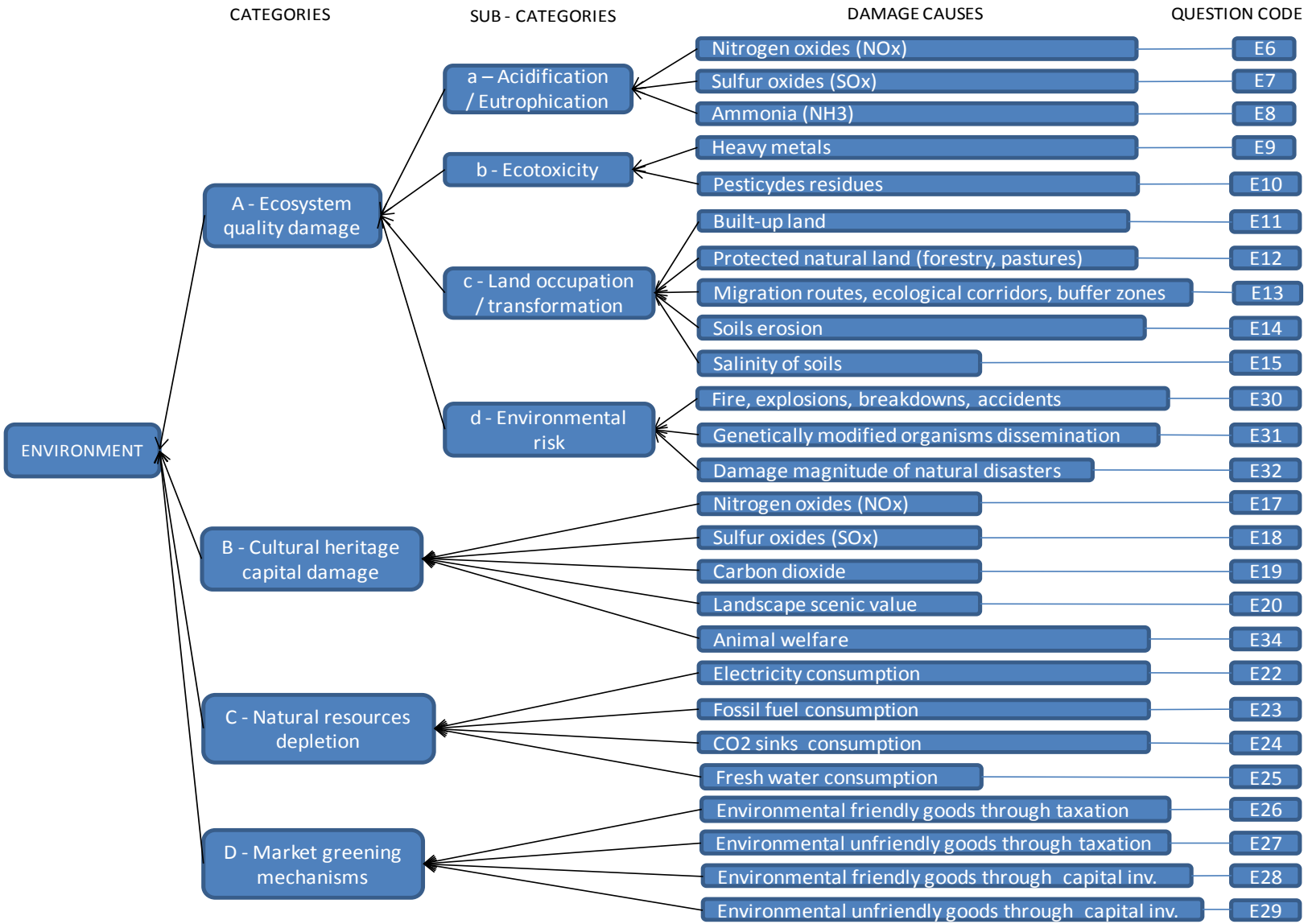| CATEGORIES	SUB - CATEGORIES	DAMAGE CAUSES	QUESTION CODE
		Nitrogen oxides (NOx)	E6
	a – Acidification / Eutrophication	Sulfur oxides (SOx)	E7
		Ammonia (NH3)	E8
	b - Ecotoxicity	Heavy metals	E9
		Pesticydes residues	E10
A - Ecosystem quality damage		Built-up land	E11
		Protected natural land (forestry, pastures)	E12
	c - Land occupation / transformation	Migration routes, ecological corridors, buffer zones	E13
		Soils erosion	E14
		Salinity of soils	E15
		Fire, explosions, breakdowns, accidents	E30
	d - Environmental risk	Genetically modified organisms dissemination	E31
		Damage magnitude of natural disasters	E32
		Nitrogen oxides (NOx)	E17
		Sulfur oxides (SOx)	E18
B - Cultural heritage capital damage		Carbon dioxide	E19
		Landscape scenic value	E20
		Animal welfare	E34
		Electricity consumption	E22
C - Natural resources depletion		Fossil fuel consumption	E23
		CO2 sinks consumption	E24
		Fresh water consumption	E25
		Environmental friendly goods through taxation	E26
D - Market greening mechanisms		Environmental unfriendly goods through taxation	E27
		Environmental friendly goods through capital inv.	E28
		Environmental unfriendly goods through capital inv.	E29

ENVIRONMENT

Figure 2.1.1.14 - Structured impact categories of the domain 'Environment'.

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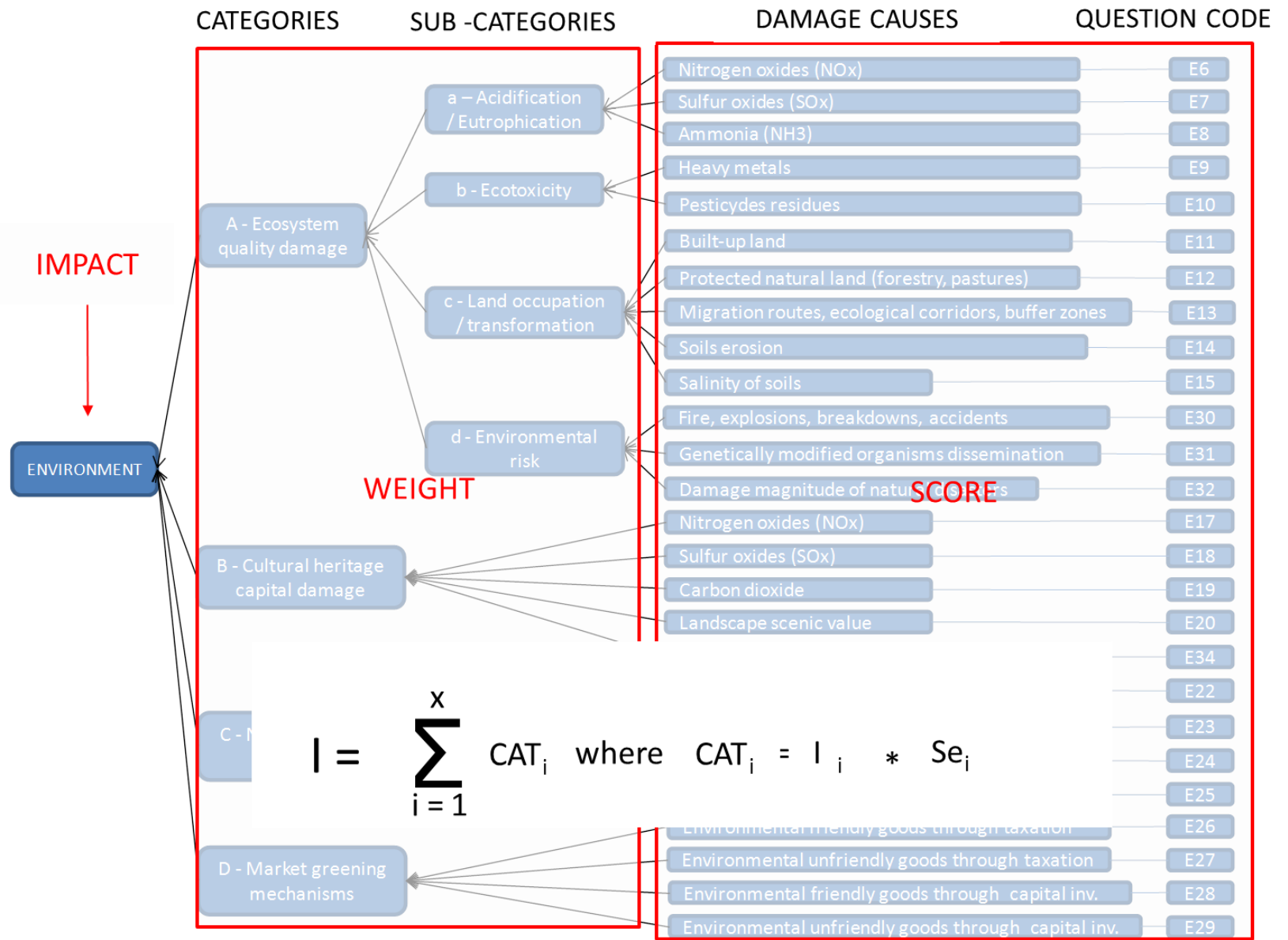
Figure 2.1.1.15 - Structured impact categories of the domain 'Environment' and model algebra.

CATEGORIES　　SUB -CATEGORIES　　DAMAGE CAUSES　　QUESTION CODE

IMPACT

ENVIRONMENT

A - Ecosystem quality damage

a – Acidification / Eutrophication

b - Ecotoxicity

c - Land occupation / transformation

d - Environmental risk

B - Cultural heritage capital damage

C - N

D - Market greening mechanisms

WEIGHT

SCORE

Damage cause	Code
Nitrogen oxides (NOx)	E6
Sulfur oxides (SOx)	E7
Ammonia (NH3)	E8
Heavy metals	E9
Pesticydes residues	E10
Built-up land	E11
Protected natural land (forestry, pastures)	E12
Migration routes, ecological corridors, buffer zones	E13
Soils erosion	E14
Salinity of soils	E15
Fire, explosions, breakdowns, accidents	E30
Genetically modified organisms dissemination	E31
Damage magnitude of natural	E32
Nitrogen oxides (NOx)	E17
Sulfur oxides (SOx)	E18
Carbon dioxide	E19
Landscape scenic value	E20
	E34
	E22
	E23
	E24
	E25
	E26
Environmental friendly goods through taxation	E27
Environmental unfriendly goods through taxation	E27
Environmental friendly goods through capital inv.	E28
Environmental unfriendly goods through capital inv.	E29

$$I = \sum_{i=1}^{x} CAT_i \quad where \quad CAT_i = I_i * Se_i$$

2.1.1.4 The output table

Through the output table I explain in the next part of the chapter how the features 'consequentiality micro-macro', 'disaggregated data collection' and 'structured knowledge' allow the multi-level model to provide the policy maker with useful information. The output table, as represented in figure 2.1.1.16, displays:

1. impact direction for every domain in the table;
2. impact intensity for every domain in the table;
3. impact uncertainty for every domain in the table;
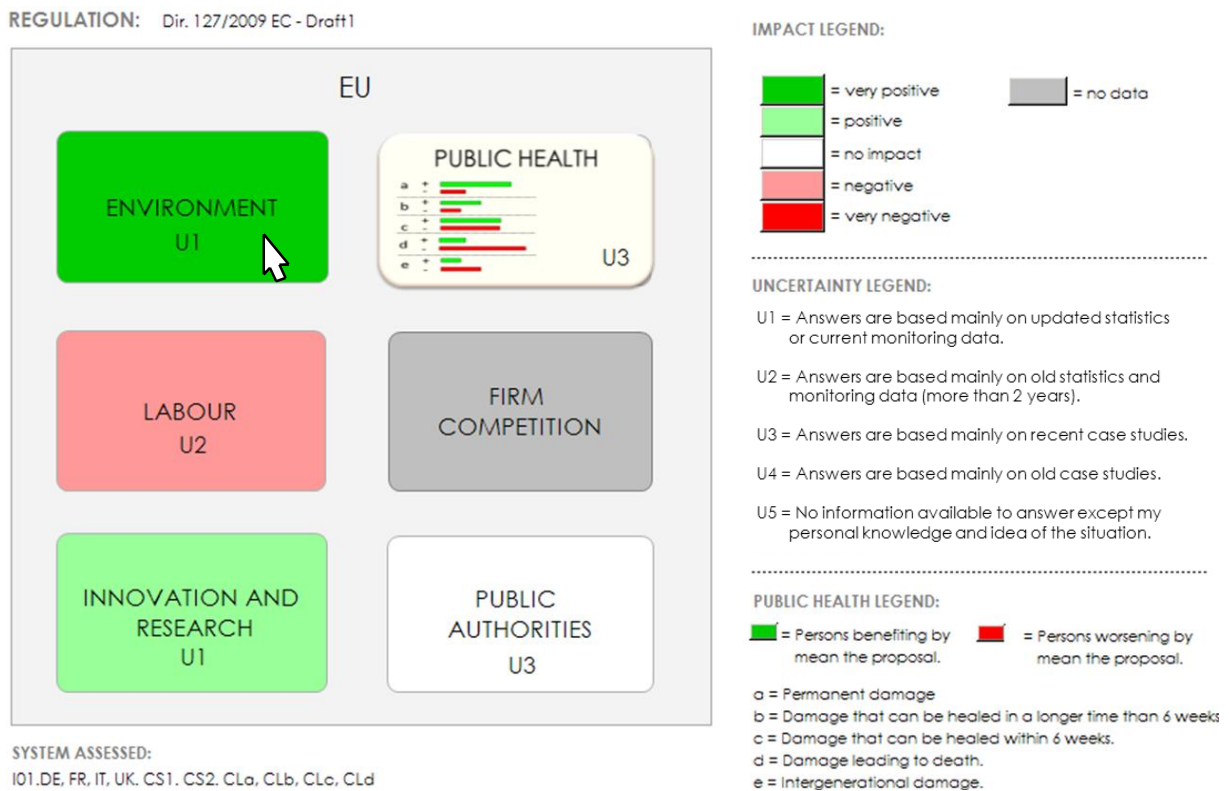4. impact reference code (information on the boundaries of the assessed system).

Figure 2.1.1.16 - Impacts output table (example).

The heading of the table reports the short denomination of the system assessed; in my example the denomination corresponds to EU as result of a European evaluation but countries or regions names can be visualized too. More specifically, countries results are visualized for every domain as long as the input is collected on a country level; the same is valid for regional results: they can be displayed for domains as Environment, Public Health and Public

Authorities considering a regional level of data collection. Under the table, an impact reference code reports the type of food industry part of the assessment process, the geographical boundaries in which impacts take place, the stages of the supply chain affected by the new legislative proposal and the classes of enterprises affected by the new legislative proposal. A legend elucidating the meaning of the table's impacts and uncertainty symbols is provided next to the impacts representation. Moreover the denomination of the legislative proposal provoking the impacts is displayed on the top of the table.

By clicking on the single domain's label is possible to enlarge the impact result to a deeper disaggregated degree (figure 2.1.1.17).
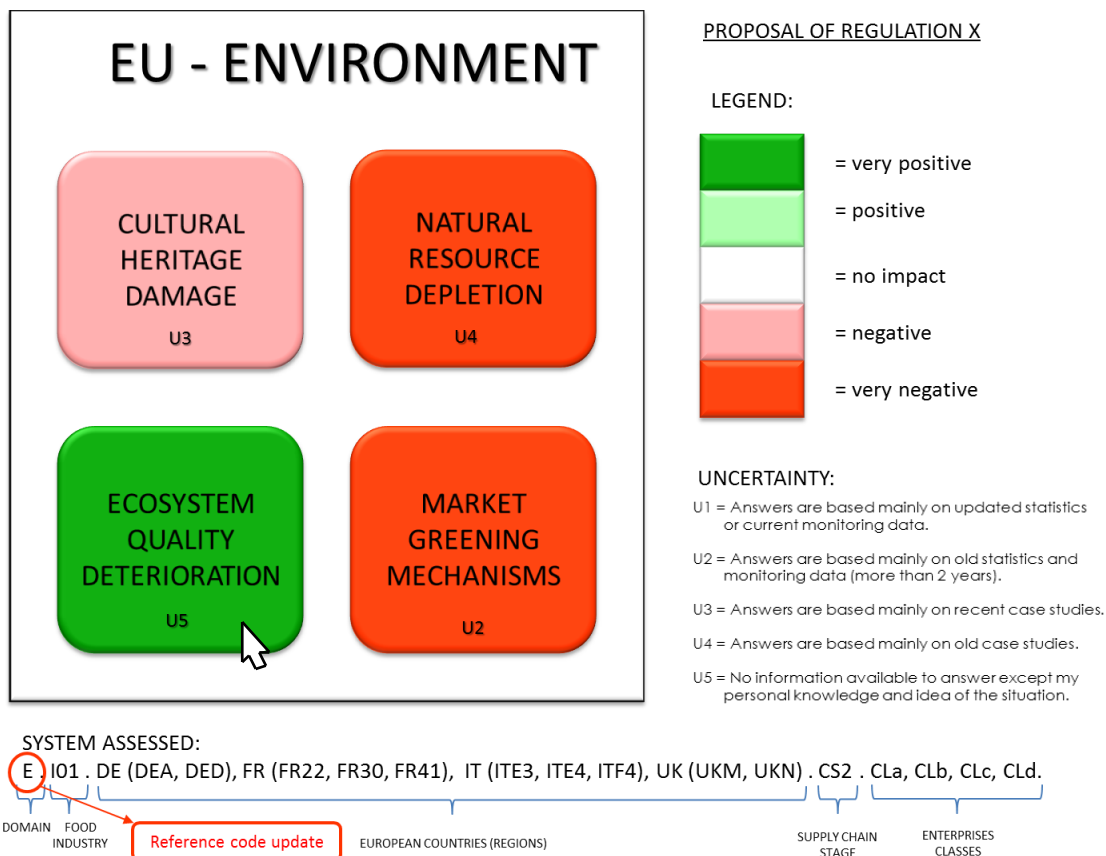

Figure 2.1.1.17 - Output table: second degree of impact information.

The value of the impact splits among sub-categories used to describe and collect the impact information along the domain evaluation process. This function is possible because of the model feature 'structured knowledge of complex phenomena'.

As the output table displays only one domain, the impact reference code automatically updates itself by inserting the domain symbol in the front of the code string.

By clicking on the single sub-category (in the example of figure 2.1.1.17 Ecosystem quality deterioration) I visualize the impact value by single country and by specific sub-category (figure 2.1.1.18).
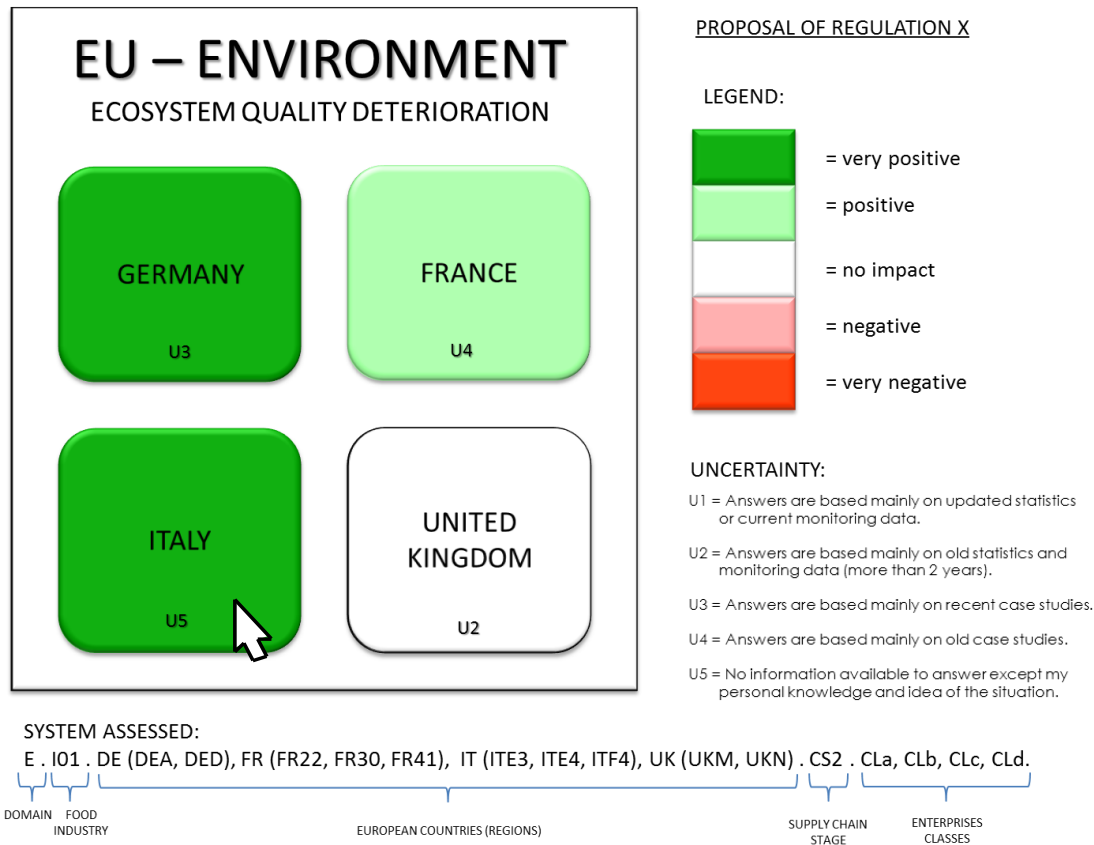

Figure 2.1.1.18 - Output table: third degree of impact information.

If the impact assessment has been carried out on a regional level the system allows the user to reach a fourth degree of output disaggregation, namely the regional impacts (figure 2.1.1.19). The possibility of displaying the results on different geographical disaggregated levels is due to the model feature 'disaggregated data collection'.

In all output tables the impact intensity is visualized through the colours and it is linked to numerical values representing the severity and the scale of the impact, results of experts' judgments (see paragraph 2.1.1.2 - Model output, algebra and impact results meaning).

The other information provided by the output table corresponds to the impact values uncertainty. The latter is given by the indicator 'Uncertainty' labeled in the output table with 'U' in the domains square labels. Next to the 'U', a number indicates the level of uncertainty of experts' opinions.
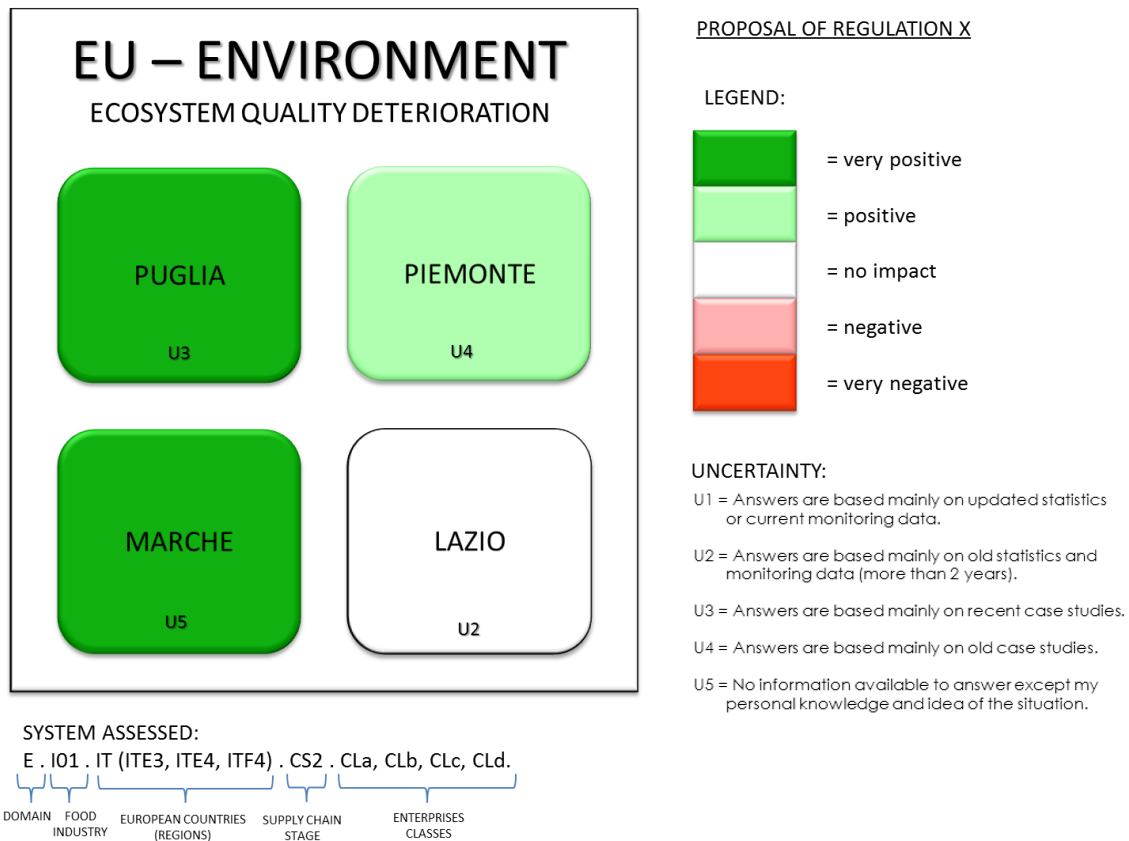
Figure 2.1.1.19 - Output table: fourth degree of impact information.

The legend on the right side of the table provides elucidations on the meaning of the uncertainty indicator values. When experts base their judgments on existing knowledge deriving from updated statistical elaboration the uncertainty is at its lowest level; following the increasing uncertainty level, there are judgments based on old statistics, recent case studies, old case studies and finally the only subjective opinion of the expert.

Uncertainty values are provided by experts when answering the survey on the proposal's impacts for the domain related to their expertise; therefore they summarize the general uncertainty of a set of questions on the same topic. As experts from many regions can assign different levels of uncertainty, the single uncertainty domain value should comply with the following two parameters:

- it is the mode value of all uncertainty values given by the experts;
- the mode value should correspond to the uncertainty value that is indicated in the majority of values given by experts.

2.1.1.5 Domains reports importance

An impact assessment study generally concerns several fields of knowledge. As displayed through the output table, in the IAS here presented there are six different domains or knowledge fields. Each of these fields refers to a particular phenomenon and therefore has its own determinants or dynamics key factors. By modelling, I isolated the latter in order to locate sources capable of providing the relevant information. This operation has been executed domain by domain and results of it are the 'domains reports', essential part of the new IAS.

Every domain report is structured in four sections:

1. Definition of the domain; this section explains what I indicate through the final impact.
2. Factors or key determinants of the domain and categorization; the categories, on which the expert should give a judgment, are isolated and translated in questions and closed-ended answers.
3. Impact assessment system; this section illustrates how experts' answers is elaborated through the calculation system and the necessary operations to obtain experts' answers.
4. References; this section lists the literature sources used for the drawing up of 'domains reports'.

In the dissertation appendix I report two 'domains reports', namely the Public Health and the Environment Domain reports. The Environment Domain report is representative of the structure of the other missing four domain reports. Although the reports are essential part of the IAS development, their presence in this work is not necessary for the understanding of the thesis argumentation line. In the case the interested reader wants to explore the impact creation and categorization path of the missing domains, I readdress him to Novelli (2012) - *Supporting strategic decisions in the food policy arena.*

The third paragraph of every report gives, by means of the Impact Assessment System diagram, a clear view on how the final impacts are calculated. Moreover, reports are designed as a fast reference tool to consult when the model user has doubts on the functioning of a specific domain or the role of a question.

2.1.2 The impact assessment system digital structure

The digital files of the new Impact Assessment System are structured as displayed in figure 2.1.2.1. The IAS is divided in three main folders:

1. the '01_Impact Assessment System Reports' folder;
2. the '02_Classifications and codes' folder;
3. the '03_Impact elaboration system' folder.

I define the three folders of the first level (figure 2.1.2.1) as 'main folders' to enable an easier comprehension of the IAS digital structure.

In the first main folder there are reports describing the impact elaboration system of each domain (see paragraph 2.1.1.5).

The second main folder contains the backbone files of the IAS, namely the taxonomy and the coding system of the IAS; the latter classification of the domains and the list of impact questions. The larger part of this folder's files works as connection between external sources inputs and model internal elaboration systems.

In the '02_Classification and codes' folder there are four different sub-folders: '01_Domains', '02_System boundaries', '03_Support files', '04_Questions'. From figure 2.1.2.3 one can see that this folder contains both Excel files and PDF files.
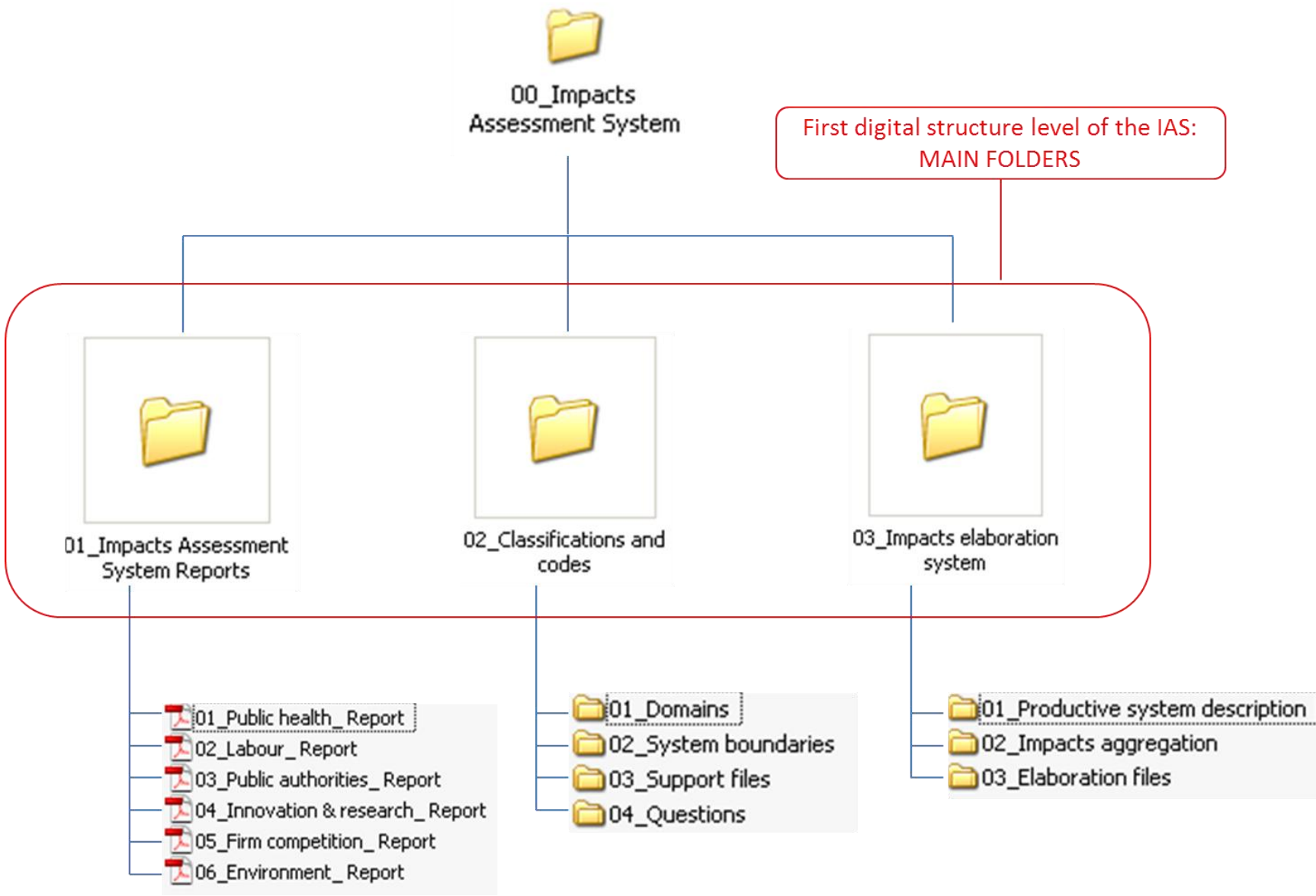
First digital structure level of the IAS:
MAIN FOLDERS

00_Impacts
Assessment System

01_Impacts Assessment
System Reports

02_Classifications and
codes

03_Impacts elaboration
system

01_Public health_ Report
02_Labour_ Report
03_Public authorities_ Report
04_Innovation & research_ Report
05_Firm competition_ Report
06_Environment_ Report

01_Domains
02_System boundaries
03_Support files
04_Questions

01_Productive system description
02_Impacts aggregation
03_Elaboration files

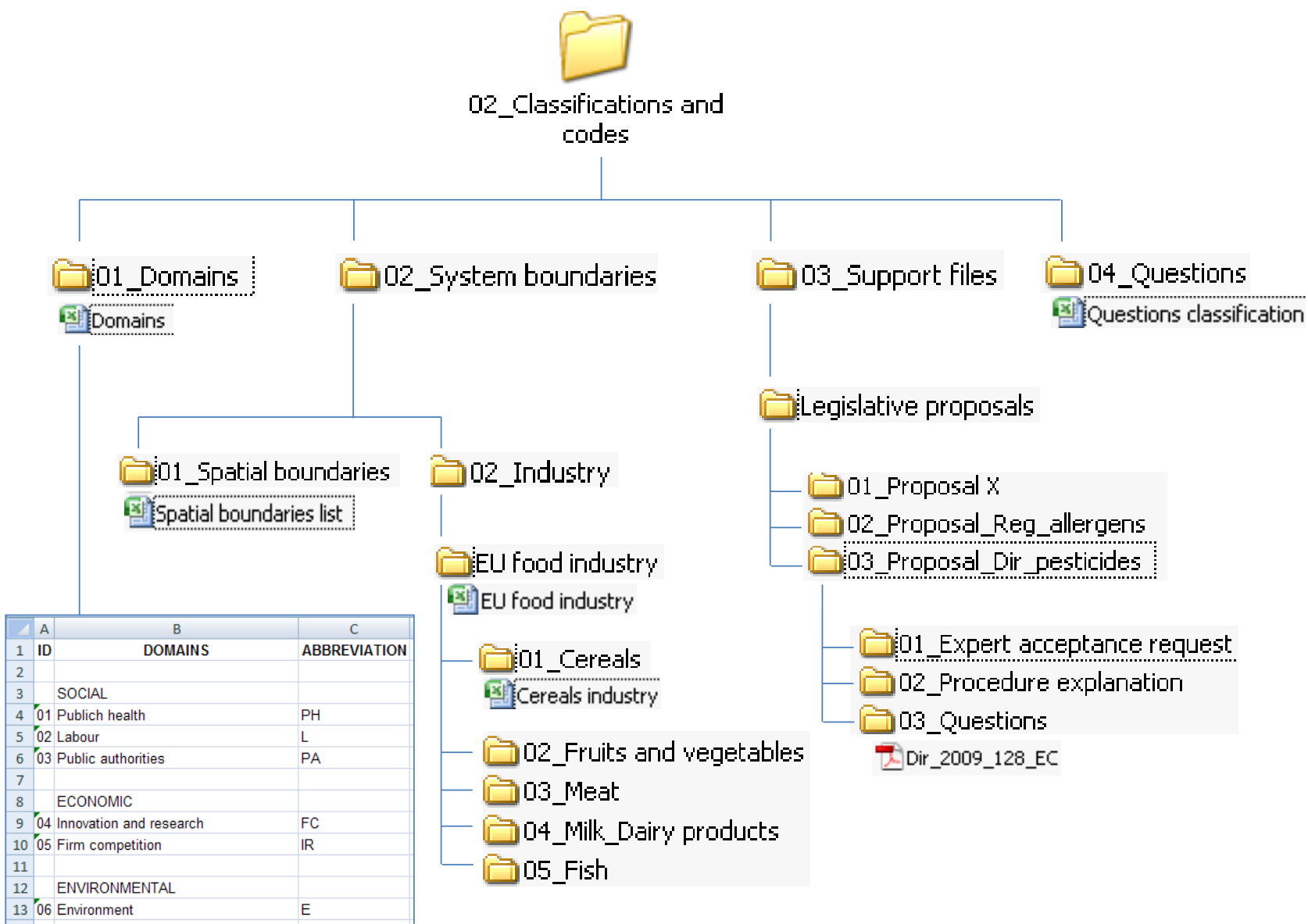**Figure 2.1.2.1 - Impact assessment system digital structure.**

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'01_Domains' folder contains an Excel file listing the observation fields of the IAS, namely the domains. Every domain has its own code.

In '02_System boundaries' folder there are two sub-folders: one concerning the spatial boundaries nomenclature and one concerning the EU food industry nomenclature. The Excel file of the first sub-folder is displayed in figure 2.1.2.4. One can see that many official spatial classification systems are available for the IAS. Depending on the domain or the specification of the policy maker, one can use EU classifications as well as UN classifications. I consider as default classification the EU nomenclature of territorial units for statistics (NUTS), because the impact calculation system is directly connected with enterprises classes' compliance in Europe; through NUTS classification (EU Regulations 1059/2003, 1888/2005 and 176/2008) I obtain homogenous statistical data concerning enterprises number and size at a European level, at a Member State level and at a regional level.

The Excel file of the second sub-folder is displayed in figure 2.1.2.2. In the file are listed the food industries suggested by the horizontal part of the IA model. Here as well each record connects to a specific code.

	A	B
1	Model ID	Food industries
2	I01	Cereals
3	I02	Fruits and vegetables
4	I03	Meat
5	I04	Milk and dairy products
6	I05	Fish

Figure 2.1.2.2 - EU 'food industry' file (nomenclature of food industries).

Figure 2.1.2.3- Content of the 'Classifications and codes' folder of the impact assessment system.

Figure 2.1.2.4 - Excel file with spatial boundaries classification criteria.

By opening the sub-folder 'EU food industry' one visualizes other folders containing Excel files describing the nomenclature of each food industry branch. In the IAS I focused on the cereals industry and therefore I report in figure 2.1.2.5 the cereals supply chain nomenclature table based on NACE Rev.2 classification. On the left part of the table displays the Eurostat codification system. The European denomination is then connected to the IAS coding system through the column 'Model ID'.

DIVISION	GROUP	CLASS		ISIC	Model ID	
			CHAIN STAGE 1			
			SECTION C - MANUFACTURING			
20			Manufacture of chemicals and chemical products			
	20,1		Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms			
		20,15	Manufacture of fertilisers and nitrogen compounds	2012	CS1.1	
	20.2		Manufacture of pesticides and other agrochemical products			
		20.20	Manufacture of pesticides and other agrochemical products	2021	CS1.2	CS1
28			Manufacture of machineryand equipment n.e.c.			
	28.3		Manufacture of agricultural and forestry machinery			
		28.30	Manufacture of agricultural and forestry machinery	2821	CS1.3	
			CHAIN STAGE 2			
			SECTION A — AGRICULTURE, FORESTRYAND FISHING			
01			Crop and animal production, hunting and related service activities			
	01.1		Growing of non-perennial crops			
		01.11	Growing of cereals (except rice), leguminous crops and oil seeds	0111	CS2.1	CS2
		01.12	Growing of rice	0112	CS2.2	
			CHAIN STAGE 3			
			SECTION G — WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES			
46			Wholesale trade, except of motor vehicles and motorcycles			
	46.1		Wholesale on a fee or contract basis			
		46.11	Agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-finished goods	4610	CS3.1	
	46.2		Wholesale of agricultural raw materials and live animals			CS3
		46.21	Wholesale of grain, unmanufactured tobacco, seeds and animal feeds	4620	CS3.2	
			CHAIN STAGE 4			
			SECTION C — MANUFACTURING			
10						
	10.6		Manufacture of grain mill products, starches and starch products			
		10.61	Manufacture of grain mill products	1061	CS4.1	
		10.62	Manufacture of starches and starch products	1062	CS4.2	
	10.7		Manufacture of bakery and farinaceous products			CS4
		10.71	Manufacture of bread; manufacture of fresh pastrygoods and cakes	1071	CS4.3	
		10.72	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	1071	CS4.4	
		10.73	Manufacture of macaroni, noodles, couscous and similar farinaceous products	1074	CS4.5	
			CHAIN STAGE 5			
			SECTION G — WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES			
46			Wholesale trade, except of motor vehicles and motorcycles			
	46.1		Wholesale on a fee or contract basis			
		46.17	Agents involved in the sale of food, beverages and tobacco	4610	CS5.1	
	46.3		Wholesale of food, beverages and tobacco			
		46.38	Wholesale of other food, including fish, crustaceans and molluscs	4630	CS5.2	
		46.39	Non-specialised wholesale of food, beverages and tobacco	4630	CS5.3	
47			Retail trade, except of motor vehicles and motorcycles			CS5
	47.1		Retail sale in non-specialised stores			
		47.11	Retail sale in non-specialised stores with food, beverages or tobacco predominating	4711	CS5.4	
	47.2		Retail sale of food, beverages and tobacco in specialised stores			
		47.24	Retail sale of bread, cakes, flour confectionery and sugar confectionery in specialised stores	4721	CS5.5	

Figure 2.1.2.5- Codes conversion table for the cereals supply chain.

Although I opted for the Eurostat updated nomenclature NACE Rev. 2 the model considers other nomenclature systems too. Especially when data concerning the productive system are missing or they are not homogeneous among countries, other classification systems are suitable. In any case, the choice of the productive system classification type depends on the 'horizontal part' of the IAS.

The 'Support files' folder contains all written documents necessary to support the expert in answering the questions of the IAS. Every time a new impact assessment begins (2.1.2.6), a new folder with the proposal name has to be created. In the folder with the proposal name there should be three sub-folders:

- 'Expert acceptance request';
- 'Procedure explanation';
- 'Questions'.

All three sub-folders present the same structure, namely a general template for the regional level, the country level and the European level.

In '01_Expert acceptance request' there are mails asking for experts participation in the survey. '02_Procedure explanation' contains file presenting an overview of the model to make the expert conscious of the value and the role of his answers within the whole IAS. In '03_Questions' folder there are questionnaires for each domain. All questions in these files can be printed and sent via mail or alternatively uploaded in a web-page. Part of the questionnaire file consists of the productive system complying information that, as previously explained, supports the expert in answering questions.

Depending on the output of the 'horizontal part', several templates of the 'Support files' can be tailored on countries or regions selected (see figure 2.1.2.6 - folders with regions and countries name).

'04_Questions' is the last and most important 'Classification and codes' sub-folder. '04_Questions' contains the Excel file with the IAS questions database. Here all questions are classified by the four different criteria:
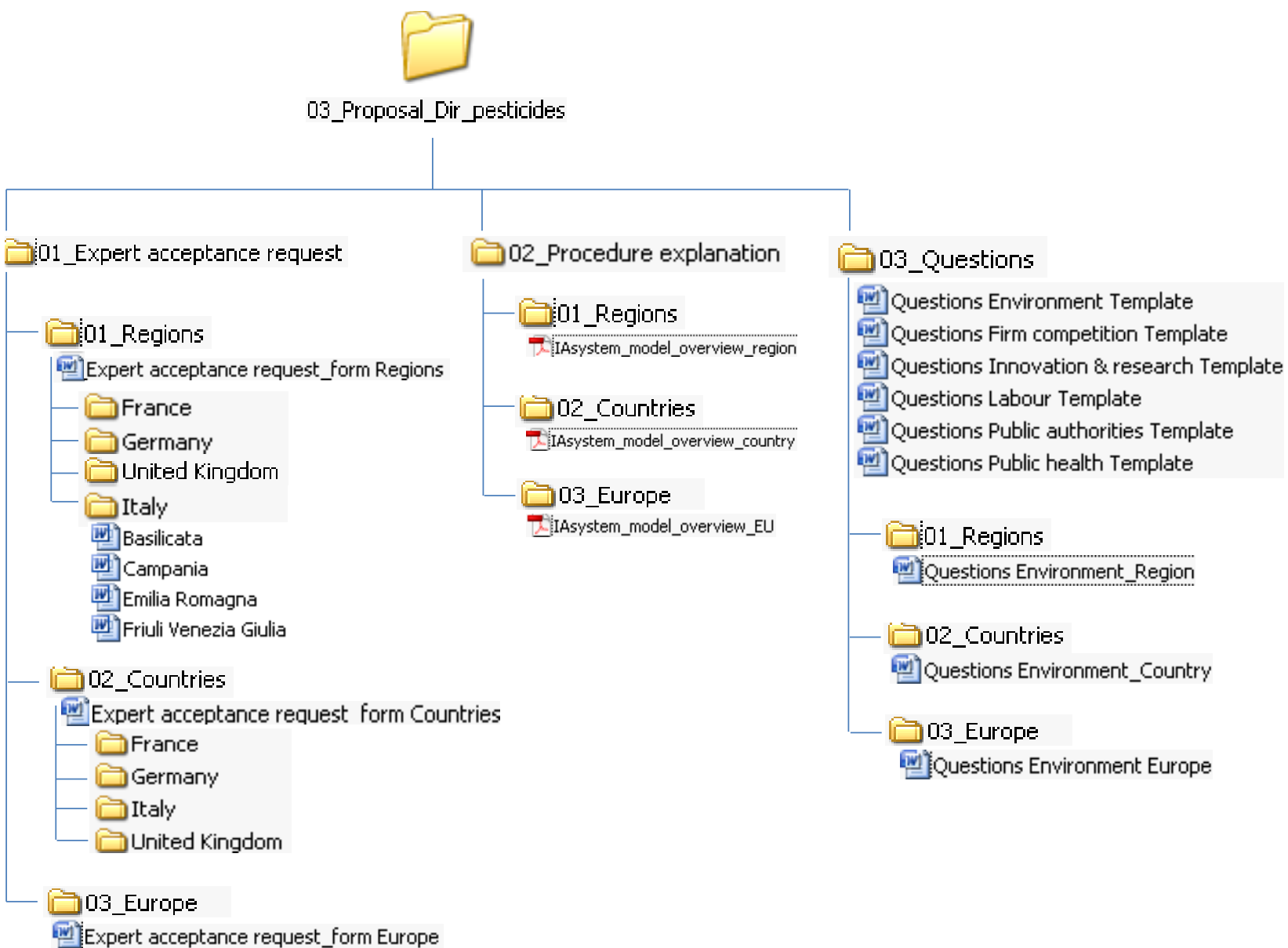
Figure 2.1.2.6- Support file folder; detail of pesticides proposal folder and support files.

1. domain to which the question contributes;
2. geographical boundary or region;
3. type of support file;
4. function of the question.

In figure 2.1.2.7 one can see on the left side of the table the general identification number (new ID) of every question producing, by the relative answer, an effect on the belonging domain. The second identification number (old ID) says to which domain the question contributes. Following on the right part of the table, the questions are reported together with the answers' options. Again on the right the first classification criterion, the domain of impact, is indicated by the domain ID code. Still following in the same direction, the rest of the criteria are displayed. After the classification of the function, a further column describes the possible answers sources.

In figure 2.1.2.7 one sees that the Excel file contains other three worksheets over the worksheet 'Questions classification'. Each one of the three worksheets contains questions sorted by type of question function; the function can be of three types: selective question (generating a selection of other questions), ranking[2] question (assigning a weight/severity to the impact category or sub-category the question represents) and scoring question (leading to the impact direction concerning the single category or sub-category the question represents). This file structure allows the user to transform in an easier way the current multiple files IAS in on-line software system, where no analyst is needed for data elaboration and transfer. The whole IAS system has been thought in terms of system entities or in a programming language 'objects'. Moreover the IAS modeled the relations among these entities; this is the reason why the system can be easily programmed as software working on a server without the use of an analyst to operate data transfer.

Figure 2.1.2.8 and 2.1.2.9 reports the graphical interfaces used to display questions of figure 2.1.2.7. Interfaces are interactive and experts can use a slider to assign a weight (severity) in case of multiple choice ranking questions (figure 2.1.2.8) or

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[2] I use the term 'ranking' for questions assigning a severity value, because in the preliminary version of the IAS the impact categories' weight was supposed to be assigned through a ranking procedure. Lately the use of sliding bars, enabled by 'LimeSurvey' software, allowed me to change the severity assignment process; previously I used the rank to obtain the weight, now I can directly obtain the categories' weight.

Figure 2.1.2.7 - Excel 'Questions classification' file.

Figure 2.1.2.8 - Interactive interface of 'LimeSurvey' obtain experts' answers to ranking questions.

Figure 2.1.2.9 - Interactive interfaces of 'LimeSurvey' to obtain experts' answers to scoring questions.

to provide a single answer among three impact options (figure 2.1.2.9) in case of scoring questions. I built the interactive interfaces by means of the open-source software 'LimeSurvey'.

As can be noticed by means of figure 2.1.2.10, the third main folder of the IAS digital structure contains two sub-folders: '01_Productive system description', and '02_Elaboration files'.

In the same picture, one can see the first sub-folder and its relative Excel files; the 'Productive system description' Excel file is the directory for the 'horizontal part' outputs. By means of the Excel files in '02_Classifications and codes' main folder, I input the productive system nomenclature data in the 'Productive system description' file. A series of cells' links automatically overwrite the ID codes of the productive systems' components (enterprises classes, supply chain stages, countries affected by the new legislative proposal) into '02_Elaboration files' files. In this way it is possible to trace all system's final values and to build the reference code shown in the output table of figure 2.1.1.16.

The '02_Elaboration files' folder contains Excel files for the final calculation of the impact domain by domain. In these files I input the experts' answers and the information coming from the horizontal part of the model, namely the magnitude of the enterprises' compliance or scale. I use the latter information, as shown in figure 2.1.2.11, to create the expert support files too.
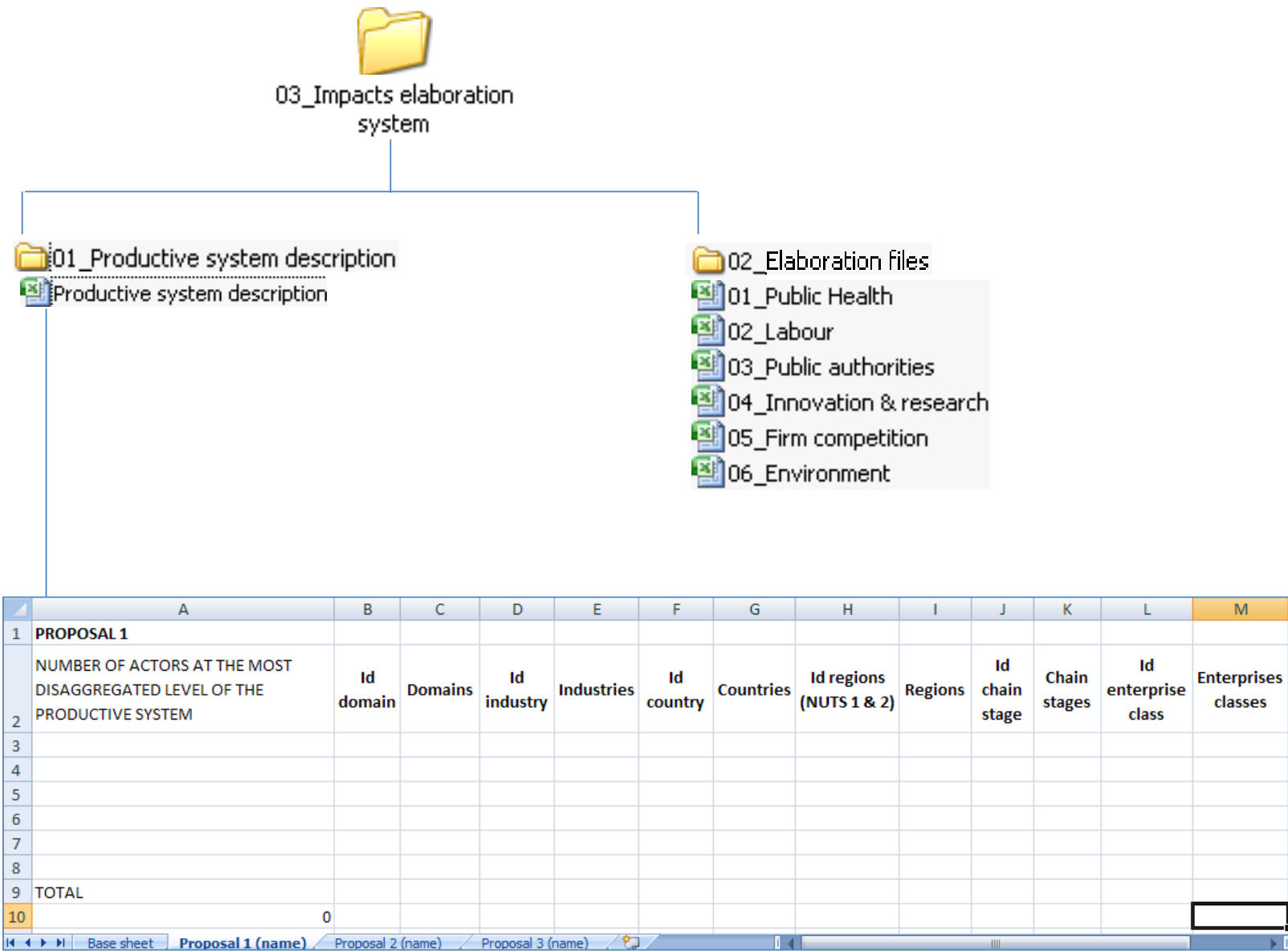
Figure 2.1.2.10 - Digital structure of the main folder '03_Impacts elaboration system'.
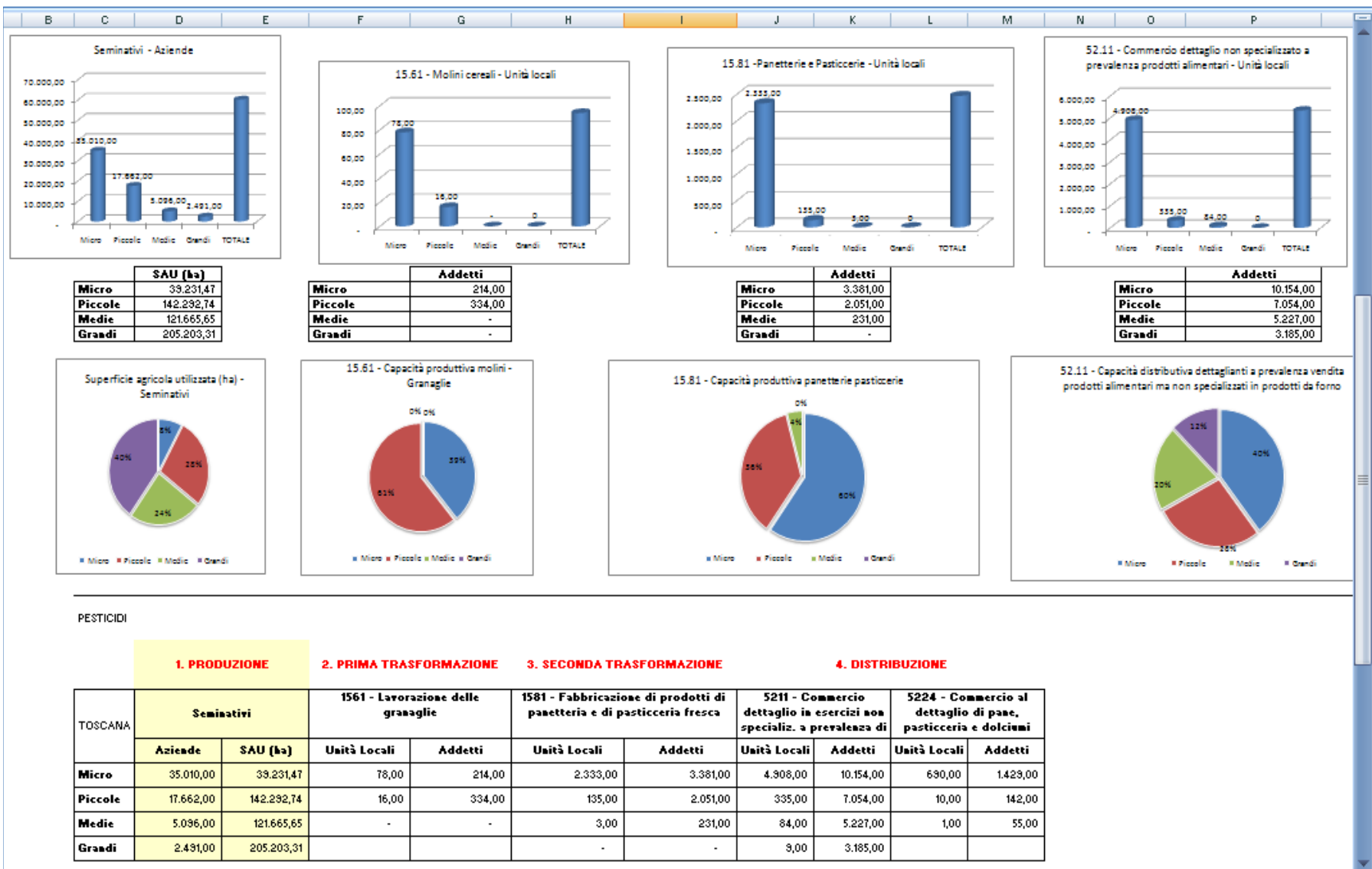
Figure 2.1.2.11 - Elaboration of compliance information to support experts' answers.

I focus on the single Excel elaboration file '06_Environment' to give an overview of the second most relevant element of the IAS digital structure: the folder '02_Elaboration files'. In this folder there is an Excel file for every domain. The main file structure is the same for all domains:

1. a first worksheet for the elaboration of the impact caused by the whole food system affected by the regulation (EU food system);

2. a second worksheet for the elaboration of the impact caused by a single food industry affected by the regulation (01_Cereals industry class);

3. a third worksheet for the elaboration of the impact caused by the food productive system of the single country (Country_01_Elab);

4. a fourth worksheet for the visualization of questions, experts' answers and associated scores (Country_01_Visual, figure 2.2.1.14 and 2.2.1.15);

5. a fifth worksheet for the visualization of the sources providing the answers (Country_01_sources, figure 2.2.1.13).
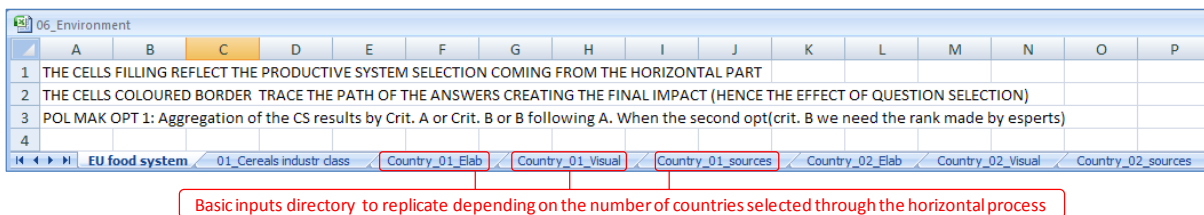
Figure 2.1.2.12 - Structure of the elaboration file.

The last three worksheets are replicated depending on the number of countries selected through the IAS 'horizontal part' (figure 2.2.1.13). The last three worksheets contain also the elaboration and visualization systems where regional data can be inputted.
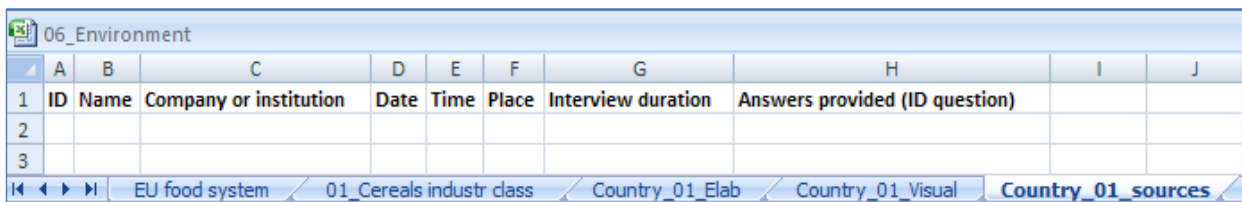
Figure 2.1.2.13 - Visualization of the worksheet necessary to input answers' sources.

Figure 2.1.2.14 - Visualization of the worksheet necessary to input experts' answers concerning ranking questions.

Figure 2.1.2.15 - Visualization of the worksheet necessary to input experts' answers concerning scoring questions.

Figure 2.2.1.15 demonstrates how the specific expert's answer connects to the score value of the impact direction. From the left side of the screenshot to the right side, I input answers given by European experts, countries experts and regional experts.

By means of the coding system, I transfer the score of every answer to the 'Country_01_Elab' worksheet. The main feature of this worksheet is to compute values in a final country impact or in domain's sub-categories impacts. The computing system offers two possibilities:

1. to calculate impacts from national experts' answers (figure 2.2.1.17);
2. to calculate impacts from regional experts' answers (figure 2.2.1.18).

In the first case the national expert should assign a weight to the domain's sub-categories by answering ranking questions (severity). Values are inputted in a table present in the same worksheet (figure 2.2.1.16). Only through this weight assignment process I obtain the final impact for the country or the main sub-categories indicated with A, B, C and D.

Figure 2.1.2.16 - Visualization of the worksheet necessary to input experts' answers concerning scoring questions.

Figure 2.1.2.17 - Visualization of the worksheet necessary to input experts' answers concerning scoring questions.

	06_Environment																							– □ X
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	X	Y	Z	AB	AC	AD
1	COUNTRY ID	0																						

	A	SCORE A1	SCORE A2	SCORE A3	SCORE A4	SCORE B	SCORE C	REGIONAL WEIGHT (based on % of compliance at a regional level- horiz. Output)
15					COUNTRY RESULT FROM REGIONAL EXPERTS			
16		SCORE A1	SCORE A2	SCORE A3	SCORE A4	SCORE B	SCORE C	REGIONAL WEIGHT (based on % of compliance at a regional level- horiz. Output)
17	Region1	0	0	0		0	0	
18	Region2	0	0	0		0	0	
19	Region3	0	0	0		0	0	
20	Region4	0	0	0		0	0	
21	Region5	0	0	0		0	0	
22	Region6	0	0	0		0	0	
23	Region7	0	0	0		0	0	
24	Region8	0	0	0		0	0	
25	Region9	0	0	0		0	0	
26	Region10	0	0	0		0	0	
27	Second weight	Weight A1	Weight A2	Weight A3	Weight A4			
28		0	0	0	0			
29	Score subcat A1 - A4	0	0	0	0			
30	Third weight	Weight A				Weight B	Weight C	
31		0				0	0	
32	Score subcat A - B - C	0				0	0	
33	FINAL COUNTRY SCORE	0						

EU food system / 01_Cereals industr class / **Country_01_Elab** / Country_01_Visual / Count

Figure 2.1.2.18 - Visualization of the worksheet necessary to input experts' answers concerning scoring questions.

To input regional experts' answers in the table of figure 2.2.1.18 it is first necessary to create a regional impact value or a regional level of sub-categories impacts. The calculations of these values are in 'Country_01_Elab' as well (figure 2.2.1.19).

Once impacts values have been obtained from countries elaboration worksheets I input them in the worksheet of the final European impact: '01_cereals industr class' (figure 2.2.1.20). Depending on information sources (regional, national or European level) I have different calculations tables (figures 2.2.1.20, 2.2.1.21, 2.2.1.22) working with the same principles already explained through the 'Country_01_Elab' worksheet.

06_Environment

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	X	Y	Z	AB	AC	AD
1	COUNTRY ID	0																							

REGION 1 ID

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	AB	AC	AD
45	NEW ID	50	51	52	53	54	55	56	57	58	59	61	62	63	64	66	67	68	69	79	80	81
46	OLD ID	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E17	E18	E19	E20	E22	E23	E24	E25	E22b	E23b	E25b
47	Experts' answers score																					
48	First weight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
49	Value to aggregate with magnitude criteria	0			0		0					0				0				0		
50	Second weight	Weight A1			Weight A2		Weight A3															
51		0			0		0															
52	Score	0																				
53	Third weight	Weight A										Weight B				Weight C				Weight C		
54		0										0				0				0		
55	Regional Impact score	0																				

ENVIRONMENTAL CATEGORIES (REGIONAL LEVEL)

A	weight	B	weight	C	weight
A1		E17		E22	
A2		E18		E23	
A3		E19		E24	
E6		E20		E25	

A1	E7
	E8
A2	E9
	E10
A3	E11
	E12
	E13
	E14
	E15

Sheet tabs: EU food system | 01_Cereals industr class | **Country_01_Elab** | Country_01_Visual | Country_01_sources | Country_02_Elab

Figure 2.1.2.19 - Visualization of the worksheet necessary to input experts' answers concerning regional scoring questions.

Figure 2.1.2.20 - Visualization of the worksheet necessary to obtain a European impact value by inputting European experts' answers impact values.

Figure 2.1.2.21 - Visualization of the worksheet necessary to obtain a European impact value by inputting countries' impact values from regional impacts aggregation.

Figure 2.1.2.22 - Visualization of the worksheet necessary to obtain a European impact value by inputting national experts' answers impact values.

2.1.3 The impact assessment procedure step by step

Before explaining the operational steps to obtain the final impact table, the user should know which outputs the 'horizontal part' has to deliver to allow the functioning of the model 'vertical part'.

Outputs provided by the 'horizontal part':

a. Sector analysis to demonstrate that the bigger part of the food supply chain affected by the new proposal is in EU.

b. Sector analysis to select European countries that with their productive systems produce more than 50% of European value added of each supply chain stage.

c. Legislative act (PDF files) requiring the impacts assessment.

d. Number and type of productive system actors affected by the legislative proposal.

e. Number and type of productive system actors complying with the new proposal requirements.

f. Scale factor (related to the proposal of point c): dimension of enterprises classes' compliance given by the product between number of complying companies and number of their workers (Excel file).

g. Experts support files (PDF) displaying:

   1) summary of the proposal;
   2) graphs and tables about the number of enterprises complying with the proposal's requirements separated by enterprise dimension and by a specific spatial boundary (region, country, EU);
   3) description of changes affecting enterprises' production processes induced by the proposal.

Steps of the impact assessment procedure (vertical procedure):

1. Read all domains reports in the main folder '01_Impact Assessment System Reports'. Every report displays the domain's definition, the description of factors leading to an impact on the specific domain (domain's categories and sub-categories definitions) and the domain impact assessment modelling theory and calculation procedure.

2. Upload on a server, by means of 'LimeSurvey' software, on-line questionnaires prepared for every domain (figure 2.1.3.1). Once uploaded the surveys' files activate them.

3. Identify for every domain suitable experts in order to obtain answers to ranking and scoring questions. If a permanent list of experts cannot be created, follow indications in domains reports and the 'Questions classification' file (column sources) to create the list of contacts. Select a single person contact and not the general agency contact details. The number of experts depends on the type of domain and on the impact assessment analysis level (regional, national, European).

4 By use of the template in folder '01_Expert_acceptance_request' send a first mail/e-mail to every selected expert asking for his participation to the on-line survey. Experts welcoming the request and answering back within one week (specified in the mail) will be part of the evaluation process.

LimeSurvey

Administration -- Logged in as: admin

Surveys: Regional environmental impact

None
Active
Environmental impacts of new EU food policies...
Environmental impacts of new EU food policies...
Regional environmental impacts of new EU food...
Inactive
Direct monetary Consequences
Direct not-monetary consequences
Diseases related to sociological factors
Expert IR
Firm Competition
Firm Competition I
Firm Competition II
Food production & Consumption related problem...
Privat Institution IR
Public Institution IR
Respiratory Effects

Survey Regional environmental impacts of new EU food policies (ID:29565)

Question groups:

Title: Regional environmental impacts of new EU food policies (ID 29565)
Survey URL (English): http://www.gruese.de/limesurvey/index.php?sid=29565&lang=en
Description: Dear Expertwe are pleased to lead you through the steps of the questionnaire filling procedure: Answe state of the environment; Read the summary of Dir. 2009/128/EC with the suggested focal points an analysis; Answer the impact questions in respect of Dir. 2009/128/EC possible effects. Read the summ Information to Consumers" with the suggested focal points (focus on food allergens) and the affected Answer the impact questions in respect of Reg. proposal "on the Provision of Food Information to Cons referred to the REGIONAL situation, likewise should be the answers!!! Do not hesitate to contact your can support you, elucidate a specific impact question or provide an answer: it is possible to buffer answers to continue survey at a later time. The computational model will focus on "major relevant impacts", hence, even if the level of uncertainty of your answer is extremely high, provide it! A question is concerning the uncertainty level of expert's answers to signal whether or not a calculated impact wil be a reliable information.
Welcome:
Administrator: Emanuele Novelli (emanuele.novelli@uni-bonn.de)
Fax to: 0049 228 73 3431
Start date/time: -
Expiry date/time: 16.12.2010 23:59
Template: custom_emanuele
Base language: English
Additional languages: Italian
Exit link: Survey on impacts of new EU food policies
Number of questions/groups: 27/4
Survey currently active: Yes
Survey table name: lime_survey_29565
Hints: Answers to this survey are anonymized.
It is presented group by group.
It uses cookies for access control.
Participants can save partially finished surveys
No email notification
Regenerate question codes: [Straight] [By group]

Figure 2.1.3.1 – Step 2: upload and activation of the on-line questionnaire.

5   Send an e-mail (use template in 'Procedure explanation' folder) to experts of point four with the following elements (all in 'Support files' folder):

- short introduction to the impact assessment procedure.
- IA_system_model_overview (in 'Procedure explanation' folder) PDF file in attachment;
- legislative act's PDF file in attachment;
- PDF Support files in attachment;
- link to access the web-page with the on-line questionnaire;
- deadline for the answers submission.

Alternatively to the email, on request of the expert, the questionnaire can be provided on paper and sent by post. The paper questionnaire template is in the folder '03_Questions'. I suggest to contact the expert telephonically after that half of the available submission time passed; in this way some questionnaire filling problems can be prevented. Experts should have at least one month for answers submission.

6   Create a folder with the name of the evaluated proposal; copy the Excel files 'Productive system description' and the 6 Excel files of the folder '02_Elaboration files' from the main folder '03_Impacts elaboration system'. Paste them in the new folder with the name of the legislative proposal.

7   Open the copied Excel files of the IAS in the suggested order:
(a)   productive system description;
(b)   the 6 Excel files of the folder '02_Elaboration files'.

8   Enter the information concerning the scale factor provided by the 'horizontal part' (point 'f' of page 84) in the file 'Productive system description' (figure 2.1.3.2). To input the correct ID, use the files in the main folder '02_Classifications and codes'. The data are automatically uploaded in the Excel elaboration files of the folder '02_Elaboration files'.

Figure 2.1.3.2 - Step 8: horizontal output data denomination entry (Excel file 'Productive system description').

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	INFORMATION COMING FROM THE HORIZONTAL PART												
2	LIST THE PRODUCTIVE SYSTEM ACTORS												
3	WHEN FILLING USE THE SPATIAL BOUNDARIES CLASSIFICATION												
4													
5	PROPOSAL												
6	ACTORS AT THE MOST DISAGGREGATED INFORMATION FOR THE TOTAL OF THE PRODUCTIVE SYSTEM	Id domain	Domains	Id industry	Industries	Id country	Countries	Id regions (NUTS 1 & 2)	Regions	Id chain stage (NACE REV.1)	Chain Stages	Id Enterprise class	Enterprises Classes
7		E	1	01	1	IT	1	ITC1		CS1 = agricultural holdings		CIa	
8								ITD3		CS2 = 15.61		CLb	
9								ITD4		CS3 = 15.81	5	CLc	4
10								ITD5		CS4 = 52.21		CLd	
11								ITE2		CS5 = 52.24			
12								ITE3	11				
13	TOTAL							ITE4					
14		20						ITF4					
15								ITF5					
16								ITG1					
17								ITG2					
18													

9   After the survey submission deadline passed, extract (figure 2.1.3.4) and collect (figure 2.1.3.5) all answers, domain by domain, in the worksheet 'Country_0x_Visual' (Excel files indicated in step 6 c). While filling experts' answers input the source reference in the worksheet 'Country_0x_sources'.

10   Transfer then answers' impact values in the worksheets of the same Excel files denominated 'Country_0x_Elab' (figure 2.1.3.6). A series of formulas automatically match weights partly given by the 'horizontal part' output with the impact values (figure 2.1.3.7). Depending on the impact assessment analysis level, I obtain the correspondent domain final impact value.

11   Through codes' links from file to file built the reference code. Use Excel conditional formatting function or Power Point to display the impacts results with the format of figure 2.1.3.3.
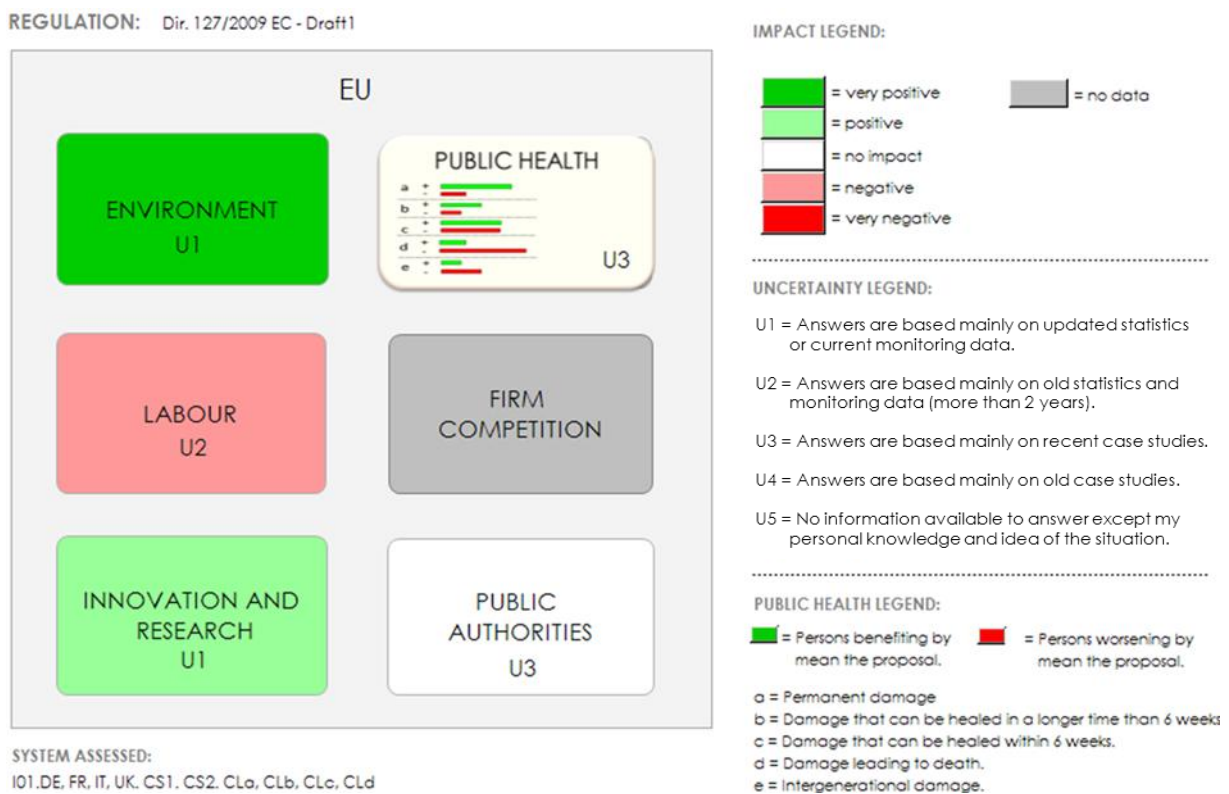
Figure 2.1.3.3 - Step 11: output visualization.

Figure 2.1.3.4 - Step 9: experts' answers extraction.

Row	NEW ID	OLD ID	C	D	E	F	HIGHLIGHT THE ANSWER	Reg 1		Reg 2		Reg 3		Reg 4		Reg 5		Reg 6		Reg 7		Reg 8		Reg 9		Reg 10	
60			COUNTRY																										
61							EU	Reg 1		Reg 2		Reg 3		Reg 4		Reg 5		Reg 6		Reg 7		Reg 8		Reg 9		Reg 10	
62				Increase	-1	C	the probability of ecosystem acidification / eutrophication due to nitrogen oxides (NOx)?	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C
63	50	E6	Will the proposal	Not influence	0	B		0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B
64				Decrease	1	A		1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A
68				Increase	-1	C	the probability of ecosystem acidification / eutrophication due to sulfur oxides (SOx)?	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C
69	51	E7	Will the proposal	Not influence	0	B		0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B
70				Decrease	1	A		1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A
74				Increase	-1	C	the probability of ecosystem acidification / eutrophication due to ammonia (NH3)?	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C
75	52	E8	Will the proposal	Not influence	0	B		0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B
76				Decrease	1	A		1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A
80				Increase	-1	C	the probability of ecosystem ecotoxicity due to heavy metals bioaccumulation?	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C
81	53	E9	Will the proposal	Not influence	0	B		0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B
82				Decrease	1	A		1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A
86				Increase	-1	C	the probability of ecosystem ecotoxicity due to pesticides residues bioaccumulation?	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C
87	54	E10	Will the proposal	Not influence	0	B		0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B
88				Decrease	1	A		1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A
92				Increase	-1	C	the amount of built up land?	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C
93	55	E11	Will the proposal	Not influence	0	B		0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B
94				Decrease	1	A		1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A
98				Increase	1	A	the amount of protected natural land (forestry, pastures)?	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A
99	56	E12	Will the proposal	Not influence	0	B		0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B
100				Decrease	-1	C		-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C
104				Increase	1	A	crop land?	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A
105	57	E13	Will the proposal	Not influence	0	B		0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B
106				Decrease	-1	C		-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C
110				Increase	-1	C	land with high soil erosion?	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C
111	58	E14	Will the proposal	Not influence	0	B		0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B
112				Decrease	1	A		1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A	1	A
116				Increase	-1	C		-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C	-1	C

Sheet tabs: Country_01_Visual | Country_01_sources | Country_02_

Figure 2.1.3.5 - Step 9: experts' answers collection (experts' answers highlighted in yellow).
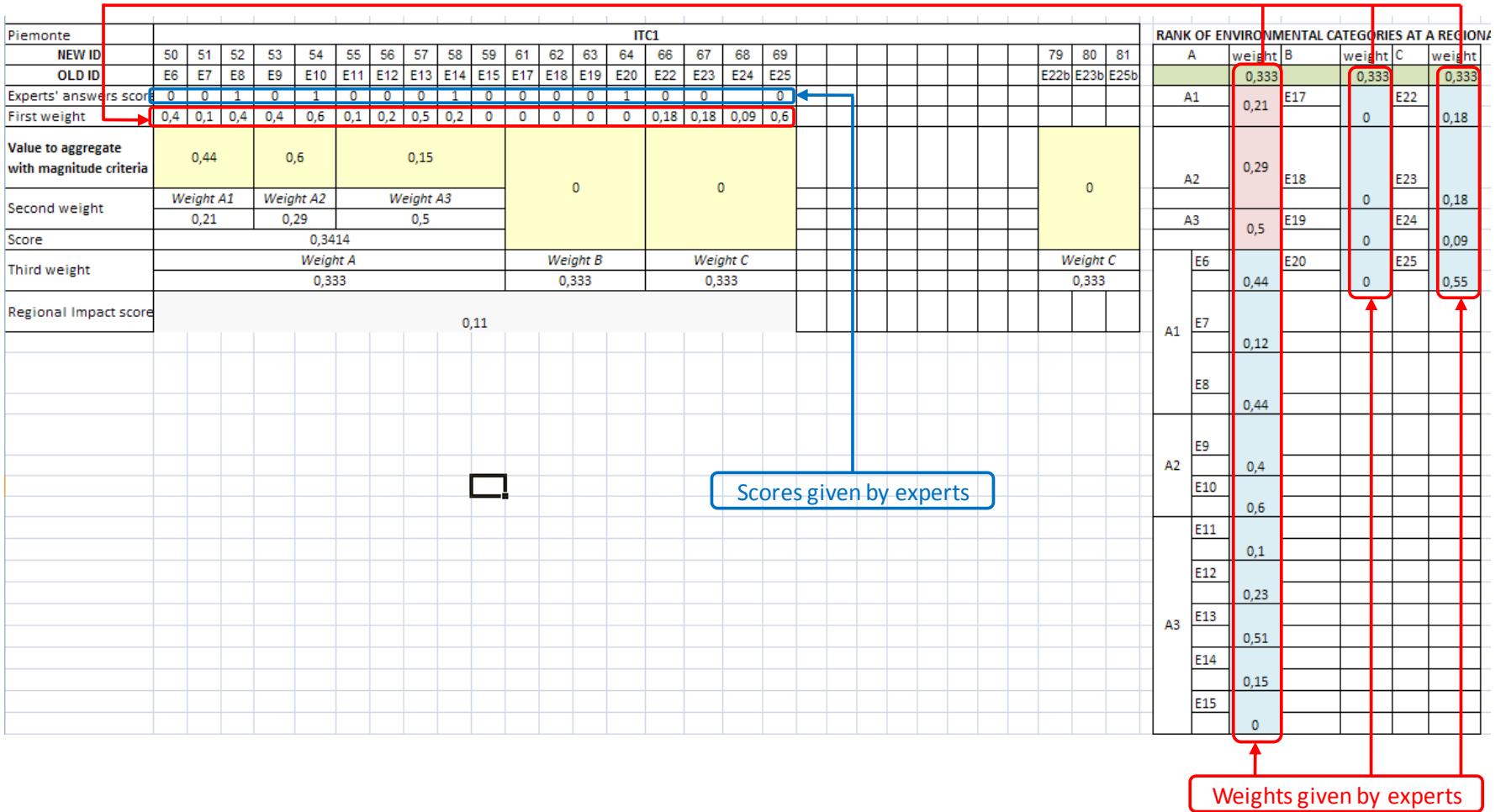
Figure 2.1.3.6 - Step 10: experts' answers elaboration.

Piemonte									ITC1													79	80	81
NEW ID	50	51	52	53	54	55	56	57	58	59	61	62	63	64	66	67	68	69				79	80	81
OLD ID	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E17	E18	E19	E20	E22	E23	E24	E25				E22b	E23b	E25b
Experts' answers score	0	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0						
First weight	0,4	0,1	0,4	0,4	0,6	0,1	0,2	0,5	0,2	0	0	0	0	0	0,18	0,18	0,09	0,6						
Value to aggregate with magnitude criteria	0,44			0,6			0,15			0					0							0		
Second weight	Weight A1			Weight A2			Weight A3																	
	0,21			0,29			0,5																	
Score	0,3414																							
Third weight	Weight A						Weight B				Weight C									Weight C				
	0,333						0,333				0,333									0,333				
Regional Impact score	0,11																							

RANK OF ENVIRONMENTAL CATEGORIES AT A REGIONAL

A		weight	B	weight	C	weight
A		0,333		0,333		0,333
A1		0,21	E17	0	E22	0,18
A2		0,29	E18	0	E23	0,18
A3		0,5	E19	0	E24	0,09
	E6	0,44	E20	0	E25	0,55
A1	E7	0,12				
	E8	0,44				
A2	E9	0,4				
	E10	0,6				
A3	E11	0,1				
	E12	0,23				
	E13	0,51				
	E14	0,15				
	E15	0				

Scores given by experts

Weights given by experts

		SCORE A1	SCORE A2	SCORE A3	SCORE A4	SCORE B	SCORE C	REGIONAL WEIGHT (based on % of compliance at a regional level- horiz. Output)
15								COUNTRY RESULT FROM REGIONAL EXPERTS
17	Region1	0,44	0,6	0,15		0	0	0,08
18	Region2	0	0,7	0,1		0	-0,27	0,11
19	Region3	0,8	0,67	0		0,92	0,2	0,03
20	Region4	1	1	0,21		0	0	0,11
21	Region5	0,68	0,71	0,45		0,24	0,13	0,03
22	Region6	0	0,67	0		0	0	0,06
23	Region7	0,89	0,5	0,33		0	0	0,03
24	Region8	0	1	0,32		0,38	1,055	0,12
25	Region9	0	0	0		0	0,16	0,06
26	Region10	1	1	0		0	0,65	0,09
27	Second weight	Weight A1	Weight A2	Weight A3	Weight A4			
28		0	0	0	0			
29	Score subcat A1 - A4	0,310912	0,5425992	0,1093681	0			
30	Third weight		Weight A			Weight B	Weight C	
31			0			0	0	
32	Score subcat A - B - C		0			0,085517	0,175816	
33	FINAL COUNTRY SCORE			0				
34								

Horizontal process output

FINAL DOMAIN IMPACT

Figure 2.1.3.7 - Step 10: experts' answers elaboration: final domain impact.

2.2   The Analysis of the Impact Assessment System

To analyse whether the new impact assessment here presented can better support the food policy maker in his decisional process I proceed with three operations. Each operation corresponds to one of the sections of paragraph 2.2.

The first analysis step consists in testing the new IAS by means of case studies; I want to see if the assessment procedure presents functioning problems and, in case of emerging issues, I want to define them and propose solutions. The second section illustrates a simulation framework with the objective of visualizing the range of possible impact values the model creates. Once obtained the range of potential values, or impact values distribution for a given set of variables, it is possible to better understand to which conditions and uses the model suits. Finally, the third section of the paragraph addresses potential users and it consists of interviews submitted to members of the Directorates-General (hereafter DG) or Departments of the European Commission. The objective of this section is to understand whether for the food legislative proposals the new IAS could be used as alternative in respect of part of the existing EC IAS or as complementary method.

2.2.1   The case studies

In accord with the researcher in charge of the 'horizontal part' of the model, I decided to use two case studies to test the correct functioning of the new IAS. The two case studies concern, respectively, the Directive 2009/128/EC of the 21st of October 2009 'Establishing a framework for Community action to achieve the sustainable use of pesticides' and the European Commission Proposal of Regulation of 30th January 2008 'On the provision of food information to consumers'. Two constraints are present in the testing of the new IAS for both legislative acts proposed; the first constraint consists of the test of a single domain, namely the Environment. In other words, among potential impacts reported in the output table and originated from the proposals, only the Environment has been considered.

The other constraint concerns the limitation of the food supply chain to which both proposals apply. More specifically, the 'horizontal part' of the model, corresponding to the enterprises' classes compliance information, has been limited to the cereals industry leaving out the meat, the milk and dairy products, the fruits and vegetables and the fish industries. Consequently, the case study considers proposals' consequences strictly related to the cereals supply chain.

The choice of considering a single domain and a single industry in the test evaluation is due to time and resources constraints for the analysis. In both cases data availability played a relevant role: the existence of a European network of environmental agencies allows the user to collect information on a highly disaggregated level. Moreover the Environment Domain could easily highlight potential consequences deriving from the Directive 2009/128 EC.

One more specificity of the case study is about the classification of the supply chain stages through which the enterprises' compliance information is provided by the horizontal part of the IAS; instead of using the conversion table based on NACE Rev.2 of figure 2.1.2.5, the input of the horizontal part is provided through a conversion table based on NACE Rev.1. In the latter conversion table, CS1 corresponds to primary producers (agricultural holdings), CS2 to first processors, CS3 to second processors, CS4 to wholesalers and CS5 to retailers.

Next chapter provides the accurate description of the case studies framework and their outcomes.

2.2.2 Simulation

By means of the simulation software ExtendSim I modelled the impact calculation system. The software allows as well to input random values having the role of artificial experts' answers. By running the simulation I aim at obtaining a distribution of the output values or domains' impact values.

The simulation regards the Environment domain outputs from different perspectives or scenarios:
1) Regional inputs to obtain a regional Environment domain impact.
2) Regional inputs to obtain a national Environment domain impact.
3) Regional inputs to obtain a European Environment domain impact.

The algebraic module to proceed with the calculation is the regional inputs to obtain a regional output (number one). This module is formed by eighteen questions for the impact direction (corresponding to experts' answers on proposal's consequences) and by 26 questions for the category or impact severity. For the first type of question, possible values are +1, 0, and 1, while, for the second type of question, possible values are decimal numbers between 0 and 1. Every time the simulation runs I obtain through the software one thousand outputs values, hence the model works one thousand times, inputting for each run completely new values.

In order to visualize the outputs distribution, I will run the simulation twenty times. For every run, I will record the percentage of values that produce extreme impact values (labels very positive and very negative with values above 0,5 or below -0,5), normal impact values (labels positive with values between 0,25 and 0,499 and negative with values -0,25 and -0,499) and no impact values (label no impact with values between -0,249 and 0,249) in respect of the total (1000 impacts values for every run).

By observing these percentages I know how robust is the model, or in other words how often I obtain same impact values although varying the initial inputs. Random values for categories' severity/weight inputs are generated following a uniform real distribution (figure 2.2.2.1) with minimum value 0 and maximum value 1.
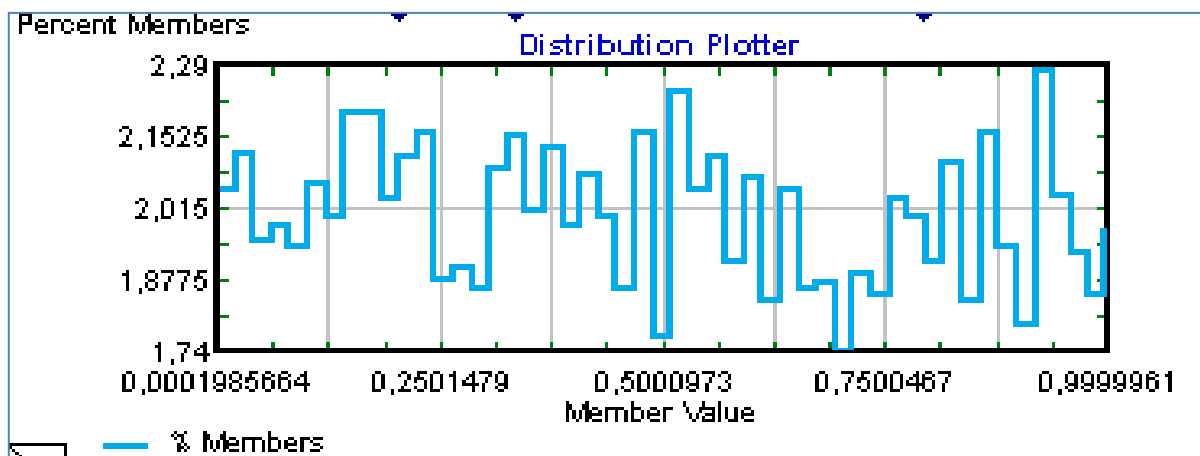
Figure 2.2.2.1 – Graph of generated random values through the uniform real distribution for categories' relevance inputs.

The impact direction values are generated by means of a function assigning the same extraction probability to all possible answers (figure 2.2.2.2).
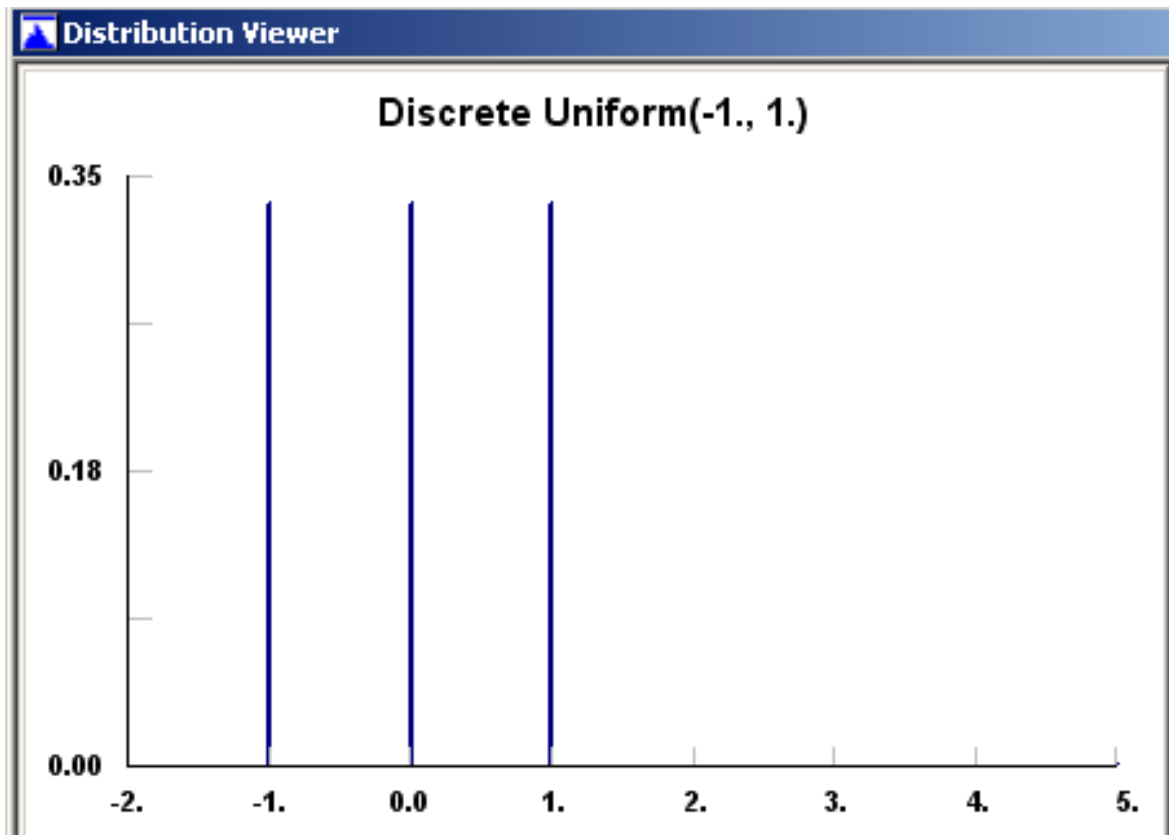
Figure 2.2.2.2 – Distribution function generating random values for the domain's impact direction questions.

Through the simulation, I want to see also how the domain impact values' distribution changes in respect of the variations of the number of categories or impact direction values inputted. Moreover, I want to see how the variation of the number of regions influences the country results. In doing so I record the means and the standard deviation output values for every of the scenarios afore described.

In building the scenarios two and three I use the module of scenario one. Detailed information on the simulation is in the chapter 'Results'.

2.2.3 Interviews to European Commission members

To understand whether or not the new IAS has a potential for future use, I decided to directly address prospective users as members of the DGs of the European Commission. The final goal of this third testing step is to collect experts' opinions on the possibility of the new IAS to overcome evaluation problems part of the current IAS adopted by the EC or to complement it.

The EC has many DGs responsible for specific issues and knowledge areas. I address those DGs that share the same knowledge area connected to the domains of impact in the output table. Within the single DG there are different sections; each of them is specialized in one of the functions that make operational the whole system of the DG. One of these sections is usually in charge of the Impact Assessment procedure and of the drawing up of the Impact Assessment Report (IAR). This section, if not directly affected by the effect of the proposal, should provide impact information to the other DGs' impact assessment sections requiring it. Differently, the section of the DG in charge of the IAR, should actively promote the Impact Assessment if its DG is the one bringing the new proposal at the EC attention, hence being the main proposal author. In the latter case this section is contacting and requiring information to other DGs impact assessment sections.

The target of my interviews were members of the impact assessment sections of DGs Environment (ENV), Enterprise and Industry (ENTR), Health and consumers (SANCO), Regional Policy (REGIO), Employment, Social Affairs and Inclusion (EMPL). In inviting experts in a personal consultation, I sent by email a short description of the model features and of the goals of the new IAS. Moreover, I clarified the main points to discuss during the meeting. The latter can be grouped in the following three main themes:

a) utility of the IAS outputs in respect of the current EC Impact Assessment System procedure;

b) utility of the IAS in respect of its use as regulatory strategic tool;

c) time required and costs of current impact assessments.

Starting from the explanation of the model functioning, I then display to the EC experts the case studies results; the latter have been used to compare the IAS procedure here proposed and the one currently used by the European Commission members.

3   Results

3.1   The Case studies Results

For the case studies as well as for the rest of this work I focused on the 'vertical part' of the IAS. Therefore I summarize below the elements available at the end of the 'horizontal part procedure' necessary to elaborate the impact of the two legislative acts on the Environment Domain, or in other words, necessary to proceed with the 'vertical part'.

Outputs from the horizontal part procedure:

CASE STUDY 1:

1. Legislative proposal: Directive 2009/128/EC establishing a framework for Community action to achieve the sustainable use of pesticides.
2. Food industry: cereals industry.
3. European countries whom, through their productive systems, produce more than 50% of European value added for each supply chain stage: France, Germany, Italy and United Kingdom.
4. Number and type of productive system actors affected by the legislative proposal: first supply chain stage (CS1); micro, small, medium and large agricultural holdings.
5. Number and type of productive system actors complying with the new proposal: no information available.

CASE STUDY 2:

1. Legislative proposal: Regulation proposal 'On the provision of food information to consumer' (allergens focus).
2. Food industry: cereals industry.
3. European countries that, through their productive systems, produce more than 50% of European value added for each supply chain stage: France, Germany, Italy and United Kingdom.
4. Number and type of productive system actors affected by the legislative proposal: third, fourth and fifth supply chain stages (CS3, CS4, and CS5); micro, small, medium and large enterprises.

5. Number and type of productive system actors complying with the new proposal: no information available.

Since the model shows environmental pressures provoked by enterprises complying and given the fast nature of the assessment, the 'horizontal part' operated a sector analysis to select the countries representing with their companies 'activity more than 50% of the created total value added of the cereals' supply chain in Europe. The same concept has been applied for the regions selection within the Member State context; it follows that I need experts' opinions of those regional environmental agencies located in regions whose productive system together represent more than 50% of the created total value added of the cereals' supply chain in the Member State.

For the two case studies I contacted all in all 61 experts (figure 3.1.1). In the figure, experts, who accepted after a first mail request without submitting the questionnaire's answers by the dead-line agreed upon, are in blue; differently, the yellow colour highlights experts that submitted the filled survey concerning the environmental impacts of the proposed legislations.

The evaluation procedure I described in chapter 'Method' suggests for the IAS the use of the same spatial boundaries level to collect inputs. However, in assessing the Environment domain impact (figure 3.1.1), I used different NUTS levels to gather inputs; this was due to the different geographical boundaries dimensions where regional environmental agencies operate. In fact, the DG Environment can rely on a network of regional environmental agencies to collect environmental data and to monitor the state of the European environment. The last observation drove me to opt for the regional environmental agency as functional unit of inputs collection. More specifically, to gather regional experts' views on the two proposals' impacts, I addressed managers of regional environmental agencies of countries selected through the 'horizontal part' of the IAS process; when I could not reach the manager I addressed the responsible for the Strategic Environmental Assessment within the regional agency structure.

As explained in chapter 'Method', the environmental impact assessment here proposed offers several impact outputs depending on two factors:

a. the level of detail required by the client;
b. the information availability.

Figure 3.1.1 - List of environmental agencies contacted for the vertical procedure.

EU							
Indipendent European expert from SEI (Stockholm Environment Institute)							
ITALY		GERMANY		FRANCE		UK	
National expert from ISPRA		National expert from Umwelt BundesAmt		National expert Ministère de l'écologie		National expert from FERA	
Agencies denomination	Region denomination	Agencies denomination	Region denomination	Agencies denomination	Region denomination	Agencies denomination	Region denomination
Agenzie Regionali Per l'Ambiente	1 Piemonte	Umwelt LandesAmt	1 Baden-Württemberg	Direction Régionale de l'Environment de l'Aménagement et du Logement	1 Basse-Normandie	Environmental agencies	1 Southern
	2 Lombardia		2 Bayern		2 Champagne-Ardenne		2 Thames
	3 Veneto		3 Brandeburg		3 Picardie		3 South West
	4 Friuli-Venezia Giulia		4 Hessen		4 Haute-Normandie		4 Midlands
	5 Emilia-Romagna		5 Mecklenburg-Vorpommern		5 Centre		5 Anglian
	6 Toscana		6 Niedersachesen		6 Basse-Normandie		6 Wales
	7 Umbria		7 Nordrhein-Westfalen		7 Bourgogne		7 North West
	8 Marche		8 Rheinland-Pfalz		8 Nord - Pas-de-Calais		8 North East
	9 Lazio		9 Sachsen		9 Lorraine		9 Northern Ireland
	10 Abruzzo		10 Sachsen-Anhalt		10 Franche-Comté		10 Scotland
	11 Puglia		11 Schleswig-Holstein		11 Pays de la Loire		
	12 Campania		12 Thüringen		12 Bretagne		
	13 Basilicata				13 Poitou-Charentes		
	14 Sicilia				14 Aquitaine		
	15 Sardegna				15 Limousin		
					16 Auvergne		
					17 Corse		
	NUTS 2		NUTS 1		NUTS 2		NUTS 1

= Regional agency contacted with no feedback.

= Regional agency confirming the survey partecipation without submitting answers.

= Regional agency confirming the survey partecipation submitting answers.

Figure 3.1.2 – Regional coverage of experts' answers by type of expert feedback (a = Germany; b = United Kingdom; c = France; d = Italy).

The higher is the detail level, the less the uncertainty of the final impact visualized through the output table. By observing figure 3.1.2, one can see that, inputs provided by experts via surveys submission, are few for the following countries: France, England and Germany. Differently almost all Italian regional environmental agencies' experts submitted filled in surveys.

For the latter reason, instead of calculating an unrepresentative European impact value, to test the model I worked only on the Italian impact. By figure 3.1.2 one can see that italian regional environmental experts' inputs are enough to obtain a valuable output from the model; Italian regions, on which experts expressed an impact judgement, cover, in the first case study, (sustainable use of pesticides) 70% of the agricultural land of the whole country and, for the second case study (allergens labelling), 56% of the created value added (indicated by the number of workers of companies in the producing and processing sectors) of the three italian chain stages affected by the proposal of regulation. Both values are relevant for the impacts aggregation meaning (environmental pressures expressed by experts' answers) from the regional level to the national one. As previously stated, the scale factor, or productive system magnitude of one region, determines the weight of the environmental expert impact opinion when aggregated with other regional impacts values. If I obtain experts' opinions upon regions that with their scale represent less than 50% of the national productive system, the aggregated impact at the Member State level has no significance because the bigger part of the productive system has been excluded from the evaluation.

As no enterprises classes' compliance information was available from the 'horizontal part' of the model, I proposed regional experts to answer the questionnaire bearing in mind the 100% compliance hypothesis; in other words they had to consider the regional environmental impact generated by the whole regional productive system complying with the new proposal's requirements. The same hypothesis has been used to aggregate impacts in the case studies: the total amount of arable land of all regional agricultural holdings producing cereals and the total amount of workers of all regional enterprises producing and selling processed cereals products, were the two criteria used to aggregate the regional impacts.

Before displaying the impact results another evaluation point should be highlighted: the final country result. Unfortunately, the Italian national experts did not provide any answer concerning the country state of the environment. Therefore I operated the last impact

aggregation step, from environmental categories impacts to the single country impact, by assigning the same weight to every environmental category. Nevertheless the relative variation of 20% weight (negatively and positively) did not affect the final country impact results in both case studies.

Experts had access to questionnaires related to the two legislative proposals by means of a single web-page. Below (figure 3.1.3) I report the survey opening message, together with the questionnaire filling procedure explanation and the questionnaire structure description, for regional experts.

Regional environmental impacts of new EU food policies

Dear Expert

we are pleased to lead you through the steps of the questionnaire filling procedure:

1. Answer the questions concerning the current regional state of the environment;
2. Read the summary of Dir. 2009/128/EC with the suggested focal points and the affected food productive system context analysis;
3. Answer the impact questions in respect of Dir. 2009/128/EC possible effects.
4. Read the summary of Reg. proposal "on the Provision of Food Information to Consumers" with the suggested focal points (focus on food allergens) and the affected food productive system context analysis;
5. Answer the impact questions in respect of Reg. proposal "on the Provision of Food Information to Consumers" possible effects.

All the questions are referred to the REGIONAL situation, likewise should be the answers!!!

- Do not hesitate to contact your network of expert/colleagues if you think they can support you, elucidate a specific impact question or provide an answer: it is possible to buffer answers to continue survey at a later time.

- The computational model will focus on "major relevant impacts", hence, even if the level of uncertainty of your answer is extremely high, provide it! A question is concerning the uncertainty level of expert's answers to signal whether or not a calculated impact wil be a reliable information.

There are 27 questions in this survey.

A note on privacy
This survey is anonymous.
The record kept of your survey responses does not contain any identifying information about you unless a specific question in the survey has asked for this. If you have responded to a survey that used an identifying token to allow you to access the survey, you can rest assured that the identifying token is not kept with your responses. It is managed in a separate database, and will only be updated to indicate that you have (or haven't) completed this survey. There is no way of matching identification tokens with survey responses in this survey.

ad unfinished survey | Next >> | Exit and clear survey

Figure 3.1.3 – Initial message of the survey concerning regional environmental impacts of the two legislative proposals evaluated.

I created three different types of survey respectively for regional experts, national experts and European experts. Nevertheless, I reintroduced part of the severity questions of the regional survey also in the national survey too to visualize potential contrasting answers.

In figure 3.1.3 one can see that the questionnaire was divided in three parts and five steps. The first part, or group of questions, concerns the state of the environment (Regional, National or European depending on the expert addressed) within a given geographical boundary. The

second questions group concerns impacts generated by the first legislative proposal. The third questions group instead regards impacts generated by the second legislative proposal. The last questions group relates to the survey evaluation and the uncertainty of submitted answers.

Before the second and the third questions groups could be answered, the expert had to read the support files composed by:

1) the proposal summary,
2) the description of the productive system affected by the proposal,
3) the changes and consequences on the production process caused by the proposal.

3.1.1   The pesticides case study

In figure 3.1.1.1 I display the output table of the first case study. Since the evaluation regarded the Environment domain, no impact value is displayed for other domains. The final value elaborated by the assessment system says that no relevant environmental impact originates from the directive 2009/128/EC in Italy.

SYSTEM ASSESSED:
E . I01 . IT (ITC1, ITD3, ITD4, ITD5, ITE2, ITE3, ITE4, ITF4, ITG1, ITG2) . CS1 . CLa, CLb, CLc, CLd.
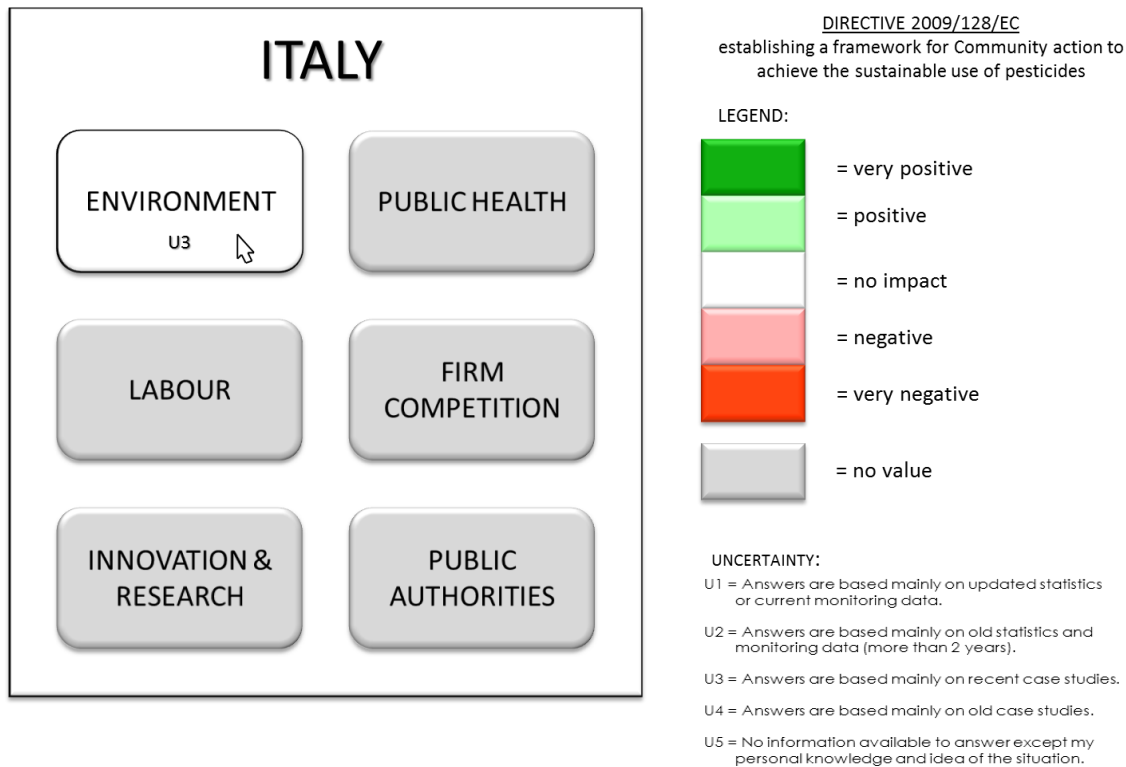
Figure 3.1.1.1 – Output table of the first case study.

As explained in the previous paragraph, the Italian result derives from an average weight, assigned by the analyst, regarding the three active environmental categories displayed in figure 3.1.1.2. Although a 20% variation of the single environmental category's weight did not produce any difference on the impact output labeled results, for weights variation higher than 50%, the impact would switch to 'positive'. Even though the final impact value is not visualized by the output table, the national impact value is 0,20 and therefore close to the upper positive impact label.

Paragraph 2.1.1.4 explained that impact results can be enlarged by two criteria:
- national environmental impacts categories (also defined determinants of impact);

- regional impacts.

By clicking on the Environment label in figure 3.1.1.1 I open the impact value by environmental impact categories. One can observe that the legislative proposal has a positive national impact on the category ecosystem quality deterioration.

SYSTEM ASSESSED:
E . I01 . IT (ITC1, ITD3, ITD4, ITD5, ITE2, ITE3, ITE4, ITF4, ITG1, ITG2) . CS1 . CLa, CLb, CLc, CLd.
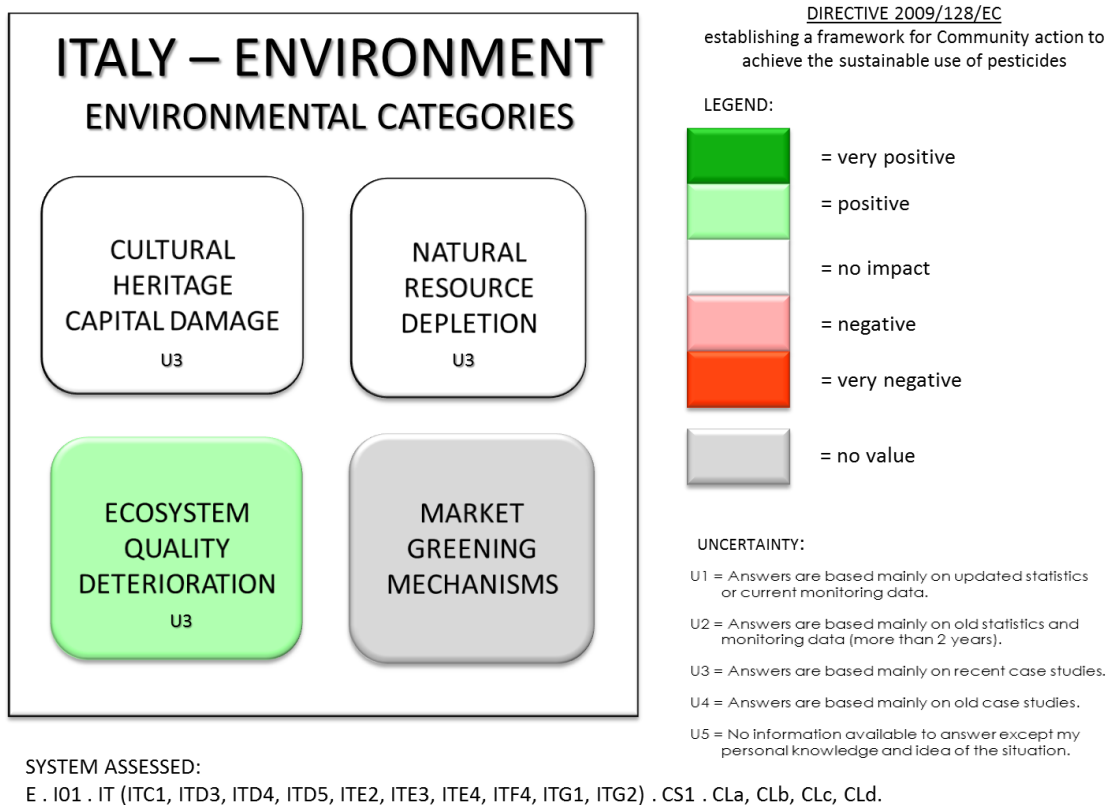
Figure 3.1.1.2 – Output table of the first case study enlarged by environmental category impact.

I can also enlarge the impact information by the geographical boundary criterion, hence by region (figure 3.1.1.3). Here again I needed to assign an average weight value for the regional impact values aggregation because regional experts did not provide the information required through the questionnaires. I applied, in the weights assignment process, the same principle I used for the country impact severity weights.

SYSTEM ASSESSED:
E . I01 . IT (ITC1, ITD3, ITD4, ITD5, ITE2, ITE3, ITE4, ITF4, ITG1, ITG2) . CS1 . CLa, CLb, CLc, CLd.
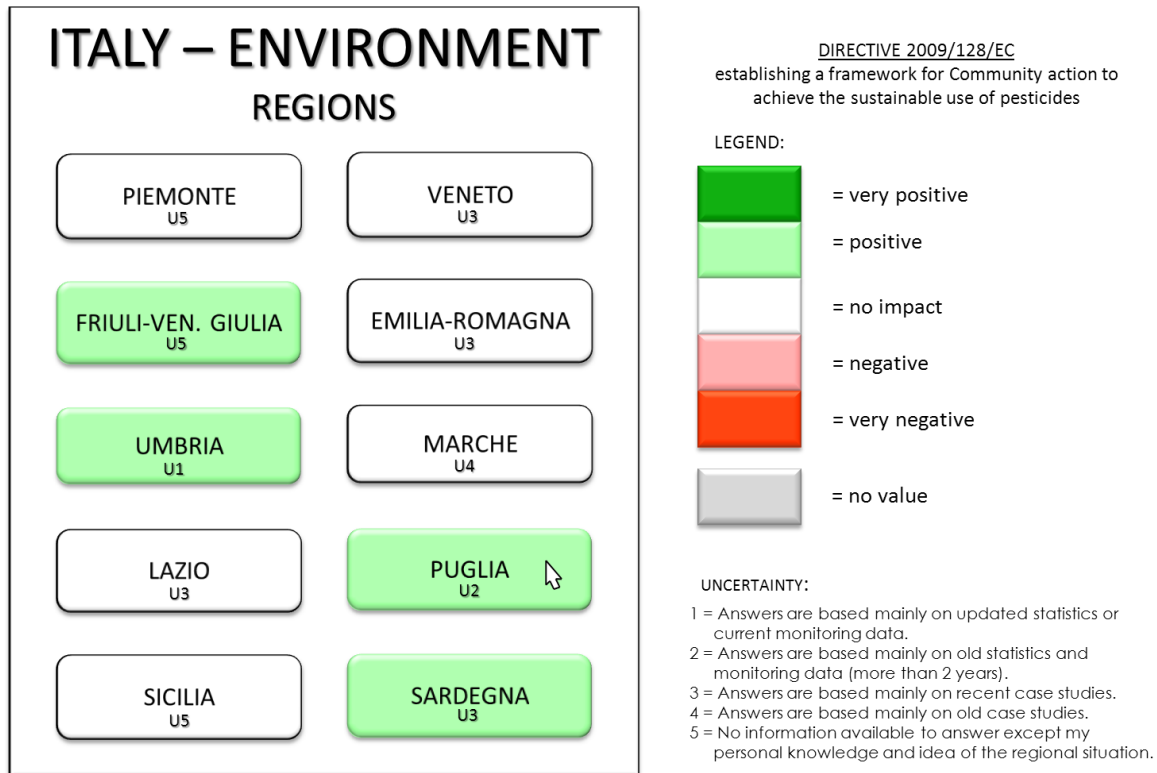
Figure 3.1.1.3 - Output table of the first case study enlarged by regional impact.

Figure 3.1.1.3 illustrates that the legislation does not cause regional negative impacts. By clicking again on one of the region labels I obtain the regional impact values by type of environmental category.

In figure 3.1.1.5 I display the environmental impact categories of Puglia region. Since Puglia region is one of the most important in terms of cereal production in Italy and since the legislation applies to agricultural holdings, the information given by the model could be of relevance for decision makers.

Along the whole results' displaying process the output table updates in every screenshot the reference code of the system evaluated.

The output table of figure 3.1.1.3 corresponds to the first type of operative output of the IAS. The same information can be read as impact map or second type of operative output of the IAS (figure 3.1.1.4).
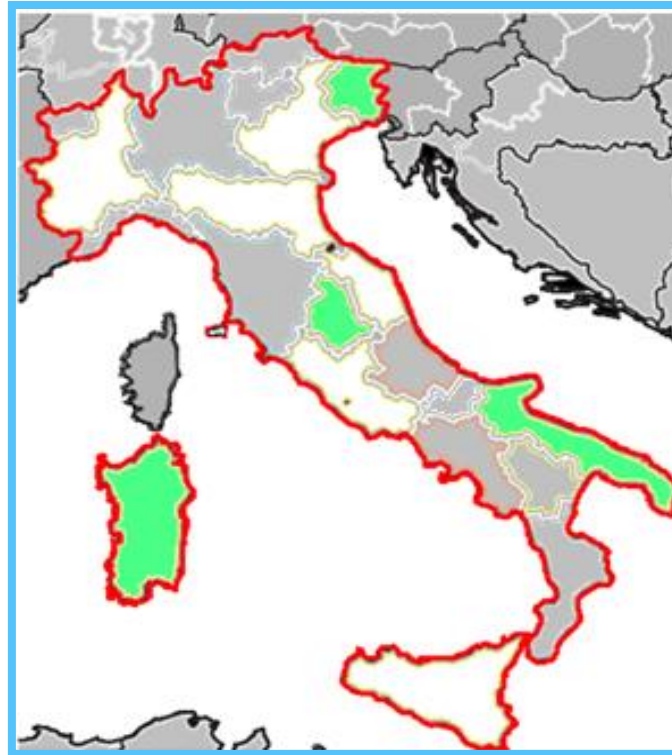
Figure 3.1.1.4 – Impact map of the first case study enlarged by regional impact.
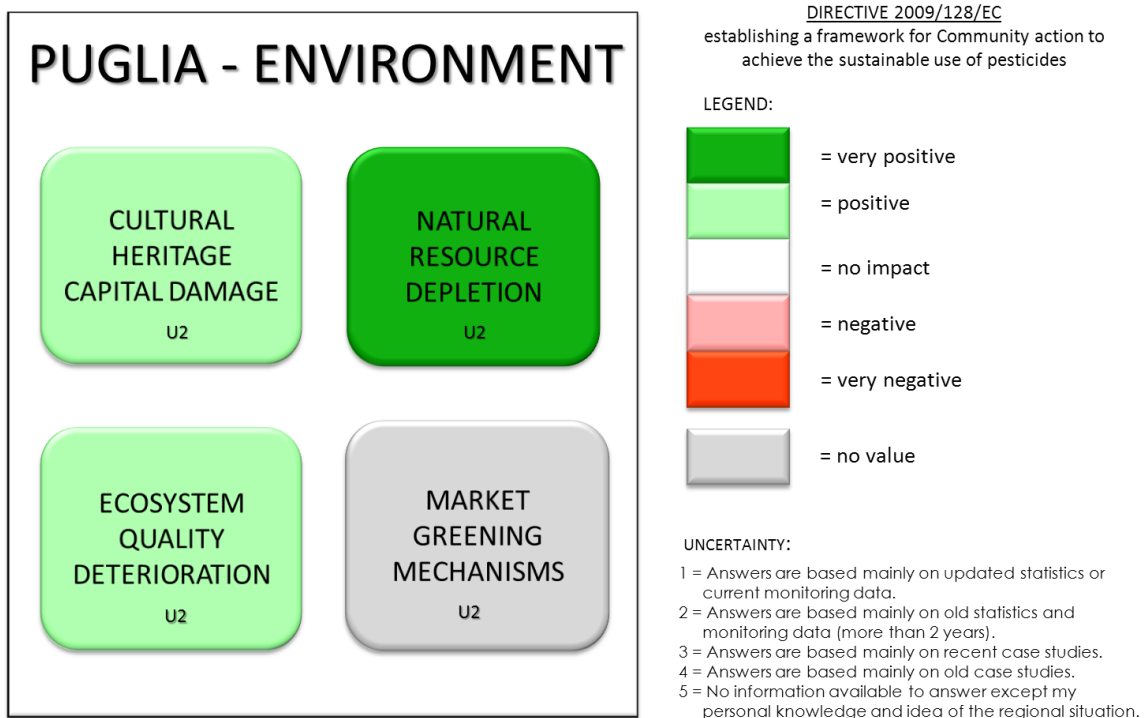
SYSTEM ASSESSED:
E . I01 . IT (ITF4) . CS1 . CLa, CLb, CLc, CLd.

Figure 3.1.1.5 – Output table of Puglia region by category of environmental impact.

The third operative output of the IAS, namely experts' knowledge deficiencies information, tells the client, through the uncertainty indicated by experts' answers, that interaction phenomena between pesticides and environment are known and monitored. This is particularly true for regional agencies displaying positive impacts.

3.1.2 The allergens case study

Figure 3.1.2.1 demonstrates that the regulation proposal 'on the provision of food information to consumer', with a specific evaluation focus on allergens, has no relevant environmental impact. As for the first case study, here too the displayed impact result is not influenced by impact categories weights' variation. The 'no impact' value could be result of two factors:

- the scarce experts' information on the environmental effects of allergens analysis methods (indicated by the high uncertainty level in the Environment domain label).
- the almost inexistent environmental impacts caused by the two retailing chain stages selling loose food products.
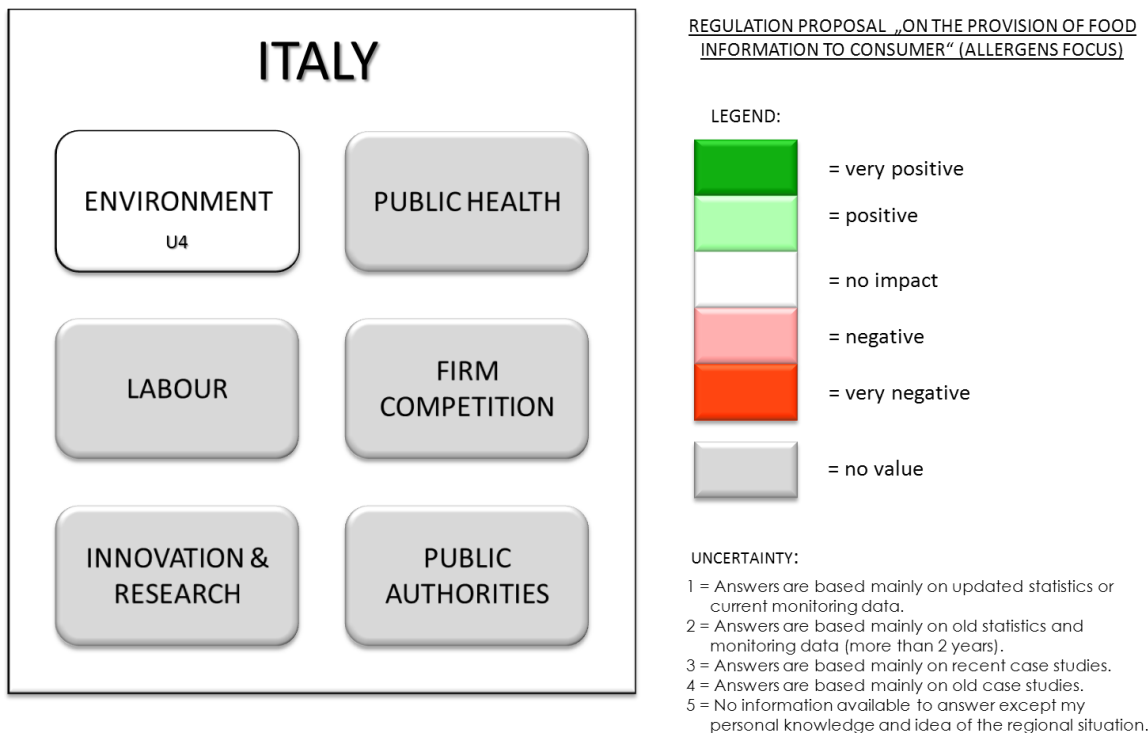
SYSTEM ASSESSED:
E . I01 . IT (ITC1, ITD3, ITD4, ITD5, ITE2, ITE3, ITE4, ITF4, ITG1, ITG2) . CS3, CS4, CS5. CLa, CLb, CLc, CLd.

Figure 3.1.2.1– Output table of the second case study.

Figures 3.1.2.2 and 3.1.2.3 enlarge impact results respectively by environmental category and by region. The first output table indicates the label 'no impact'. Differently, in the second output table, some regions have negative values but with a high uncertainty.
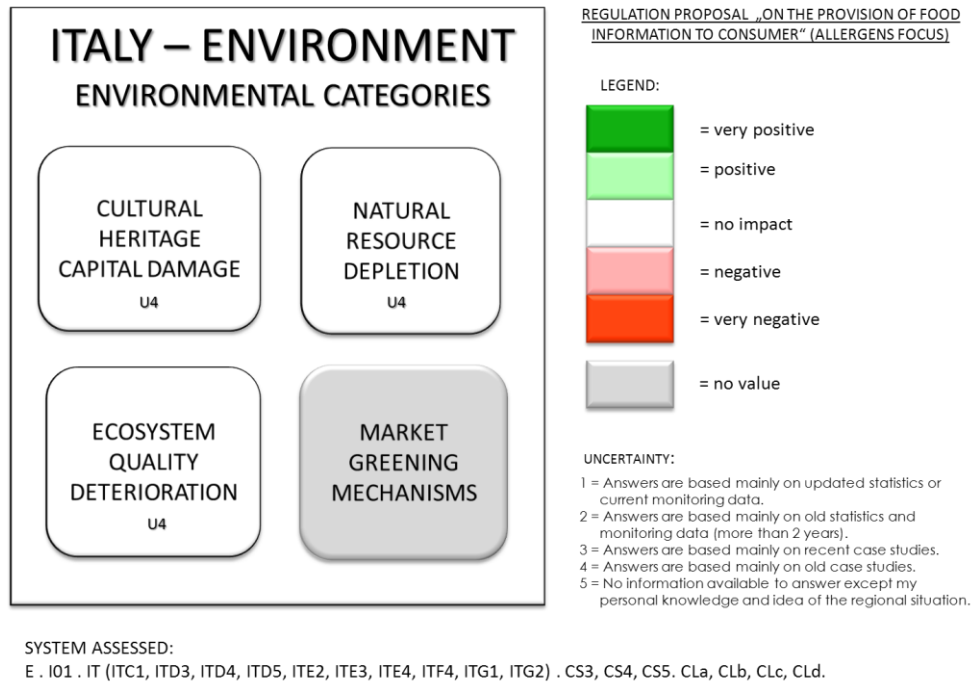
Figure 3.1.2.2 - Output table of the second case study enlarged by category of environmental impact
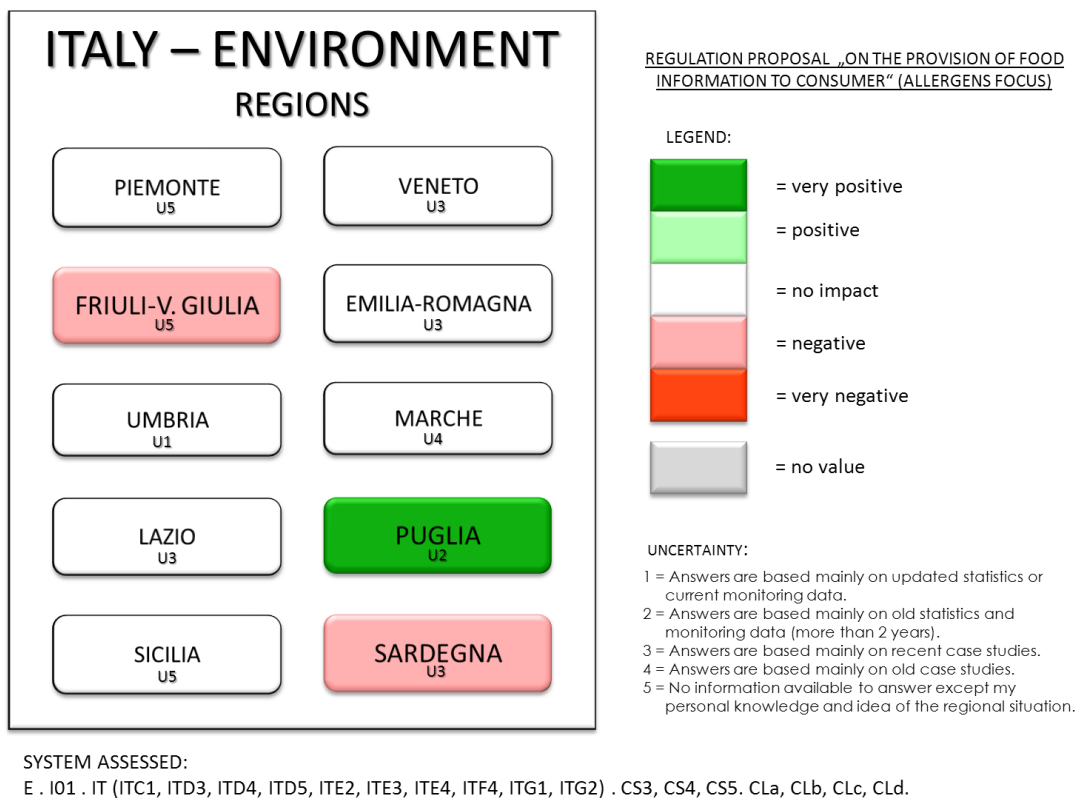
Figure 3.1.2.3 - Output table of the second case study enlarged by regional impact.

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By displaying results through the impact map (figure 3.1.2.4) one can see that Puglia region has a 'very positive' impact. In such a situation the policy maker could further investigate through a quantitative analysis the reasons why the region Puglia has a very positive impact while Sardegna and Friuli Venezia Giulia present negative ones.
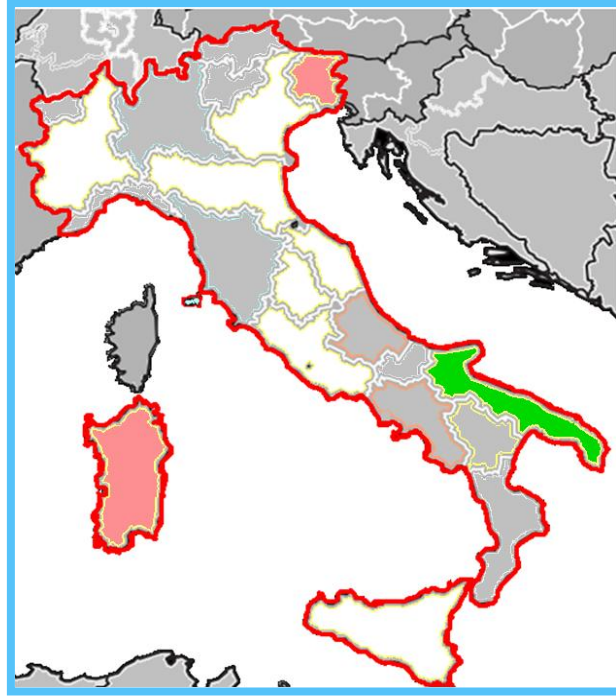
Figure 3.1.2.4 – Impact map of the second case study enlarged by regional impact.

For what concerns the third output of the impact assessment procedure, namely experts' knowledge deficiencies, I can state, by means of the high uncertainty of expert' answers, that regional experts know few on interactions between food allergens and related environmental impacts.

3.2   The Simulation Results

Through ExtendSim software use, I wanted to obtain the Environment Domain outputs for different scenarios:

1) regional inputs to obtain a regional Environment Domain impact;

2) regional inputs to obtain a national Environment Domain impact;

3) regional inputs to obtain a European Environment Domain impact.

The final simulations I carried out are slightly different than the scenarios above mentioned; below I report the main features of the simulations:

SIMULATION ONE (REGIONAL IMPACT SIMULATION – FIRST SCENARIO)

Domain: Environment

Number of simulations run: 20

Total number of final impact values per simulation: 1000

Number of regions: one

Number of questions/values assigning the impact direction value (i): 18

Number of questions/values assigning the category's severity/weight (Se): 26

SIMULATION TWO (COUNTRY IMPACT SIMULATION – SECOND SCENARIO)

Domain: Environment

Number of simulations run: 20

Total number of final impact values per simulation: 1000

Number of regions: 21

Number of questions/values assigning the impact direction value (i): 103

Number of questions/values assigning the category's severity/weight (Se): 363

SIMULATION THREE (COUNTRY IMPACT SIMULATION – ONLY FOUR REGIONS)

Domain: Environment

Number of simulations run: 20

Total number of final impact values per simulation: 1000

Number of regions: four

Number of questions/values assigning the impact direction value (i): 23

Number of questions/values assigning the category's severity/weight (Se): 75

SIMULATION FOUR (COUNTRY IMPACT SIMULATION – ONLY CATEGORY A)

Domain: Environment

Number of simulations run: 20

Total number of final impact values per simulation: 1000

Number of regions: 21

Number of questions/values assigning the impact direction value (i): 63

Number of questions/values assigning the category severity/weight (Se): 203

I decided to limit the simulations to regional and country values, without entering the European ones, because the trend of the impact values' distribution, from one simulation to another, was clear: the higher the number of categories/weight questions, the lower the possibility to obtain extreme impacts labeled as very positive or very negative. The number of categories can increase or by having several regions (with same categories) or by having more categories within the single regional structure of experts' inputs collection.

In the chapter 'Discussion' I explain why the simulation gives such a trend and which conclusions I can draw out of this situation for the model future use.

In figure 3.2.1, 3.2.2, 3.2.3 and 3.2.4 I report the results' plots of the four simulations above described. By means of figure 3.2.5 one can observe that, by increasing the number of severity/weight questions, outputs, resulting in an extreme impact (values higher than 0,5 or below -0,5) and in a normal impact (labels 'positive' with values between 0,25 and 0,499 and 'negative' with values -0,25 and -0,499), decrease. The possibility to obtain an impact value (very negative, negative, positive, and very positive), when using the regional impact system module structure, is roundabout forty percent. Differently, when the number of questions increases, the probability of obtaining an impact decreases to fifteen percent.

Figure 3.2.6 and 3.2.7 display respectively the mean of the 20 impact outputs distributions for the four scenarios and their standard deviation. Both figures confirm the data of the table in figure 3.2.5. The mean impact value, for most of distributions, is higher in the first simulation scenario. The standard deviation results higher in the first simulation scenario, decreasing proportionally from simulation scenario three and four to simulation scenario two, with the growth of questions' number.
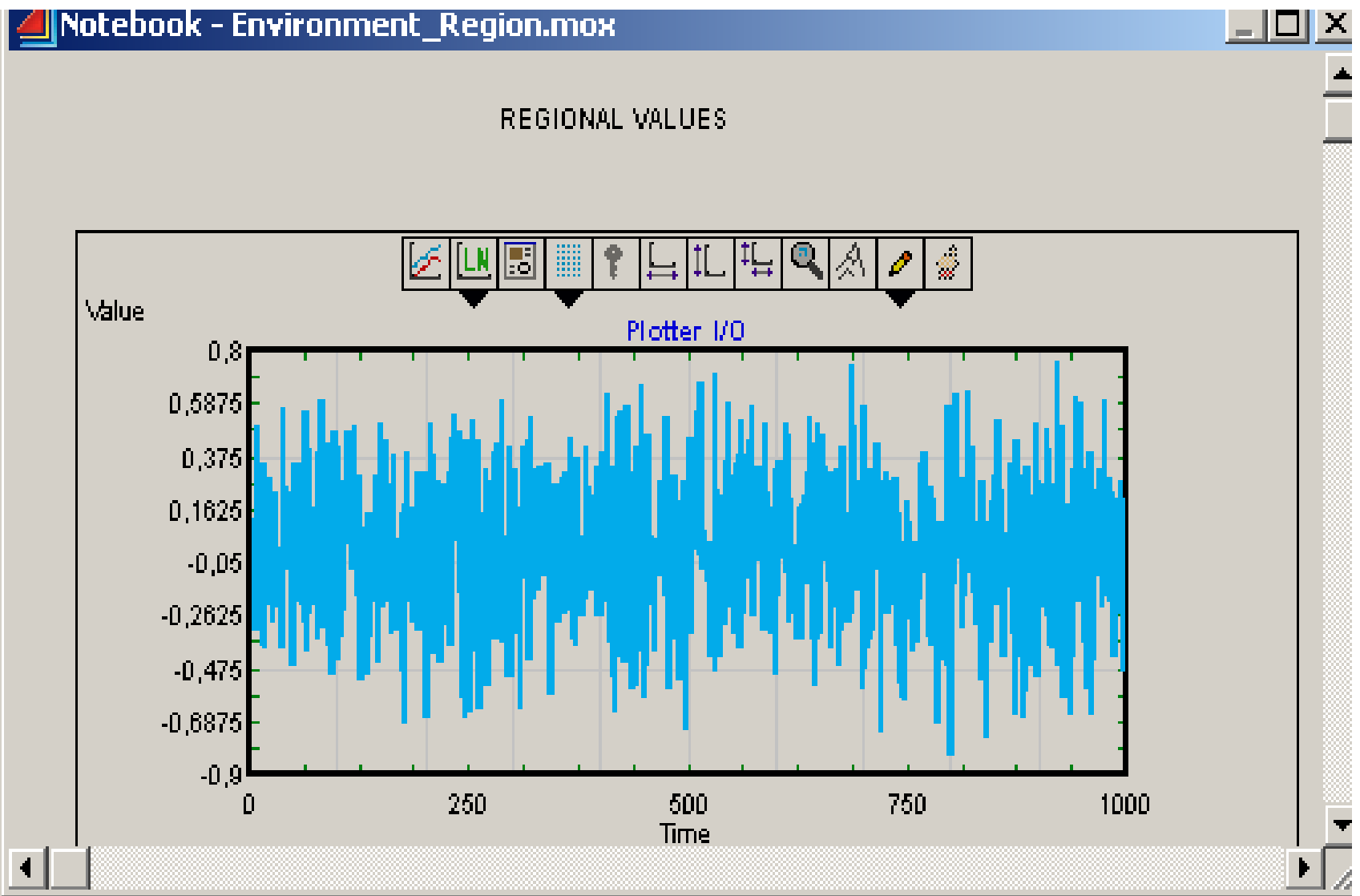
Figure 3.2.1- Results plot of simulation one: potential regional Environment Domain impact values.
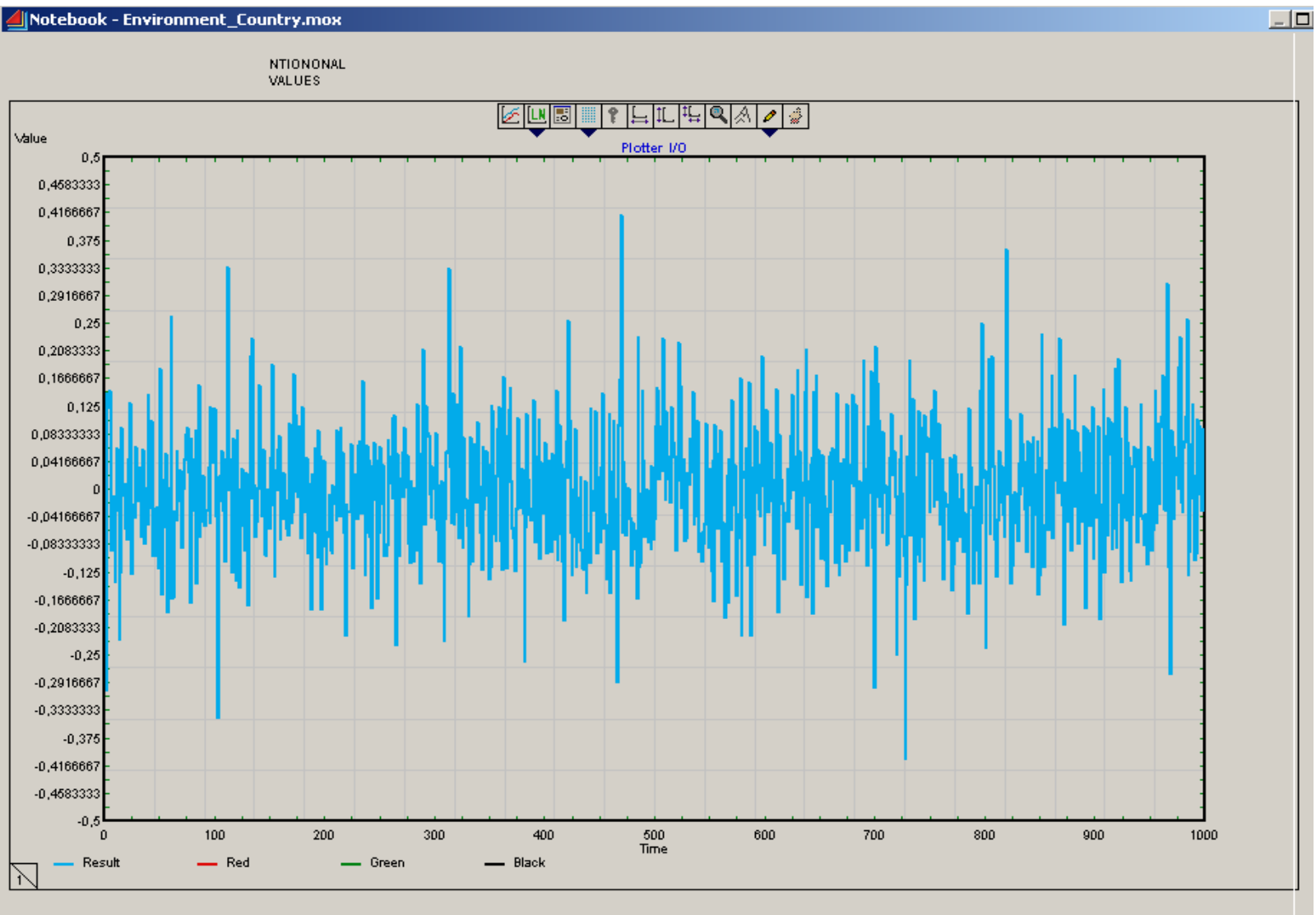
Figure 3.2.2- Results plot of simulation two: potential national (21 regions) Environment Domain impact values.
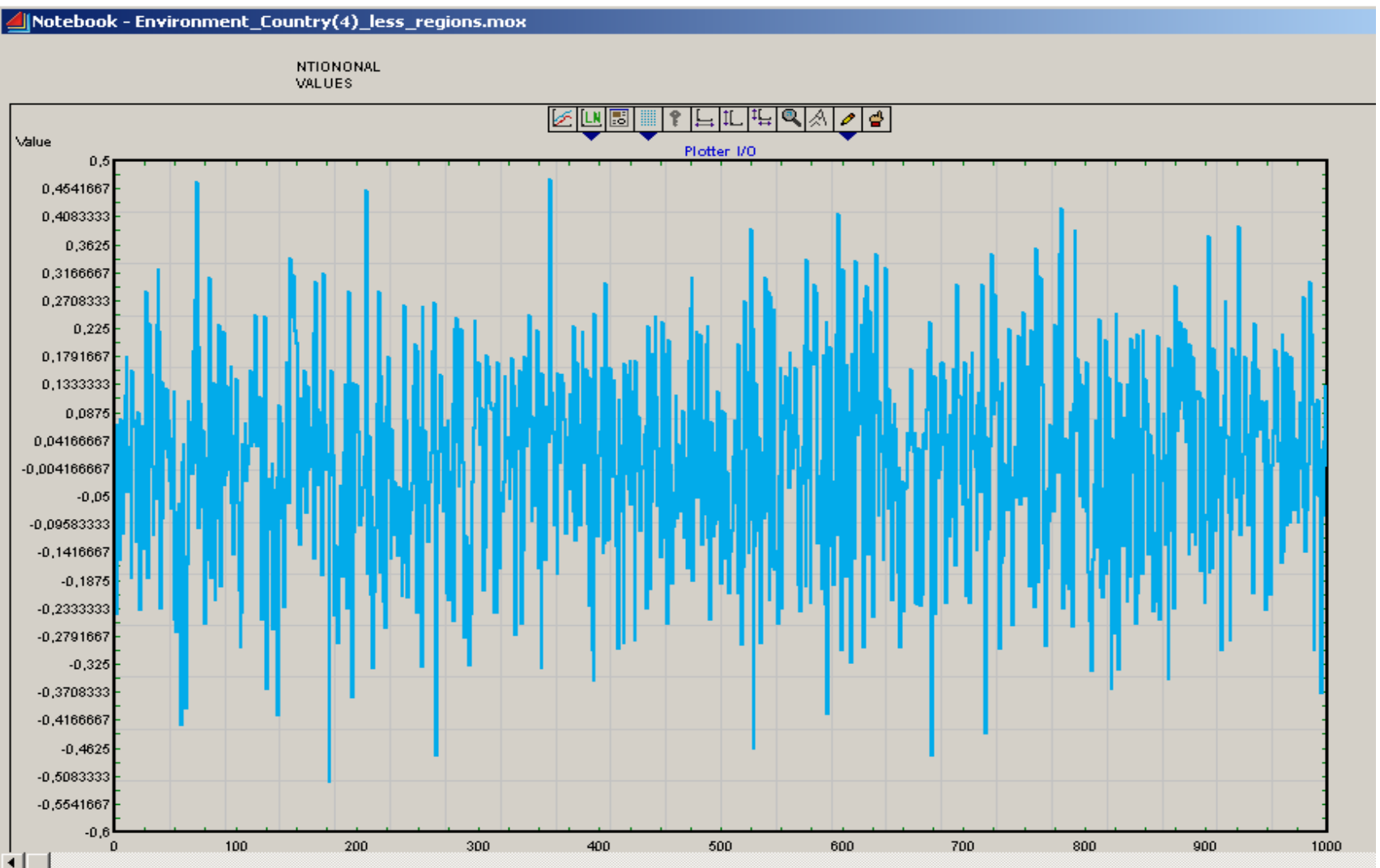
Figure 3.2.3- Results plot of simulation three: potential national (4 regions) Environment Domain impact values.
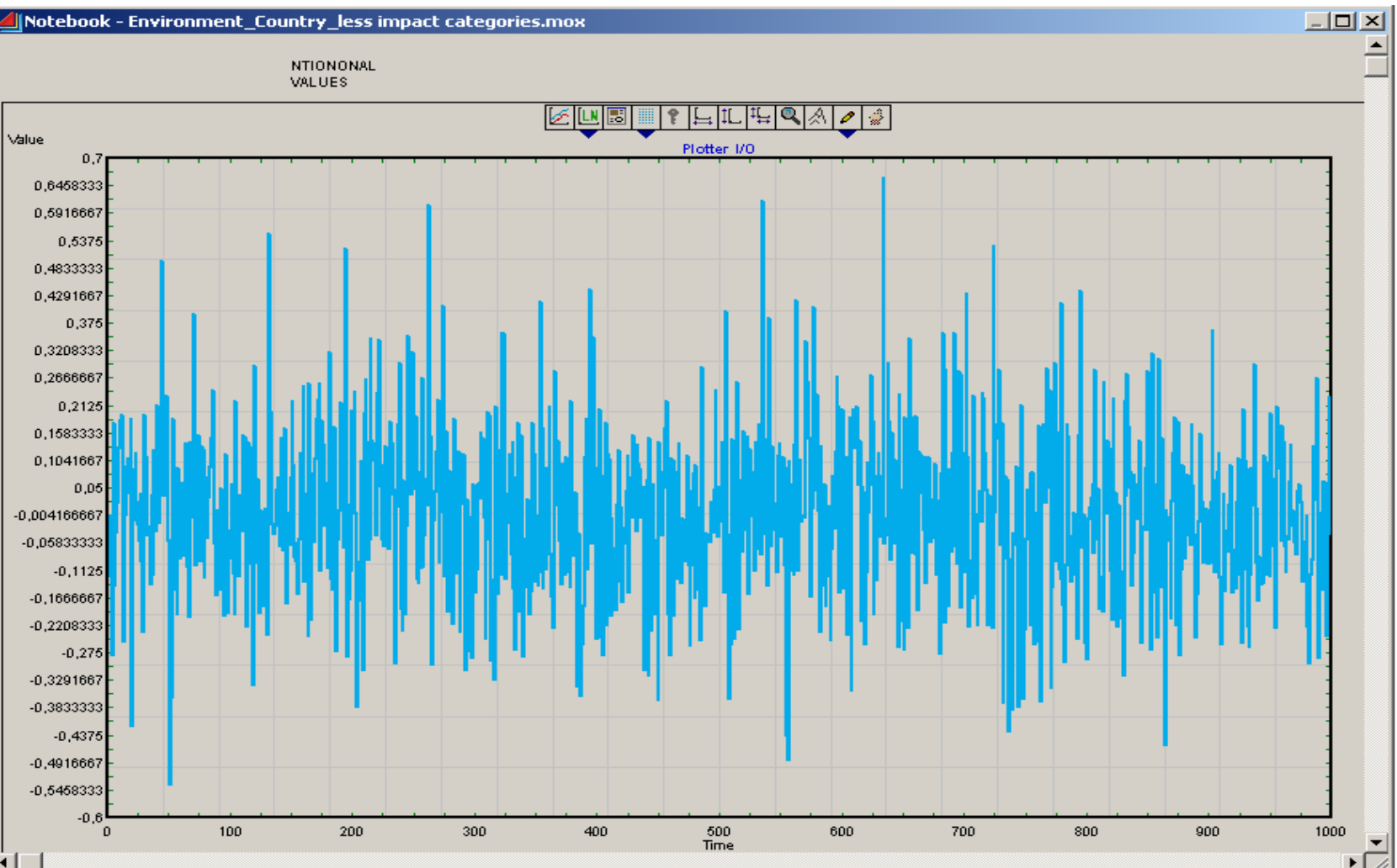
Figure 3.2.4- Results plot of simulation four: potential national (21 regions without impact categories B, C and D) Environment Domain impact values.

	SIMULATION ONE (REGIONAL IMPACT SIMULATION – FIRST SCENARIO)	SIMULATION THREE (COUNTRY IMPACT SIMULATION – ONLY FOUR REGIONS)	SIMULATION FOUR (COUNTRY IMPACT SIMULATION – ONLY CATEGORY A)	SIMULATION TWO (COUNTRY IMPACT SIMULATION – SECOND SCENARIO)
Categories/weight questions	26	75	203	363
Impact direction questions	18	23	63	103
Impacts (% in all values)	37% - 40%	12% - 15%	12% - 14%	13% - 15%
Extreme impacts (% in all values)	8% -10%	1%	1%	1%

Figure 3.2.5- Percentage of simulated model outputs resulting in an impact or extreme impact.
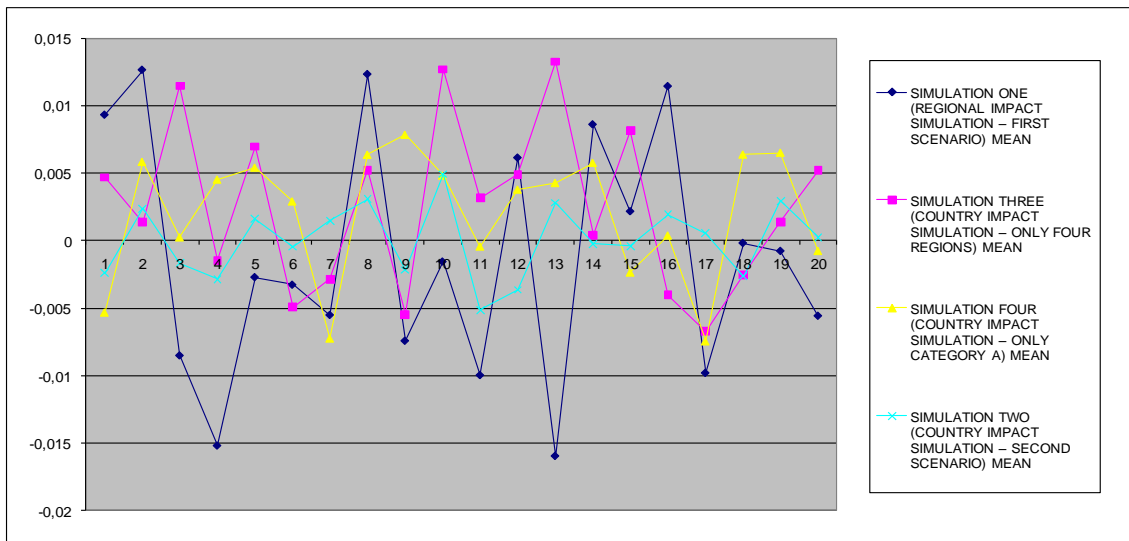
Figure 3.2.6 - Mean of model outputs for the four simulation scenarios.
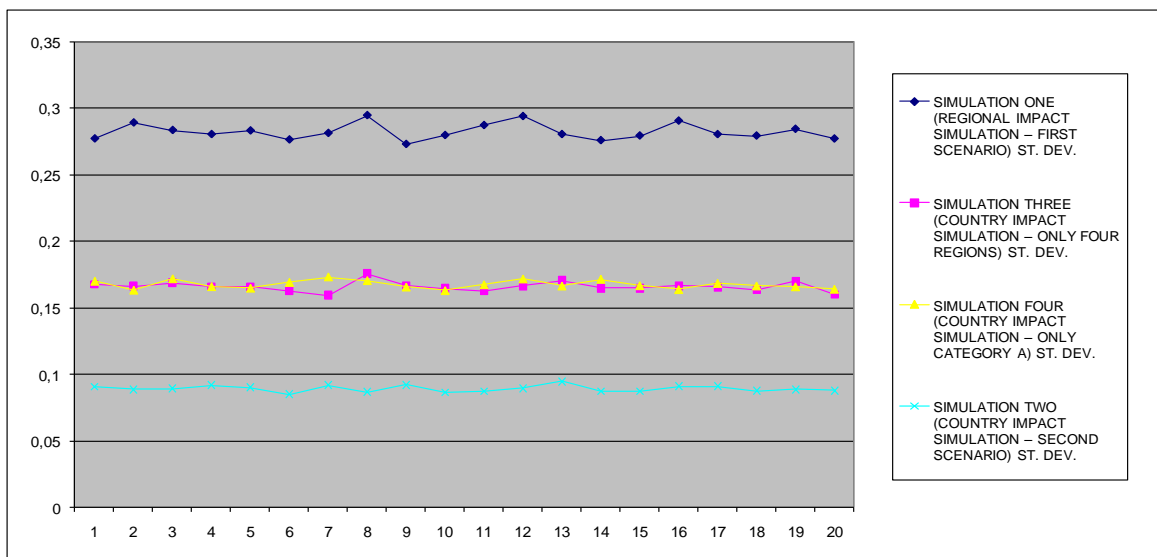
Figure 3.2.7 – Standard deviation of model outputs for the four simulation scenarios.

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3.3 The European Commission Experts' Interviews Results

Of the several DGs' experts contacted only two accepted to be interviewed. The first interviewee was from the DG ENTR, while the second one was from the DG ENV. As explained in paragraph 2.2.3, initially, the model has been illustrated to the expert. Then by means of the case studies' results three main points of discussion were debated:

a) utility of the rapid IAS in respect of his features and in comparison to part of the current EC Impact Assessment System procedure;

b) potential of the rapid IAS as regulatory strategy developer tool;

c) time required and costs of current impact assessments.

Below I report the discussion outcomes separated by expert and debated points:

DG ENTR:

a) There is a general interest for the IAS; the main model features, as though innovative, present a coherent theoretical background. The main point of interest is unfortunately the less defensible since no formula can answer how the enterprises' compliance information is obtained. The current IA procedure of the EC starts in a different way compared to IAS proposed in the dissertation. Usually, the analyst in charge of the procedure operates an initial review of old legislative acts; the latter operation reveals contrasting points with regard to the new proposal. Through this method the analyst identifies the impact categories to investigate. Moreover, an expert of a specific knowledge field is able to immediately isolate impact areas of high relevance; an open expert consultation could be more valuable than considering several fixed, pre-determined specific impact issues. However a test of the model would be of interest for single MSs. In this case the IAS could highlight problems among different regions and among key experts with decisional power.

b) For what concerns the use of the model as regulatory strategy developer tool, the proposed system is too specific. This is particularly true if one wants to draw up first draft strategies based on general, simple, undefined ideas and concepts, reduced just in a second step to a series of actions. The use of the new IAS should be rather

considered after this first step, hence even before starting the impact assessment procedure. In this view the cost to obtain the final output table is of extreme importance. The analysis should be executed only by few European experts.

c) The cost, in terms of permanent work of a normal impact assessment, corresponds normally to 6 person months; the worker is responsible for the whole impact assessment procedure and moreover, he has to contact the other DGs and external consultants to arrange meetings and to draw reports. The overall cost hence varies between 60.000,00 € (considering only the person responsible) and 1.000.000 € (considering consultancies' cost and stakeholders' meetings). The impact assessment cost should be referred only to impacts evaluated by the DG ENTR.

DG ENV:

a) The IAS is not of relevance for the DG ENV since impacts calculations are not based on opinions of key stakeholders as managers of regional environmental agencies. DG ENV does not use multi-criteria or in general weighing systems since the information elaborated through these systems is too subjective. Nevertheless the IAS could be compared to the current stakeholders' consultation procedure used by the DG ENV before proposing legislative acts. As the type of legislative acts the DG ENV deals with is the Directive, where no specifications or rules of production process changes are specified, the DG ENV expert suggests the IAS testing at a national level, where legislative acts concerning environmental issues are detailed to an operational level.

b) No major information has been given on this point. However, the DG ENV expert stressed once more that the DG ENV policies strategy cannot be shaped by a system based on totally subjective opinions.

c) The cost of an impact assessment could be internally absorbed by the DG through permanent workers. The latter cost can vary from 6 person months / 12 person months to 4 person years. The maximum budget for an impact assessment, considering consultancies and stakeholders meetings, is 4 million € (impact assessment of extremely relevant issues).

4   Discussion

The results of the new IAS system analysis should be examined in regards to the purpose of this thesis, namely the potential to overcome specific evaluation issues and to aid food policy makers in visualizing potential impacts of regulation within a short time frame. With the latter in mind, I consider two major aspects of the results' analysis: the functioning of the rapid IAS in its subsequent working steps (IAS operability) and the usefulness of the tool and its features in respect of current European food policy decision-makers' needs and evaluation problems.

In testing the IAS operability we adopted two methods: the application of the IAS to two case studies and a simulation providing the range of the model possible impact values. In order to obtain a judgment on the usefulness of the IAS and its features, I instead interviewed, through direct interviews, members of the European Commission.

By referring to chapter 'Results' I will go through several positive and negative considerations emerging from case studies and simulation's results and from EC experts' interviews.

4.1   The IAS Operability

I analyse and judge the IAS operability from three different perspectives: the formal problems and direct suggestions signaled by regional experts' answers, the content of the information provided by the system through its flow from one step of the procedure to the other and the simulation results indications on the relation between use of the system and assessment objective.

4.1.1   Regional environmental agencies experts' feedbacks

A first raising observation is on the experts' acceptance and the return rate of the questionnaires submitted by means of the on-line survey system. As demonstrated in the chapter 'Method', experts' opinions are extremely relevant for the whole model as they provide the key to the algebraic inputs of the impacts calculation. Under this aspect, as remarked by Rumiani and Bonini (Rumiati & Bonini, 1996), the questions' framing have been a crucial factor. Figure 3.1.1 indicates the questionnaires' return rate for regional environmental agencies from the following participating countries: 73%, Italy; 8% Germany;

0%, France; 20%, United Kingdom. As the responsible party for drafting the questionnaire was an Italian native speaker, the questionnaire for the Italian regional environmental agencies was written in Italian. For the other countries the questionnaire was written in British English; in fact the 20% return rate of UK surveys should be considered as a 60% since, excluded Scotland and Northern Ireland, there is only one environmental agency representing the rest of the sub regions of figure 3.1.1 for what concerns environmental impacts deriving from the food productive system: Food and Environment Research Agency.

Most of German and French regional environmental agencies have been recalled several times after initial contact and, at the question why they did not want to take part in the survey, most of them answered they were not sure of their understanding of a foreign language.

Other relevant information provided by experts in answering the questionnaires concerns the endorsement measures to incentivize experts' commitment, the complexity of the questions asked, the supporting material, the time necessary to send back filled survey, the use of the final results. Below I address each of these points individually, analyzing their causes and proposing solutions:

- Endorsement measures: more than one expert indicated how little the incentive was in completing the questionnaire. Managers of national environmental agencies especially face an extremely tight agenda, carrying on many national and international projects simultaneously. Under pressure of binding regulations, such as Directive 2003/87/EC on EU Emissions Trading System, they have little space left for new data collection that is not directly requested from the government and lacking of financial covering.

- Questions complexity: although the analyst tried as much as possible to simplify the questions asked, a certain degree of complexity has been remarked by the experts on the answering mode and the variety of the impact answers requested. Even if the framing of the single question can be improved by using a more graphically developed software and a better explanation of the answering procedure that the expert should follow, a certain degree of complexity will be always part of the investigation of the impact for two reasons: the natural complexity of environmental phenomena and the broad range of potential environmental impact. For the latter a filter rule could be used in order to select only those impact categories that the proposal affects;

consequentially the expert reduces the number and type of questions to those he considers relevant for potential impacts.

- Supporting materials: some experts pointed out that the supporting material was of no use for the consideration of potential impacts. This criticism could originate from the way the support information has been presented as well as from the geographical region of the expert and the type of proposal discussed. Figure 2.1.1.12 demonstrates the function of the support file: to inform the expert of how many enterprises are going to change their production processes because of the proposal and how big these enterprises are. The hypothesis is that the expert could locate these enterprises in the region territory, signaling whether or not the impacts will occur on an already environmental sensitive part of the region. As a consequence if a region has no particular environmental problems deriving from the industry-territory interaction the expert will find the support file useless for the impact calculation. Moreover some proposal could affect just marginally the regional productive system; hence the information on the enterprises' compliance has little value for the impact calculation.

- Time necessary to send back filled survey: given the complexity of the information required, the experts highlighted the need for a larger time window in order to collect and elaborate the information. A month time has been indicated has a sufficient limit to complete the questionnaire.

- Final results use: many experts were doubtful whether or not participating in the survey, as they did not know the final use of the data they provided. Although the survey has been indicated as an input for a scientific study, the experts disclaimed their official agencies role; therefore they participated as single individuals with a high degree of expertise. For future surveys previous personal formal contacts should be established between the analyst and the experts providing the answers.

A final remark concerning experts' direct feedback is the general appreciation and interest that most of them showed for the consideration of their role in an impact assessment. Some experts stressed that they often need to make suddenly operative a European directive, further detailed by the Member State legislative act, without knowing a lot in advance. Sometimes the legislative acts can be contradictory in terms of real regional impacts if compared with

their primary objectives. The latter problem could be avoided by taking in consideration - as the IAS here proposes - the expertise of people with a higher degree of knowledge of the territory.

4.1.2 The system functioning and its influence on the final impact information

Results from the two case studies reveal how the IAS is dependent on experts' participation; as the initial idea was to obtain a European impact value I had to rework the expected system results displaying only the Italian output table. For the future is therefore suggested to consider all possible formal improvements recommended through paragraph 4.1.1.

Another important highlight from the case studies is the acknowledgment of the role and importance of the IAS easiness of use. The data collection and elaboration, as much as the possibility to smoothly surf on the final results and play interactively with them, are essential requirements of the IAS necessary to organize experts' opinions and letting them serve the final decision of the policy maker.

As long as the transfer of collected data to elaboration files requires hours, the system cannot really be used to support an experts' discussion and lead the policy maker to a decision.

In figure 2.1.3.7 one can see the role of the statistical data in the aggregation from regional impacts to a national impact. Two issues emerged through the case studies; the first is on the availability of such a detailed level of data; in fact I asked for the regional number of companies of the producing (EUROSTAT: Agricultural holdings producing cereals) and processing (NACE rev. 1.1 - groups 15.61, 15.81, 52.11 and 52.24) chain stages divided by class of workers (micro, small, medium, large). A homogeneous European database for this information does not exist and therefore I directly addressed the national statistical agencies. Because of the different privacy policies on stored data some of the statistical offices contacted could not provide the information requested.

The second and most important consideration on the role of the statistical data for the impact assessment concerns the statistical indicators to use in order to satisfy the coherence of the aggregation criteria with the phenomenon described through the domain. In the case studies I used two different indicators for the 'Pesticides Directive' and the 'Allergens Proposal'. For the pesticide case study I used the amount of agricultural productive land in the region, while

for the allergens case studies I used the amount of workers of the two chain stages affected in the region. This choice is due to the type of proposal analysed and the domain investigated.

The pesticide directive concerns mainly the use of pesticides done by agricultural operators; hence I operate in the first chain stage indicated by the horizontal part of the model: the agricultural holding. A measure with statistical relevance of the potential effect that an agricultural holding can have while using pesticides on the regional territory is the amount of productive land owned by it in percentage in respect of the total productive land of the region. Considering that we want to assess the environmental effect of the proposal (Environment domain) it is reasonable to use as aggregation criterion for the effects on many regions the amount of productive hectares. The second case study concerns instead the allergens detection and labeling process. Both actions' impacts can be linked to the market relevance of the processors executing them, therefore here the impact aggregation criterion was the number of workers of the regional cereals processing industry expressed in percentage in respect of the national value for the same chain stage.

Both case studies' aggregation criteria highlight the need for future impact assessments to tailor the indicators used for aggregation on the type of domain explored, the type of proposal discussed by the policy maker and the data availability. This discussion point leaves room for further studies as the aggregation of impact results is a key feature of the IAS.

Another relevant element of the IAS operability is its flexibility in considering new categories of impact and in eliminating irrelevant categories. To delete categories is algebraically easy as a category with weight zero will not simply affect the final added sum leading to the domain impact. Differently, if a new category has to be modified or added, the operation is complex. In the first case it requires time changing the question representing the category and its subsequent alternative answers; therefore the IAS loses in rapidity if used in a direct experts' discussion even if with few inputs. In the second case the calculation system should be rearranged in the Excel worksheet as a new term is added to the impact expression. This latter operation requires too reconsidering the logic of the aggregation among the many categories and of course it adds to the necessary work for the writing of the questions and the potential answers. As a solution the model usability should be improved, in order to allow a transparent but fast impact categories modifying process.

In general a reduction of the impact categories or an interchangeability of their content would let the IAS be more suitable for strategic purposes, discussed on broad terms among a restricted amount of experts or policy makers.

Finally the case studies allowed me to collect regional agencies experts' opinions on a potential refunding for their consultancies. Through this information I was able to trace an indicative idea of the cost range of the IAS for the Environment domain (figure 4.1.2.1). The range reflects the possibility to consult few European experts as well as the total of the regional European environmental agencies experts.

4 countries with 15 regions each in average

	EXPERTS	CONSULTANCY COST	TOTAL	TIME	
	Number	€ / per person	€	months	
REGIONAL EXPERTS	60,00	300,00	18.000,00	2,00	
NATIONAL EXPERTS	4,00	500,00	2.000,00	2,00	No regional impact
EUROPEAN EXPERT	1,00	700,00	700,00	2,00	dispersion information
PROFESSIONAL ANALYST	1,00	12.000,00	12.000,00	2,00	
	66,00		32.700,00	2,00	

27 countries with 15 regions each in average

	EXPERTS	CONSULTANCY COST	TOTAL	TIME	
	Number	€ / per person	€	months	
REGIONAL EXPERTS	405,00	300,00	121.500,00	2,00	
NATIONAL EXPERTS	27,00	500,00	13.500,00	2,00	No regional impact
EUROPEAN EXPERT	1,00	700,00	700,00	2,00	dispersion information
PROFESSIONAL ANALYST	1,00	12.000,00	12.000,00	2,00	
	433,00		147.700,00	2,00	

Figure 4.1.2.1 – Range of the impact assessment cost for the Environment Domain.

The first table of figure 4.1.2.1 reports the cost corresponding to the case studies in the hypothesis of a 100% survey return rate. All the values in the table have been rounded up. When considering a cost of a complete IA with six domains and for every country should be kept in mind that not all domains allow an information collection on a regional basis and not all domains have the same degree of complexity. Under these two aspects the Environment domain impact assessment and the Innovation & Research domain impact assessment are the most expensive. So the cost for a complete, six domains European impact assessment with the highest degree of information collection (27 countries of 15 regions each) could be around 500.000,00 €. Moreover the use of public agencies for consultancies could result in a much lower cost than the ones indicated in the table. The cost has a major decrease when considering only few European experts providing the inputs in a direct interview session; a rough estimation of the latter cost is 15.000 €.

4.1.3 Indication on the use of the system given by simulation results

The simulation results showed, by means of four different scenarios, how, by increasing the number of categories' relevance questions and impact direction questions, the IAS tend to reduce the possibility of signalling a positive or a negative impact. The sum of many categories' weights should add up every time to one for a single step of the aggregation process, as a consequence the higher the number of categories and their corresponding categories' relevance questions and values, the lower is their individual weight value; differently than intuitively expected the model algebra does not allow that categories' lower weight values could lead the final impact towards the value zero. As the weights' sum for every aggregation step is forced to one, the impact value is preserved throughout the aggregation process. An alignment of the domain impact result to zero is not related directly to a lower value of the single category relevance, but to the sum of negative impact values with positive impact values.

Further verifications have been carried on to confirm the above mentioned thesis; by comparing the first simulation scenario with the second simulation scenario (figure 4.1.3.1) the number of questions assigning the category relevance increase; these two scenario pictures reproduce the situation above described, with a first model with higher categories' weights values (Regional impact simulation) and a second one with lower weights categories' values (Country impact simulation). If the number of categories would be one of the variables influencing the final impact results, by having the same impact direction for all the impact direction values (e.g. -1) of the two scenarios, I would obtain two different final impacts, respectively of the regional impact simulation and of the country impact simulation.

	SIMULATION ONE (REGIONAL IMPACT SIMULATION – FIRST SCENARIO)	SIMULATION TWO (COUNTRY IMPACT SIMULATION – SECOND SCENARIO)
Categories/weight questions	26	363
Impact direction questions	18	103
Impacts (% in all values)	37% - 40%	13% - 15%
Extreme impacts (% in all values)	8% -10%	1%

Figure 4.1.3.1 – Difference in the number of categories/weight questions between regional and country simulations.

By running the simulation under this condition the latter hypothesis has been proved incorrect: both the simulation scenarios had the same final impact results corresponding to the value -1. In other words the impact result is independent from the number of categories present in the IAS.

The reason why the country simulation leads to impact results close to zero could be found in the law of large numbers. The latter states that the average of the results obtained from a large number of trials should be close to the expected value; in the simulation the expected impact value corresponds to zero as I set up in the simulation parameters (see figure 2.2.3.2) the same probability to obtain positive impact values (+1), negative impact values (-1) and no impact values (0).

The closer value of country simulation to 'no impact' result is directly related to the higher amount of random inputs generated by the simulation software. While for the twenty runs of the regional simulation the random inputs are 44 000, for the country simulation they are 466 000; therefore one can find the cause of the impact trend to zero in the larger number of random values inputted for the country scenario simulation.

Through the simulation I could test whether or not the model algebraic structure works correctly: by inputting the same impact direction value (e.g. -1) the simulation returned for all scenarios the same impact result, namely -1.

Moreover, the simulations could prove the robustness of the model; the impact results mode for the four simulations scenarios falls in the impact label 'no impact'. From all simulations trials then raises the question if the IAS is able to report minor impacts for a specific category, or better if a single category's negative or positive impact result is displayed in the final output table.

I performed a last simulation to test how responsive the IAS is to the situation above described. In this last simulation I set as inputs of the category 'natural resources' all positive impacts for both the regional simulation scenario and country simulation scenario; all other inputs have been kept randomly generated.
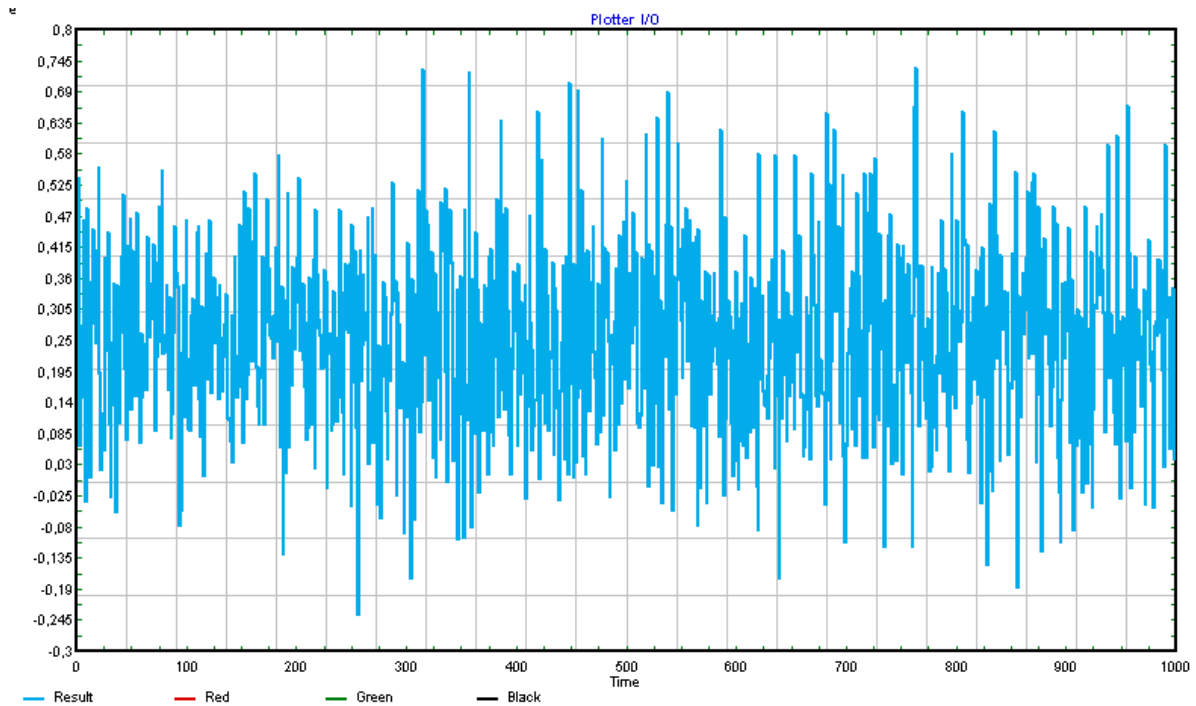
Figure 4.1.3.2 – Country scenario simulation's results with fixed inputs for one impact category.

From figure 4.1.3.2 one sees how the final domain impact results returned by the simulation tend clearly to represent a positive impact; hence they reflect the reactivity and capacity of the model to pinpoint specific impacts.

The simulations showed that the IAS is responsive in signaling impacts deriving from a single category of questions. In a real use situation this could correspond to experts judging a proposal's measure or requirement unsuitable for its consequences.

In the meanwhile the simulation informed the potential user of the IAS limitations: the main impact result in case of same amount of positive and negative answers given by experts lead easily to the label no impact. As a consequence if a final positive or negative impact emerges out of a complex system, like the country scenario level, it means that among the proposal consequences there is clearly something for the policy maker to focus on.

In other words the IAS is able to show specific problems of a proposal and when it does that, these problems are of certain relevance; otherwise they would be counterbalanced by positive impacts.

4.2 European Experts View on the Impact Assessment System Usefulness

Although the interviewed European Commission members could not take in account a direct use of the IAS they expressed a general appreciation about the impact calculation model.

The firsts of these aspects are the multi-level impacts visualization and the final European impact results as consequence of an aggregation process. Both interviewees of DG ENTR and DG ENV stressed that the IAS could have a potential for Member States decision makers when dealing with European Directives because of its regional impact aggregation structure.

Especially the expert from the DG ENTR recognized that, although innovative in his formulation procedure, the main feature of the IAS, namely the consequentiality between enterprise' compliance and macro impact calculation, is extremely interesting for future Impact Assessments.

Finally the execution cost of the IAS, if compared with current costs of the EC IAS procedure, highlights the existence of broad development margins for the IAS tool; however two conditions should be fulfilled: the improvement of the IAS usability and a simplified explanation of the model algebra and functioning.
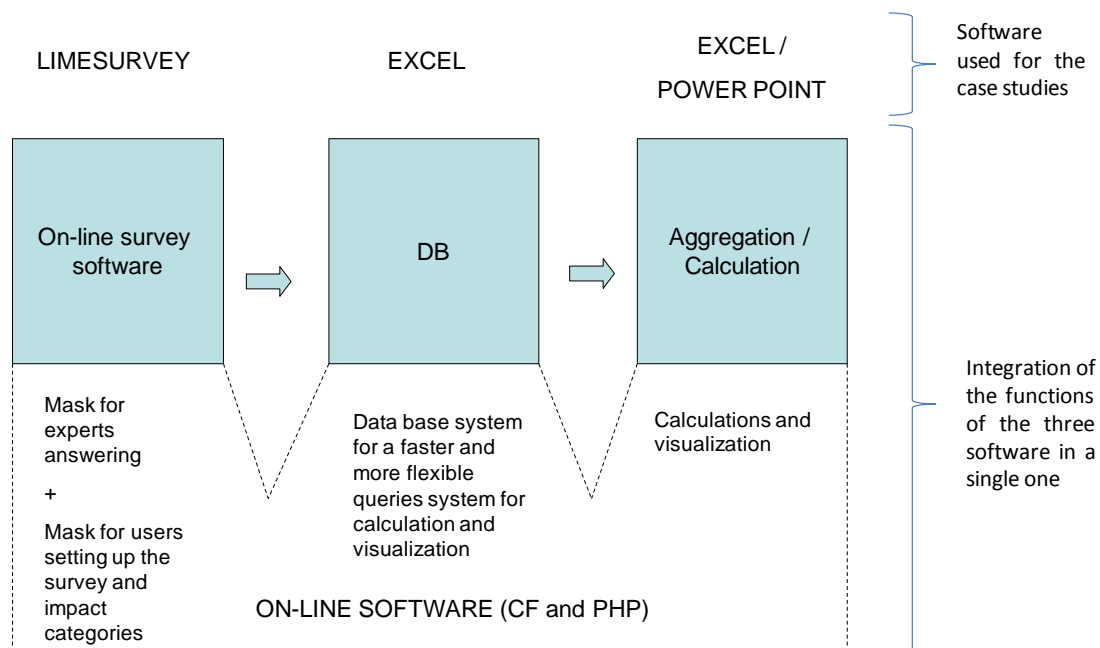
Figure 4.2.1 – Integration of the three software's functions used for the case studies in a single software.

In consideration of the usability aspect I suggest the creation of a single software able to replace and integrate the functions of the three software used for the case studies (figure 4.2.1). Through a single software the model user is not obliged to transfer the data from one informatics system to the other, therefore the time necessary to visualize the final impact is reduced. Moreover the new software could be developed in a way that the whole IAS usability could increase. If this last point is essential to aid the policy maker in visualizing the likely consequences of only one proposal, it is even more important when identifying the best policy options among many existing. In fact the IAS here proposed is able to detect the impacts deriving only from one food regulation proposal and in order to visualize other policies' impacts the system needs to be reiterated rapidly many times: once a negative impact has been obtained from the output table, by means of the reference code and the interactivity of the latter, it is possible to trace back the determinants of such an impact; after isolating the cause of the negative effect in the proposal and changing its unsuitable requirement the IAS should run a second time. At the end of this process the policy makers have a first output table relative to the first proposal draft and a second comparable output table relative to the second proposal draft[3].

Nevertheless the current IAS procedure focuses only on the impacts visualization of legislative acts. The comparison between many legislative acts' impacts and the criterion to establish which one is more suitable requires the study of a targeted ruled discussion procedure guiding the experts through the outputs tables' results evaluation. A potential support for the above mentioned procedure could be the algorithm for fuzzy multi-criteria evaluation of food safety policies created by Mazzocchi, Ragona and Zanoli (2011).

The whole IAS is the result of a puzzle that serve many functions: providing a valid impact phenomena representation, collecting and managing experts' opinions and supporting policy makers for decisions concerning the European food system. As experts' opinions collection corresponds to the first step for the working of these three functions, the IAS should facilitate the easiness for the expert to provide information. The IAS works with few European

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[3] As stated in the Acknowledgments and in the chapter 'Introduction' the current impact assessment system has been developed within a European research project lasting several years. By the time of the thesis finalization I had the opportunity to use the rapid impact assessment system theoretical framework for the creation of a Decision Support System with the software features described in figure 4.2.1.
In Appendix C 'State of the art of the current Decision Support System software based on the impact assessment system approach' I present a summary of the software functioning and structure with the purpose of making more tangible the idea of an integrated user-friendly system facilitating the policy maker in visualizing the likely consequences of his choice.

experts' inputs as well as with many European regional experts' inputs. The use of a single software would help in both input collection schemes; in fact the user/analyst could organize in a better way the information flow. More specifically, for few experts' opinions collection and management, the IAS would be more reactive, hence suitable to work in a synchronous experts-policy makers discussion. In the meantime, for a high number of experts' opinions collection and management, the IAS would leave enough freedom for the experts to analyse the information required, elaborate it and send it back without being underpressure. As the single software is on-line, the comunication of precious information between the analyst and the expert in the latter case is asynchronous. The latter model feature would definetely help in reaching one of the operative objective of the IAS, namely to obtain impacts results based on specialized expertise in a short time.

5   Conclusions

Under the pressure of many alternative stakeholders' demands, the food policy maker needs to consider regulatory decisions in order to grant a safe final product for the consumer, as well as to foster the improvement of the food supply system. However, actions promoting positive impacts in a specific field, often lead to unintended negative impacts in other fields; consequently methods able to assess and compare the several types of effects provoked by a proposal are used to support the food policy maker decision.

In this thesis I focused on the creation of an impact assessment system, based on quantitative and qualitative inputs, able to provide final outcomes in a tight time frame and with financial resources constraints. The features of the impact assessment system are: an ex-ante impact calculation view, the ease of results interpretation through an intuitive output table, the consideration of key stakeholders opinions in the final outcome, the consequentiality between food sector enterprises' compliance and potential macro impacts, the disaggregated multi-level impacts data collection, the possibility to trace back the impact causes by means of the system interactivity and transparency characteristics, the clear reasoning process based on a step by step structured procedure in analysing potential impact categories and the final impacts' uncertainty indication.

The analysis of the impact assessment system confirmed partially the initial thesis of its use as a tool aiding the food policy maker in visualizing the likely consequences of his choices. The simulation showed that the algebra of the impact assessment system works correctly and the model is at the same time robust and responsive in providing the outputs. However the system is highly dependent on its easiness of use in order to collect and manage experts' opinions in a short time frame.

The system cannot be used as alternative to part of the current European Commission impact assessment system procedure for many reasons: it focuses only on one part of the whole impact assessment procedure, namely on the impacts calculation, without exploring the comparison criteria among many policies options, and it diverges from the current impact categories identification method used by the Commission Departments.

Nevertheless the system can have a future complementary role as it proposes new peculiar ways to overcome evaluation problems intrinsically part and specifically deriving from the food sector. Moreover the system here proposed could be run in parallel to the current impact assessment systems used by food production legislating bodies in case of time constraint, at a Member State level and for specific issues that do not require deep quantitative analysis.

Potential users or policy makers could take advantage of the impact assessment system use by means of its flexibility (possibility to tailor the assessment on the time and resources constraints of the decision) and its ability in displaying conflicting impacts with an extremely comprehensible and intuitive interactive interface.

Future system developments concern the improvement of the impact assessment system usability, the development of an integrated single software and the simplification and reduction of the impact categories for strategic purposes use. Additionally, the model algebra could be enriched of new modules allowing more refined uncertainty calculations, impacts maximization functions and more complex multi-criteria analysis as the comparison of two output tables' impacts results to sort the best policy option. An extremely user friendly and simplified version of the impact assessment system could render the system suitable also for ex-ante food-related projects evaluation.

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Appendices

Appendix A: 'Public Health' Domain Report

Contents

1. Public Health Domain definition

The Public Health Domain grounds on two definitions of health:

1. '*A state of equilibrium between humans and the physical, biologic and social environment, compatible with full functional activity*' (WHO).

2. '*The extent to which an individual or a group is able to realize aspirations and satisfy needs, and to change or cope with the environment. Health is a resource for everyday life, not the objective of living; it is a positive concept, emphasizing social and personal resources as well as physical capabilities*' (WHO).

From the first definition I consider that a population's good health condition, in a specific spatial boundary, is obtained with the 'equilibrium state' achievement. Given existing health problems of european countries' population (WHO, 2004), and consistent with the basic evaluation system of the model based on an ex-ante judgment, I define as Public Health Domain's positive impacts a reduction of human health damage risk; on the contrary I consider as health domain's negative impacts an increase of human health damage risk. An increase of damage creates distance from the equilibrium state, while a decrease let closer to the worthwhile equilibrium state of a population.

The second definition describes health as a resource for every-day life; therefore, as a resource, health is subjected to consumption. In the evaluation system here proposed, the consumption of such a resource is damage to the 'stock'[4] of health a human being has in his life.

The risk of damage to human health derives from many sources. The Public Health Domain impact assessment measures only the ones provoked by changes of the productive system due to new regulations, new technologies or new institutional environments. As a consequence health determinants[5] which are not influenced by the productive system changes and the relative damages are not considered in the evaluation system.

The reference for damage categories used in the model is Eco-indicator 99 methodology (Goedkoop Mark, 2001). To these categories I added, from the EIA 2009, other aspects regarding health's socio-economic determinants (EC, 2009); since the impact assessment system is modelled on the food sector, I added in other categories concerning human health damage risk from the MoniQA project's health risks categorization (EC, 2007).

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[4] For 'stock' I intend more precisely life expectancy as following defined: average number of years a person can expect to live, if in the future they experience the current age-specific mortality rates in the population. Healthy life expectancy is a related statistic, which estimates the equivalent years in full health that a person can expect to live on the basis of the current mortality rates and prevalence distribution of health states in the population (WHO).
[5] The personal, social, cultural, economic and environmental factors that influence the health status of individuals or populations (WHO).

To describe the relation cause-effect among determinants and damages of some impact categories many type of analysis are necessary:

- fate analysis: linking an emission to a temporary change in concentration;
- exposure analysis: linking the temporary concentration to a dose;
- effect analysis: linking the dose to a number of health effects;
- damage analysis: linking health effects to a measure unit expressing the damage for human beings.

Each health determinant requires this set of analysis. Since the overall aim of the model is to provide a fast qualitative assessment it is not possible to undertake all these procedural steps. Therefore the model embodies the four analyses in the experts' judgment; I assume that, for an appropriate spatial boundary (NUTS 2 level), experts have a snapshot of population health problems of that territory and hence they are able to answer if a particular emission or pathogen agent, by increasing or decreasing, will reduce or rise the health risk of the population. If a lack of knowledge occurs and the expert is unable to provide information on the human health damage risk, the model highlights only the missing information. The model has been structured to support decisions in a fast way by managing existing information and by linking them to an uncertainty level.

In order to aid experts in answering health risk and damage questions, I provide support elements:

- description of the production process change caused by the new legislative act;
- enterprises' compliance level in the region or country by enterprise size.

To quantify the damage category Human Health, it is important to find a scale measuring the health level of a population. In this scale several factors should be included:

- number of individual affected by the problem;
- time humans suffer from the limitation, or lifetime lost by premature death;
- the severity of the health problem, ranging from premature death to irritation.

Health economics scientists did many attempts to scale the severity of health problems. For instance, in most Western countries, such a scale is used to determine the welfare or ability to work for ill and (partially) disabled persons. In these systems the relative degree of disability is the measure of the severity scale.

On the international level, a single indicator to quantify the total burden of diseases was developed by Murray for the Global Burden of Disease study, collaboratively undertaken by the World Bank and the World Health Organization. This indicator has the function of an objective tool to allocate money to health care [WORLD BANK 1993 from (Goedkoop Mark, 2001)]. This health indicator, expressed as the number of Disability-Adjusted Life Years (DALYs), measures the total amount of ill health, due to disability and premature death, attributable to specific diseases and injuries. The DALY concept thus

compares time lived with disability (YLD: Years Lived Disabled) and time lost to premature mortality (YLL: Years of Life Lost). Health is simple added across individuals. (Goedkoop Mark, 2001).

For the purpose of public health impact assessment DALYs would be the most suitable indicator. Unfortunately the information required for such an indicator has a level of detail that is hard to obtain at a regional level. Moreover, who should provide opinions on the health damage by means of this quantitative measure unit, needs time and resources often not available in a rapid assessment system. The information concerning the impact on public health should be of a qualitative way so that short time is needed between the drafting of the new proposal and the impact assessment.

I propose three criteria to visualize the final output of the domain:

- direction of the impact (increasing or decreasing human health damage risk);
- severity of the damage (based on time required to heal the problem and the type of damage);
- amount of population affected.

The first criterion allows the expert to make a statement on the effect of damage causes variation. Concerning the second criterion, I know that different kind of damages cannot be compared in the same way in terms of effects on the whole group of citizens (total impact of public health). How to add up the benefit of somebody healing a stomachache with the disability of somebody sick of cancer? As a consequence, I opted for five group of sickness severity. The final impact of the domain displays positive and negative impacts for each one of these criteria. The third criterion allows the user to sum up, among many regions and countries, the positive and negative impacts of the domain per severity of likely health damage. Questions regarding the three criteria will be answered by regional or national experts. Experts should cover a managerial role with an overview of the regional/local public health situation.

In the end the measure unit consists of likely increased (negative impact) or reduced (positive impact) health damage in terms of number of individuals affected. By indicating the amount of people potentially influenced by a damage of a specific severity I visualize at the same time possible harmful conditions or possible improvements in a population's health level.

2. Factors influencing Public Health and Public Health Domain categories

Public Health categorization relies on three different sources:

1. eco-indicator 99 methodology by Mark Goedkoop and Renilde Spriensma;
2. EU Impact Assessment guidelines 2009;
3. MoniQA working groups classification.

From these sources I derived two levels of categorization for the domain's assessment system. The first level concerns the type of vector causing human health damage. In this level I distinguished among:

a. impact from respiration;
b. impact from ingestion;
c. impact from life style change.
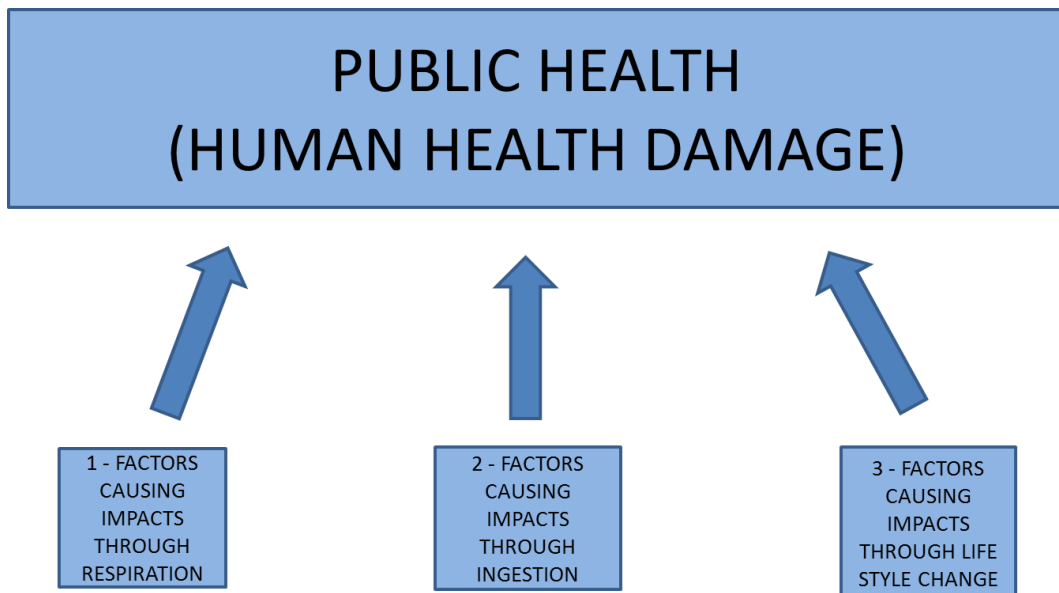
Figure 2.1 - Categories of human health damage risk.

The second level of categorization is given by direct damage causes. I selected these categories following a top down approach based on the previous level:

a. Impacts from respiration:
    1. volatile Organic Compounds (VOC's);
    2. suspended Particulate Matter (SPM);
    3. nitrogen oxides (NO_x);
    4. sulfur oxides (SO_x);
    5. hydrochlorofluorocarbons (HCFC);

    6. nuclides;

    7. polycyclic aromatic hydrocarbons (PAH's);

    8. CO_2.

b. Impacts from ingestion:

    1. heavy metals;

    2. pesticydes residues;

    3. dioxin;

    4. hormones;

    5. antibiotics;

    6. additives;

    7. microbiological contaminants;

    8. mycotoxins / Phicotoxins;

    9. allergens.

c. Impacts from life style change:

    1. noise;

    2. change in diet;

    3. stop of physical activity;

    4. tobacco consumption;

    5. alchool consumption.

1 - FACTORS CAUSING IMPACTS THROUGH RESPIRATION	2 - FACTORS CAUSING IMPACTS THROUGH INGESTION	3 - FACTORS CAUSING IMPACTS THROUGH LIFE STYLE CHANGE
•Volatile Organic Coumpounds (VOC's) •Suspended Particulate Matter (SPM) •Nitrogen oxides (NO$_x$) •Sulfur oxides (SO$_x$) •Hydrochlorofluorocarbons (HCFC) •Nuclides •Polycyclic aromatic hydrocarbons (PAH's) •CO_2	•Heavy metals •Pesticydes residues •Dioxin •Hormones •Antibiotics •Additives •Microbiological contaminants •Mycotoxins / Phicotoxins •Allergens	•Noise •Change in diet •Stop of physical activity •Tobacco consumption •Alchool consumption

Figure 2.2 - Categories of human health damage risk and relative causes.

The literature on damage causes highlights an overlap of some of them in the health impact contribution. For example pesticides can lead both to displacement problems and cancer (Horrigan, Lawrence, & Walker, 2002). Moreover pesticides residues can be absorbed by the human organisms through ingestion as well as via inhalation during the spraying operation process. In case of uncertainty in the categorization identification I chose, for precautionary principle, the damage category and vector with the higher impact on human health.

The choice of a specific category instead of another, because of a scientific knowledge lack, could be considered sometimes subjective; however this does not influence the final impact since the categorization had the purpose of finding and listing all the damage causes to consider for the domain's output. The calculation of the latter is based only on the judgement of the expert and the damage causes are aggregated not by type of health damage but by severity of the damage. Hence, concerning the example I did with pesticides, the expert can count them a severe illness in addition to not severe illness depending on the specific situation of the local health conditions.

Figure 2.3 demonstrates the relation between 'categories of damage' and 'damage causes'. In the figure one can observe the links between causes of likely health damage and model impacts questions' codes.

In the following part of the report I pass in review the questions classification. All in all the questions contributing to the impact calculation of the Public Health Domain are 25. Every question has its own ID code with the suffix PH (Public Health) and a following identification number.
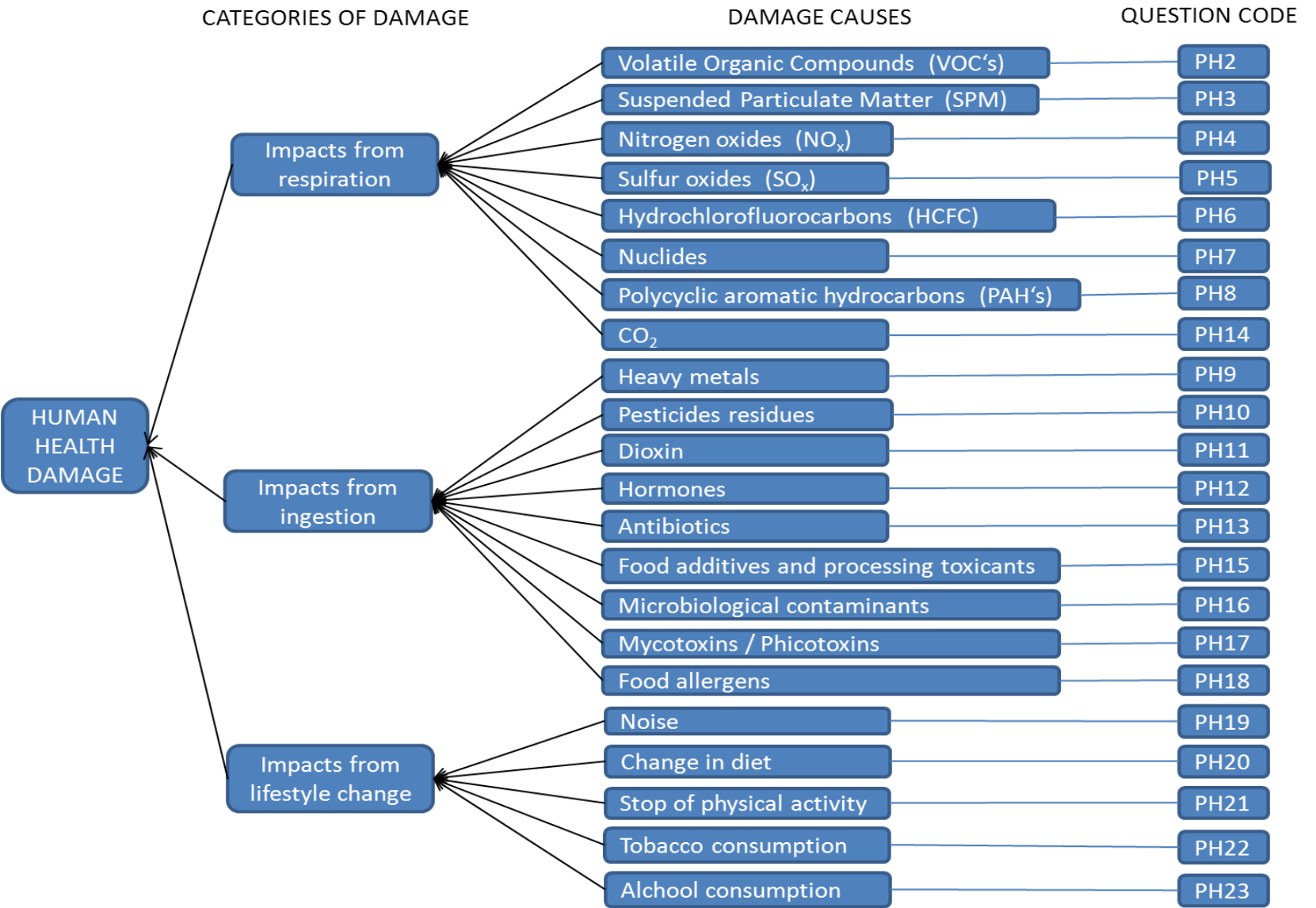
Figure 2.3 - Relation between categories of damage and damage causes

PH1 – Selection of the factors affected by the regulation leading to health problems

This first step of the IA is operated through a selective question necessary to filter potential damage causes. Explaining if one of the factors of table 2.3, from PH2 to PH23, could lead to a positive or negative impact for the public health requires in any case a minimum period of information collection; as a consequence by decreasing the breadth of investigation and by focusing on fewer aspects the output of the model can improve in accurateness and reliability.

IMPACT DIRECTION

The question has a selective function and does not lead to a score; consequently there is no impact direction.

QUESTION / PROBLEM TO ADDRESS

Select the factors in the list of damage causes (PH2 to PH23) that are affected by the regulation and can lead to health damage risk variation.

ANSWERS AND RELATED IMPACT DIRECTION

Selected cells of the text box.

PH2	Volatile organic coumpound (VOC's)
PH3	Suspended particulate matter (SPM)
PH4	Nitrogen oxides (NOx)
PH5	Sulfur oxides (SOx)
PH6	Hydrochlorofluorocarbons
PH7	Nuclides
PH8	Polycyclic aromatic hydrocarbons (PAH's)
PH9	Heavy metals
PH10	Pesticides
PH11	Dioxin
PH12	Hormones
PH13	Antibiotics
PH14	CO2
PH15	Additives
PH16	Microbiological contaminants
PH17	Mycotoxins/ phycotoxins
PH18	Allergens
PH19	Noise
PH20	Change in diet
PH21	Stop of physical activity
PH22	Tobacco consumption
PH23	Alchool consumption

FUNCTION

The question contributes with the relative answer to the selection of other scoring questions.

SYSTEM BOUNDARIES ON WHICH THE PH1 QUESTION EFFECT OPERATES

Since the model can add up positive and negative impacts of all scoring questions from PH2 to PH23 in the aggregation process from a regional level to the European one, PH1 operates at a regional level, at a national level and at a European one. The process could work by asking at a European or national level which factors from PH2 to PH23 can influence public health and then ask to every single regional expert or health agency to provide the answers for the factors previously selected. If the expertise, the knowledge and the time available allow the user to submit PH1 at a regional level the uncertainty of the final impact would be lower.

ANSWER SOURCES

Answers sources for PH1 question can be:

- technical division manager of national environmental agencies;
- technical division manager of national health agencies;
- technical division manager of regional environmental agencies;
- technical division manager of regional health agencies;
- technical division manager of national zoo-prophylactic and veterinary institutes;
- technical division manager of regional zoo-prophylactic and veterinary institutes;
- food engineers and technologists with knowledge of national and/or regional current health state and food related problems;
- occupational and social physicians with knowledge of national and/or regional current health state.

Since scoring questions PH2 – PH23 concern different fields of knowledge, there are two selection options for the input source:

- an expert owning a general overview of the local health state, necessarily in a managerial position or,
- a pool of experts from different fields with knowledge of health problems deriving from environmental pollutants, food related illnesses and work and social related illnesses.

PH2 – PH23 Damage causes

As shown by questions codes in figure 2.3 every question relates to a specific damage category and damage cause. For the explanation of the causal relation between the human health damage and the damage causes I refer again to the sources mentioned at the beginning of the second paragraph without getting in this instance into scientific details.

IMPACT DIRECTION

Every health damage cause can lead to an increase or decrease of health risk by a variation of its determinants and its relative effects on human health.

QUESTION

Will the proposal increase or decrease the probability of damage to human health due to (factor from the list PH2 – PH23)?[6]

ANSWERS AND RELATED IMPACT DIRECTION

(c) Increases   score: -1 (negative effect on public health)
(a) Decreases   score: 1 (positive effect on public health)

FUNCTION

The question contributes with the relative answer to the final score of the domain.

SYSTEM BOUNDARIES ON WHICH THE FACTOR EFFECT OPERATES

The model can add up positive and negative impacts for all scoring questions, hence PH2 to PH23 can be asked from a regional level to the European one.

ANSWER SOURCES

PH2 to PH7; PH14; PH19:

- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies;
- environmental engineers with knowledge of the territory observed.

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[6] Once the damage causes have been selected trough the PH1 step it is implied that they will certainly have an effect, whether positive or negative; as a consequence the part of the question 'not influence' and his relative answer could be deleted.

PH8 to PH13; PH15 to PH18:

- technical division manager of national health agencies;
- technical division manager of regional health agencies;
- technical division manager of national zoo-prophylactic and veterinary institutes;
- technical division manager of regional zoo-prophylactic and veterinary institutes;
- food engineers and technologists with knowledge of national and/or regional current health state and food related problems;
- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies;
- environmental engineers with knowledge of the territory observed.

PH20 to PH23:

- Occupational and social physicians with knowledge of national and/or regional current health state.

PH24 – Severity of the damage

To each damage cause's impact direction question, the expert associates the severity of the possible damage. Through the damage severity classification I can add up positive or negative impacts from different geographical systems.

I distinguish five different classes of severity of health damage. The criterion to separate the classes corresponds to the damage persistency along the time:

a. permanent damage;
b. damage that can be healed in a longer time than 6 weeks;
c. damage that can be healed within 6 weeks;
d. damage leading to death;
e. intergenerational damage.

IMPACT DIRECTION

The question has a classification function and does not lead to a score; consequently there is no impact direction.

PROBLEM TO ADDRESS

Assign the severity of the damage health increasing or decreasing.

ANSWERS

(a)   Permanent damage

(b)   Damage that can be healed in a longer time than 6 weeks

(c)   Damage that can be healed within 6 weeks

(d)   Damage leading to death

(e)   Intergenerational damage

FUNCTION

The question allows the classification and the aggregation of impacts.

SYSTEM BOUNDARIES ON WHICH THE FACTOR EFFECT OPERATES

The information is required for every single scoring question; therefore it applies on the same spatial boundaries.

ANSWERS SOURCES

PH2 to PH7; PH14; PH19:

- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies;
- environmental engineers with knowledge of the territory observed.

PH8 to PH13; PH15 to PH18:

- technical division manager of national health agencies;
- technical division manager of regional health agencies;
- technical division manager of national zoo-prophylactic and veterinary institutes;
- technical division manager of regional zoo-prophylactic and veterinary institutes;
- food engineers and technologists with knowledge of national and/or regional current health state and food related problems;
- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies;
- environmental engineers with knowledge of the territory observed.

PH20 to PH23:

- Occupational and social physicians with knowledge of national and/or regional current health state.

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PH25 – Percentage of the population likely to be affected by the impact

This element is fundamental to describe the magnitude of the positive or negative impacts likely to occur and as an aggregation criterion for the output results of different regions and countries. Moreover, the amount of people affected by the regulation's effects corresponds to the measure unit of the domain Public Health. After answering the question PH24 for every scoring question, the system asks the percentage of population likely to be subjected to health damage reduction or increase. The answer to this question allows the client to observe distributional effects of the impacts among different population's classes, like the most sensitive-ones. The answer measures every person affected by the proposal's consequences as one, an elderly person as well as a children. Since the question PH25 will follow the one concerning the severity of the health damage, the domain's final impact embodies already the information about classes of population most likely to have health problems. The expert through this answer should already consider the weakest or most sensitive population segments and count them in the overall percentage of the population. The information is required in percentage or per thousand on the overall population to simplify the expert judgement, avoiding too detailed information that, due to the qualitative assessment of the model and its uncertainty degree, would not be representative of reality anyway.

IMPACT DIRECTION

The question has an aggregation and classification function; consequently there is no impact direction.

QUESTION

In which percentage the population could be affected by the impact?

ANSWERS AND RELATED IMPACT DIRECTION

Cat 1 = Newborns less than 3 years
Cat 2 = Children from 3 to 15 years
Cat 3 = Active population from 15 to 64 years
Cat 4 = 65 years or over

FUNCTION

The question contributes with the relative answer to the final score of the domain.

SYSTEM BOUNDARIES ON WHICH THE FACTOR EFFECT OPERATES

The information is required for every single scoring question; therefore it applies on the same spatial boundaries.

SOURCES

PH2 to PH7; PH14; PH19:

- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies.

PH8 to PH13; PH15 to PH18:

- technical division manager of national health agencies;
- technical division manager of regional health agencies;
- technical division manager of national zoo-prophylactic and veterinary institutes;
- technical division manager of regional zoo-prophylactic and veterinary institutes;
- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies.

PH20 to PH23:

- Occupational and social physicians with knowledge of national and/or regional current health state.

DOMAIN DENOMINATION	ID DOMAIN'S CALCULATION ELEMENTS	DOMAIN'S CALCULATION ELEMENTS	QUESTIONS	ANSWERS	ANSWERS' IMPACT DIRECTION		FUNCTION	SPATIAL BOUNDARIES	POTENTIAL SOURCES
P H - P U B L I C H E A L T H	PH1	Selection of damage causes	Select the factors affected by the regulation leading to health problems.	PH2- PH23	-	-	Selection	EU, Country, NUTS1, NUTS2	Environmental agencies, Health agencies
	PH2	Volatile organic coumpound (VOC's)	Will the proposal increase, decrease the probability of damage to human health due to volatile organic coumpound (VOC's) contact or inhalation?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Environmental agencies
				Decrease	a	1			
	PH3	Suspended particulate matter (SPM)	Will the proposal increase, decrease the probability of damage to human health due to suspended particulate matter (SPM) contact or inhalation?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Environmental agencies
				Decrease	a	1			
	PH4	Nitrogen oxides (NOx)	Will the proposal increase, decrease the probability of damage to human health due to nitrogen oxides (NOx) contact or inhalation?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Environmental agencies
				Decrease	a	1			
	PH5	Sulfur oxides (SOx)	Will the proposal increase, decrease the probability of damage to human health due to sulfur oxides (SOx) contact or inhalation?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Environmental agencies
				Decrease	a	1			
	PH6	Hydrochlorofluorocarbons	Will the proposal increase, decrease the probability of damage to human health due to hydrochlorofluorocarbons (HCFC) emissions?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Environmental agencies
				Decrease	a	1			
	PH7	Nuclides	Will the proposal increase, decrease the probability of damage to human health due to nuclides ionizing radiation?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Environmental agencies
				Decrease	a	1			
	PH8	Polycyclic aromatic hydrocarbons (PAH's)	Will the proposal increase, decrease the probability of damage to human health due to polycyclic aromatic hydrocarbons (PAH's) ingestion or contact?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Food engineers / technologists, environmental agencies
				Decrease	a	1			
	PH9	Heavy metals	Will the proposal increase, decrease the probability of damage to human health due to heavy metals bioaccumulation?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Food engineers / technologists, environmental agencies, public veterinary institute
				Decrease	a	1			
	PH10	Pesticides	Will the proposal increase, decrease the probability of damage to human health due to pesticydes residues bioaccumulation?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Food engineers / technologists, environmental agencies, public veterinary institute
				Decrease	a	1			
	PH11	Dioxin	Will the proposal increase, decrease the probability of damage to human health due to dioxin bioaccumulation?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Food engineers / technologists, environmental agencies, public veterinary institute
				Decrease	a	1			
	PH12	Hormones	Will the proposal increase, decrease the probability of damage to human health due to hormones used in animal production?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Food engineers / technologists, environmental agencies, public veterinary institute
				Decrease	a	1			

Table 2.1b – Summary of Public Health categories and relative impact contribution on the final score –
Table 2.

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P H - P U B L I C H E A L T H	PH13	Antibiotics	Will the proposal increase, decrease the probability of damage to human health due to antibiotics used in animal production?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Food engineers / technologists, environmental agencies, public veterinary institute
				Decrease	a	1			
	PH14	CO2 emissions	Will the proposal increase, decrease the probability of damage to human health due to CO2 emissions?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Environmental agencies
				Decrease	a	1			
	PH15	Additives	Will the proposal increase, decrease the probability of damage to human health due to food additives and processing toxicants?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Food engineers / technologists, environmental agencies, public veterinary institute
				Decrease	a	1			
	PH16	Microbiological contaminants	Will the proposal increase, decrease the probability of damage to human health due to food's microbiological contaminants?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Food engineers / technologists, environmental agencies, public veterinary institute
				Decrease	a	1			
	PH17	Mycotoxins/ phycotoxins	Will the proposal increase, decrease the probability of damage to human health due to mycotoxins and phycotoxins ingestion?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Food engineers / technologists, environmental agencies, public veterinary institute
				Decrease	a	1			
	PH18	Allergens	Will the proposal increase, decrease the probability of damage to human health due to food allergens?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Food engineers / technologists
				Decrease	a	1			
	PH19	Noise	Will the proposal increase, decrease the probability of damage to human health due to noise production?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Environmental agencies
				Decrease	a	1			
	PH20	Change in diet	Will the proposal increase, decrease the probability of damage to human health due to change in diet?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Social medicine experts, health agencies
				Decrease	a	1			
	PH21	Stop of physical activity	Will the proposal increase, decrease the probability of damage to human health due to stop of physical activity?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Social medicine experts, health agencies
				Decrease	a	1			
	PH22	Tobacco consumption	Will the proposal increase, decrease the probability of damage to human health due to tobacco consumption?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Social medicine experts, health agencies
				Decrease	a	1			
	PH23	Alchool consumption	Will the proposal increase, decrease the probability of damage to human health due to alchool consumption?	Increase	c	-1	Score	EU, Country, NUTS1, NUTS2	Social medicine experts, health agencies
				Decrease	a	1			
	PH24	Severity of the damage	Assign the severity of the damage health increasing or decreasing	Permanent damage	a	-	Classification for aggregation	EU, Country, NUTS1, NUTS2	Environmental agencies, health agencies
				> 6 weeks to be healed	b	-			
				Healed within 6 weeks	c	-			
				Damage leading to death	d				
				Intergenerational damage	e				
	PH25	Population affected	In which percentage the population could be affected by the impact?	Newborns less than 3 years	1	-	Aggregation	EU, Country, NUTS1, NUTS2	Environmental agencies, health agencies
				Children from 3 to 15 years	2	-			
				Active population from 15 to 64 years	3	-			
				65 years or over	4	-			

3. Public Health impact assessment system

Figure 3.1 represents the impact assessment system valid for the Public Health domain. The main elements to consider in the assessment procedure are:

1. the boundaries of the territorial system in which impacts caused by the regulation occur. The territorial system can be defined trough the output of the horizontal part of the model. In fact connected to the enterprises' classes compliance there is their localization information. As a consequence I know where the impacts could have effects on society. More precisely this element defines the impact providers' unit (regions and countries) and consequently the impact aggregation structure. Differently than other domains, like Firm Competition, here impacts measuring and aggregation do not derive from the productive system selected, but from the territory selected. The questions leading to a score (impact direction) are asked not to representatives of the industry but to regional or national health agencies.

2. The answers' score; this element corresponds to the mathematical value leading to the final impact label of the domain.

    In the diagram the answers are linked to their relative questions and are represented by the following symbols:
    PH (from 2 to 23) and small arrows

    The question PH1 is necessary for a first selection of damage causes categories, hence does not influence in a direct way the final score. PH24 and PH25 provide, as explained in the previous paragraph, classification and aggregation criteria.
    Since there is a selection concerning the variation of causes leading to health damage increase or decrease, the causes not influencing damage health are simply not selected.

3. The aggregation principle; this element is provided through PH24 and PH25. PH24 allows classification damage severity while PH25 inform on the amount of people impacted.

Figure 3.1 – Diagram of the impact structuring path
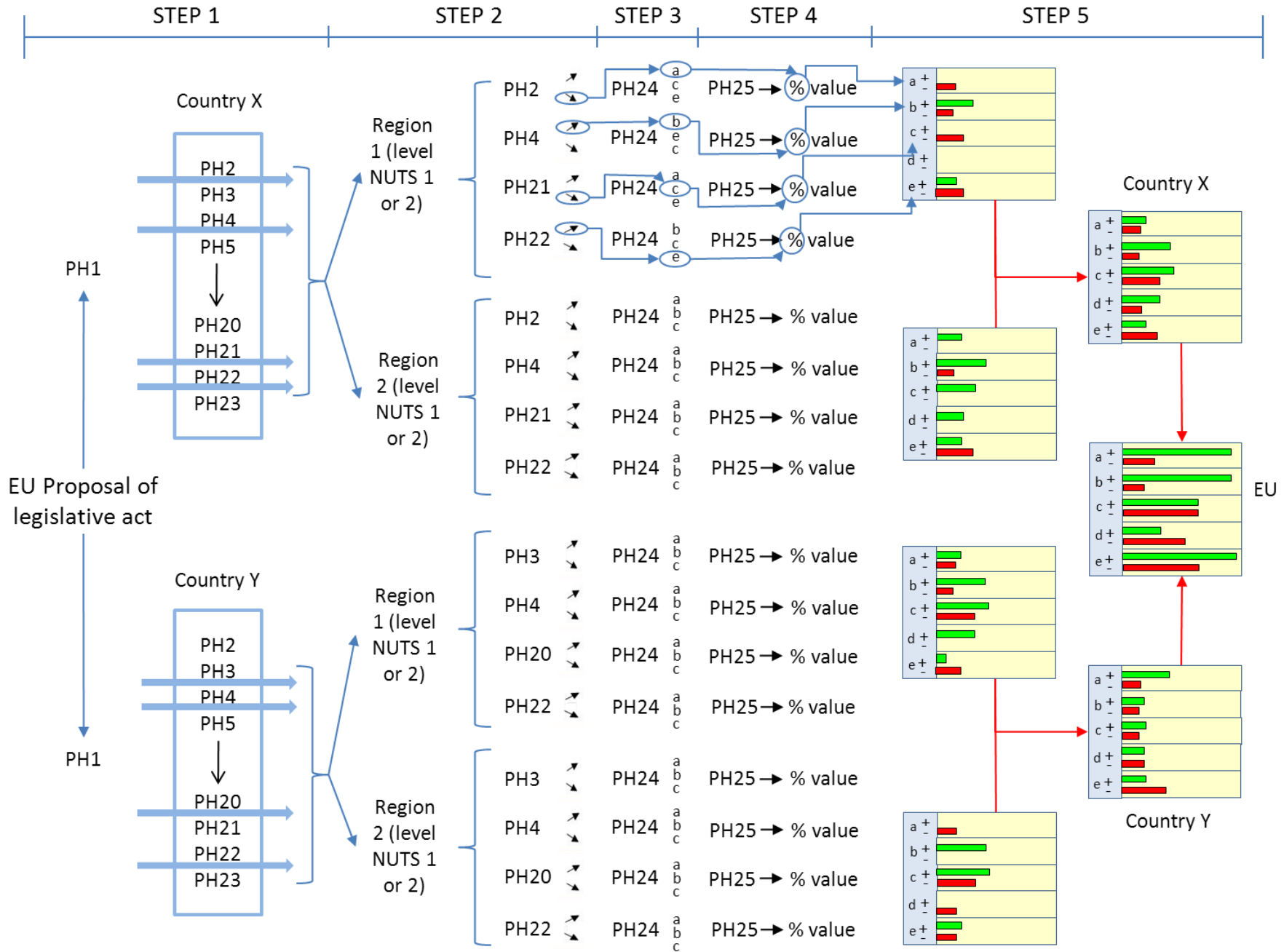
Before starting with the assessment system procedure, the user needs to activate the survey and to identify the experts to address to obtain impacts answers. The horizontal part of the model supports this operational step.

The survey activation is executed by accessing 'LimeSurvey' website and by selecting the appropriate survey (figure 3.2).
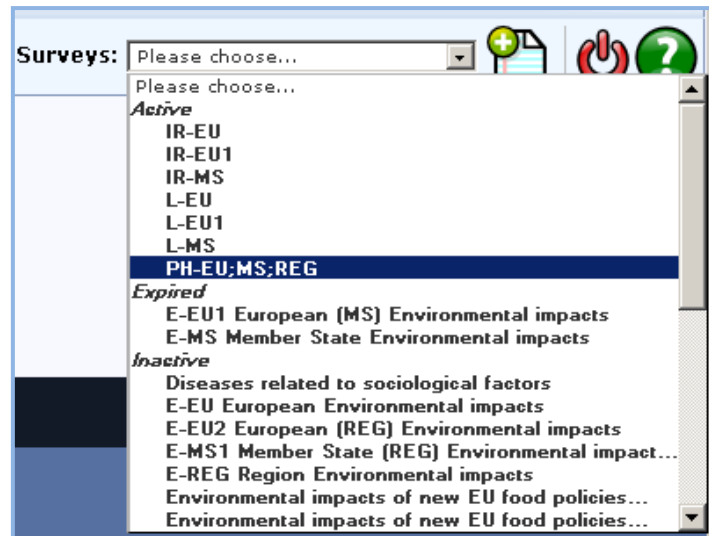
Figure 3.2 – Selection of Public Health survey in LimeSurvey software.

Once obtained regions and countries subjected to likely impacts, I can request to the regional or national health and environmental agencies' experts to provide the impact answers; below I explain the procedure to obtain the answers:

a. I send a first mail asking for the participation to a Public Health impact assessment and explaining in broad lines the model functioning. After their possible confirmation, I explain also how the assessment process works, the time requirements to fulfil the answering task and the duties to honour. Experts welcoming the request and answering back within one week (specified in the mail) take part in the assessment process.

b. After one week, I send to selected experts of point 'a' the new regulation proposal and the information concerning the compliance level of their territory. I specify that within one week they receive a questionnaire with close-ended answers regarding impacts of the new regulation. In this time the expert should carefully read and analyse the regulation trying to visualize future changes requested by new rules.

c. After one week experts receive the questions to answer. If an order to answer the question should be respected, this is specified. They have a minimum of a month to provide their answers.

    d.   After obtaining experts' answers, I input them in the model and obtain the final impact indicators.

By means of the diagram 3.1 I explain the path going from experts' inputs, to the achievement of the model output. The system assessment consists of five steps:

1. selection of causes of human health damage varying because of proposal's consequences;
2. answers for scoring questions PH2 – PH23 concerning the direction of human health damage;
3. answers for question concerning the damage severity for each question of step two;
4. answers for question concerning the number of individual affected for each question of step two;
5. aggregation of the impact results from a regional level to a European level.

To explain system functioning I can imagine of being in the point 'c' of the procedure, while obtaining experts' answers. In this point of the procedure the manager of the health or environmental agency technical department asks to his technical subordinates with specialized knowledge to read through the proposal. Afterwards he asks them to fulfil the step one of the assessment system, namely to select causes of human health damage variation affected by the proposal's consequences.

The answers can be collected through a direct interview, an e-mail or an on-line page transmitting to a server the data to be further processed. In the latter case I imagine a screen-shot like in figure 3.3 and 3.4.

Select factors leading to respiratory problems influenced by the legislative act

Check any that apply

☐ Volatile organic coumpound (VOC's)
☐ Suspendend particulate matter (SPM)
☐ Nitrogen oxides (NOc)
☐ Sulfur oxides (SOx)
☐ Hydrochlorofluorocarbons
☐ Nuclides
☐ Polycyclic aromatic hydrocarbons (PAH's)
☐ CO_2

Select the food production and food consumption related factors influenced by the legislative act leading to health problems.
Check any that apply

☐ Microbiological contaminants
☐ Heavy metals
☐ Pesticides
☐ Dioxin
☐ Hormones
☐ Antibiotics
☐ Additives
☐ Mycotoxins / phytotoxins
☐ Allergens

Select the behavioural/ sociological factors influenced by the legislative act leading to health problems.
Check any that apply

☐ Noise
☐ Change in diet
☐ Stop of physical activity
☐ Tobacco consumption
☐ Alcohol consumption

Figure 3.3 - Screen-shot to collect the input of the first step of the assessment process (Example).

To select factors affected by the regulation the expert should tick off the boxes among the ones provided in the screen. Every damage category has its correspondent list of damage causes.

After the selection of the cause leading to an increase or decrease of human health damage as consequence of the new regulation proposed, the experts have to answer if the variation will have positive or negative effects for the individuals of the territory their environmental or health agency is located in. I am in the second step of the evaluation process. Again the answer can be obtained by means of a direct interview, a mail or an on-line page.

Figure 3.4 - Selection of the impact direction, damage severity and percentage of the population affected related to PH2 damage cause (screen-shot example).

After obtaining the answer of the question concerning the impact direction, as one sees from figure 3.4, the system asks the question concerning the damage severity. The last question the expert has to answer concerns the amount of population affected.

The process of figure 3.4 is in regard of one of the damage causes selected trough the step one of the assessment procedure. The same path of questions should be followed for each one of the selected causes.

At the end of step four I obtained all information I needed from the experts. I calculate the impacts by multiplying the score of questions in step two with the percentage of the population having increasing

or decreasing probability of health problems. The result of this operation is kept divided by the likely illness severity. Finally I can display, for the observation level of the impact analysis (region or country), the impact results as reported in diagram 3.1 STEP 5. Both negative and positive impacts will be visualized for three different levels of illness severity. This impact demonstration allows an easy comparison of different regions' results. I can then aggregate impact results of many regions by adding the likely increasing or decreasing number of people with positive and negative health effects due to the new proposal.

A further operation on the final impact assessment visualization (region, country, EU level) could be operated by assigning a weight to the three different classes of damage severity affecting the overall public health output (figure 3.5). In doing so I have to be sure that the weights' sum of the three categories is one.

This last operation changes the meaning of the information delivered through the impact assessment system. In fact before this operation the system was computing, although with a high level of uncertainty, the amount of people likely to have positive or negative health consequences, hence a countable and physically representative measure unit. After the weighted sum of the three categories of damage severity, I deal with complete qualitative information based on the policy maker's preferences. Nevertheless this final aggregation option allows still the user to highlight difference of positive and negative impacts between two proposals with an even more simplified graphic.
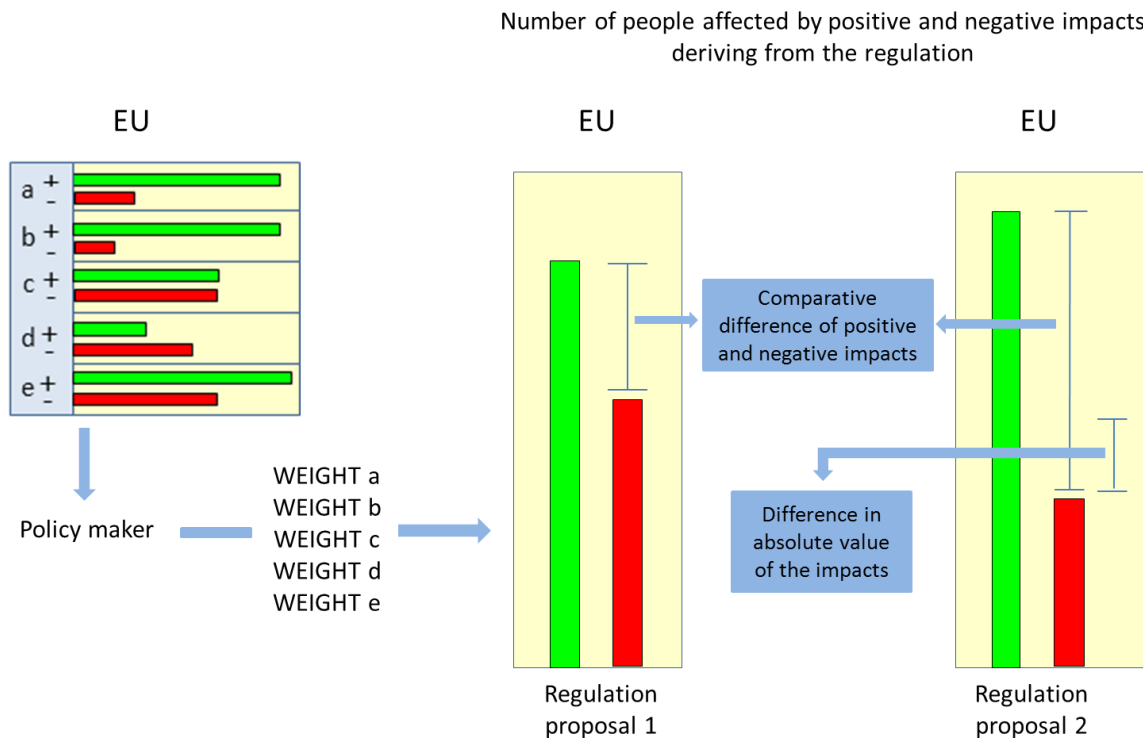
Figure 3.5 – Final impact visualization options.

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Appendix B: 'Environment' Domain Report

Contents

1. Environment Domain definition

A complete environmental impact assessment would require the use of quantitative measure-based methods; among many existing evaluation methods (Input-Output Matter Matrix, Emergy Analysis, Ecological Footprint, Energy Analysis) I consider Life Cycle Assessment the most suitable because of the following reasons:

1. cradle to grave approach;
2. multidimensional impact perspective;
3. solid scientific background in causes-effects relations by the use of fate analysis, exposure analysis, effect analysis and damage analysis;
4. society values expressed through weighting process of damage categories;
5. other environmental impact assessment methods can be built on the LCA system.

LCA method's main concept is that impacts on the environment could be dangerous for the human health. Alarming health situations can originate from:

- direct impact provoked by pollutants;
- indirect impact caused by:
  a) the lack of available natural resources for human activities due to a high resources consumption rate;
  b) a major problem of systemic ecological risk affecting in a not reversible way climate and geopedological conditions (e.g. desertification).

Unfortunately LCA analysis is a time consuming, costly and high information requiring method. As a consequence the methodology cannot fit the purposes of this evaluation system. Nevertheless, the impact categories used in the methodology called ECO-99 are useful to address, through the help of experts' knowledge, the multi-faceted aspects of the Environment concept. Therefore the Environment Domain is assessed trough a rework of ECO-99 categorization and the integration of some environmental impact questions from EC IA guidelines (EC, 2009).

For Environment I intend:

'*A set of biological, physical and chemical parameters, influenced by man, which are conditions to the functioning of man and nature. These conditions include Human Health, Ecosystem Quality and sufficient supply of Resources*'. (Goedkoop Mark, 2001)

When the set of biological, physical and chemical parameters changes in a way that the functioning of man is affected in a negative way, I indicate a state of environmental damage. From the definition of Goedkoop and Mark (2001) three damage categories are considered:

- Human Health
- Ecosystem Quality

- Resources

The category Human Health is not comprised in the Environmental Domain impact assessment system because already part of the Public Health Domain. In addition to the three categories above mentioned I include the Cultural Heritage Capital damage from EC IA guidelines (EC, 2009). Moreover, the general evaluation includes an aspect to analyse that is not corresponding to a damage judgment: the presence of market greening mechanisms.

The idea of 'Ecosystem Quality' considers that non –human species should not suffer from disruptive changes of their populations and geographical distribution. The idea of 'Resources' considers that the nature's supply of non –living goods, which are essential to human society, should be available also for future generations. For 'Cultural Heritage Capital' I intend monuments and landscapes part of society collective memory. Finally 'Market Greening Mechanisms' correspond to the set of public rules related to the production process of goods and services, incentivizing environmental virtuous behaviour or discouraging environmental unfriendly behaviour of food productive system actors.

A negative impact of the Environment Domain means that the level of damage to the environmental system, due to human economic activities, increases; while a positive impact means that the level of damage decreases. The impact evaluation concept is based on the assumption that the optimum of the system assessed corresponds to an equilibrium state between the environmental window and the economic window. If this equilibrium condition exists, the IAS outputs a 'no impact'; in fact no improvement can be brought to a system that is already at its optimum. This definition of environmental impact takes into consideration the physical relation between human activities and environmental resources as defined by Odum T. (1996) and Georgescu-Roegen N. (2003). The latter state that economic activities always produce an entropy increase in the earth environmental system. Therefore the damage to the environment can be regarded as a constant intrinsically present in human society's actions.

Moreover the evaluation approach sets an upper threshold from which pressures on the environment are assessable. The concept of environmental improvements would differently rise experts' agreement problems on a common recognized definition of what 'improvements' (positive impacts) to the existing environment-economy equilibrium state should correspond to.

2. Factors influencing the Environment and Environment's domain categories

The categories grouping environmental food regulations' effects are:

a. ecosystem quality damage;

b. cultural heritage capital damage;

c. natural resource depletion;

d. market greening mechanisms.
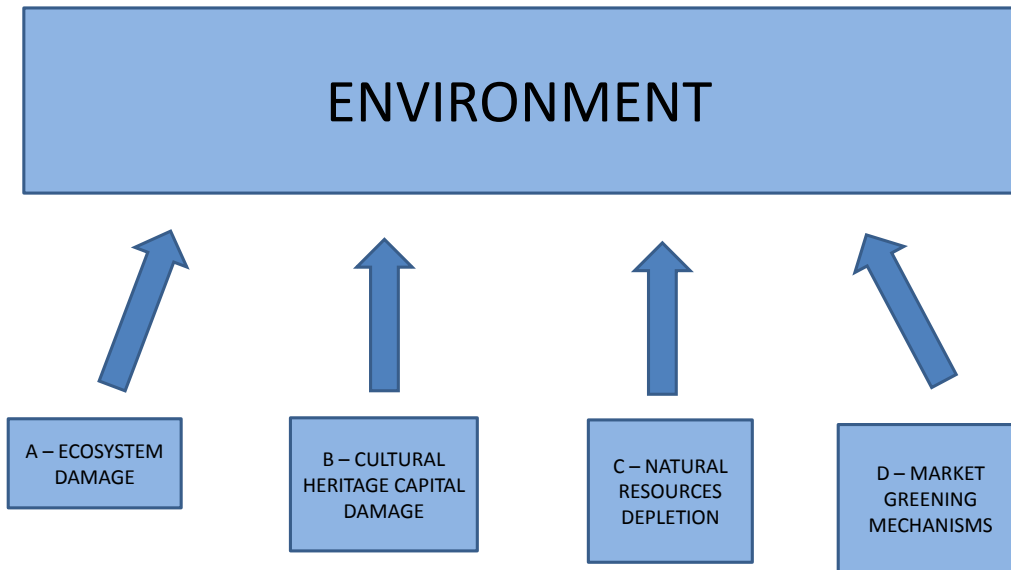
Figure 2.1 - Environment Domain categories.

The second level of categories consists of causes of damages or factors influencing categories above illustrated. Category A is the only one having a deeper level of factors disaggregation. All damage causes have been identified following a top down approach from the upper level:

a. Ecosystem quality damage:

    a) acidification/ Eutrophication:

        1. nitrogen oxides (NOx);

        2. sulfur oxides (SOx);

        3. ammonia (NH3).

    b) Ecotoxicity:

        1. heavy metals bioaccumulation;

        2. pesticydes residues bioaccumulation.

    c) Land occupation / transformation:

        1. built-up land;

        2. protected natural land (forestry, pastures);

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3. migration routes, ecological corridors or buffer zones;
4. soils erosion;
5. salinity of soils.

d) Environmental risk:
1. fire, explosions,breakdowns, accidents;
2. genetically modified organisms dissemination;
3. damage magnitude of natural disasters.

b. Cultural heritage capital damage:
10. nitrogen oxides (NOx);
11. sulfur oxides (SOx);
12. carbon dioxide (CO_2);
13. landscape scenic value;
14. animal welfare.

c. Natural resources depletion:
1. electricity consumption;
2. fossil fuel consumption (direct use of gasoline, coal, methane, LPG);
3. minerals consumption;
4. fresh water consumption.

d. Market greening mechanisms:
1. purchase of environmentally friendly goods and services through changes in taxation, certification, product, designed rules, procurement rules;
2. purchase of environmentally unfriendly goods and services through changes in taxation, certification, product, designed rules, procurement rules;
3. purchase of environmentally friendly goods and services through changes in the rules of capital investments, loans, insurance services;
4. purchase of environmentally unfriendly goods and services through changes in the rules of capital investments, loans, insurance services.

Figure 2.2 displays the relation between 'categories of damage' and 'damage causes'. In the figure one can observe links between causes of damage and questions' codes of the model. In the following part of the paragraph I pass in review the questions classification. All in all questions contributing to the impact calculation of the Environment Domain are 34. Every question has its own ID code with the suffix E (Environment) and a following number.

Fig. 2.2 Relation between categories of damage and damage causes

Appendix B: "Environment" Domain Report

CATEGORIES	SUB - CATEGORIES	DAMAGE CAUSES	QUESTION CODE
	a – Acidification / Eutrophication	Nitrogen oxides (NOx)	E6
		Sulfur oxides (SOx)	E7
		Ammonia (NH3)	E8
A - Ecosystem quality damage	b - Ecotoxicity	Heavy metals	E9
		Pesticydes residues	E10
	c - Land occupation / transformation	Built-up land	E11
		Protected natural land (forestry, pastures)	E12
		Migration routes, ecological corridors, buffer zones	E13
		Soils erosion	E14
		Salinity of soils	E15
	d - Environmental risk	Fire, explosions, breakdowns, accidents	E30
		Genetically modified organisms dissemination	E31
		Damage magnitude of natural disasters	E32
B - Cultural heritage capital damage		Nitrogen oxides (NOx)	E17
		Sulfur oxides (SOx)	E18
		Carbon dioxide	E19
		Landscape scenic value	E20
		Animal welfare	E34
C - Natural resources depletion		Electricity consumption	E22
		Fossil fuel consumption	E23
		Minerals consumption	E24
		Fresh water consumption	E25
D - Market greening mechanisms		Environmental friendly goods through taxation	E26
		Environmental unfriendly goods through taxation	E27
		Environmental friendly goods through capital inv.	E28
		Environmental unfriendly goods through capital inv.	E29

ENVIRONMENT

E1 – E5; E16; E21; E33 Weights/severity and importance of the factors leading to Environmental problems

The assignment of weights or severity values is possible through a ranking question establishing the level of impact relevance that every category has in respect of the others in the observed environmental system. Severity values allow the calculation of the Environment Domain impact output (Region, Member State, Europe levels) and, when available, the aggregation of data from the regional level to the EU level. The rank gives a weight to scoring questions answered in a second step of the evaluation system. Following the list of ranking questions:

E1 - Rank the following categories by importance in affecting the Environment:

	CATEGORIES	EU (1 - 4)	Country A, B, C (1 - 3)	Region A, B, C (1 - 3)
A	Ecosystem quality damage			
B	Cultural capital damage			
C	Natural resources depletion			
D	Market greening mechanisms			

E2 - Rank the following categories by importance in contributing to Ecosystem quality disruption:

	CATEGORIES	EU (1-4)	Country (1-4)	Region a, b, c (1-3)
a	Acidification / Eutrophication			
b	Ecotoxicity			
c	Land occupation / Transformation			
d	Environmental risk			

E3 - Rank the following categories by importance in contributing to Acidification / Eutrophication:

	CATEGORIES	EU (1-3)	Country (1-3)	Region (1-3)
E6	Nitrogen oxides (NOx)			
E7	Sulfur oxides (SOx)			
E8	Ammonia (NH3)			

E4 - Rank the following categories by importance in contributing to Ecotoxicity:

	CATEGORIES	EU (1-2)	Country (1-2)	Region (1-2)
E9	Heavy metals bioaccumulation			
E10	Pesticydes residues bioaccumulation			

E5 - Rank the following categories by importance in affecting Land Occupation / Transformation

	CATEGORIES	EU (1-5)	Country (1-5)	Region (1-5)
E11	Built up land			
E12	Protected natural land			
E13	Migration routes, ecological corridors, buffer zones			
E14	Soils erosion			
E15	Salinity of soils			

E33 - Rank the following categories by importance in contributing to Environmental risk

	CATEGORIES	EU (1-3)	Country (1-3)	
E30	Prevention of fire, explosions, accidental emissions			
E31	Unauthorised dissemination of GMO			
E32	Natural disasters prevention (hydrogeological instability, floods)			

E16 - Rank the following categories by importance in contributing to Cultural heritage capital damage

	CATEGORIES	EU (1-3) E17,18,19 tog.	Country (1-4) not E34	Region (1-4) not E34
E17	Nitrogen oxides (NOx)			
E18	Sulfur oxides (SOx)			
E19	Carbon dioxide (CO2)			
E20	Landscape scenic value			
E34	Animal welfare			

E21 - Rank the following categories by importance in contributing to the Natural resource depletion

	CATEGORIES	EU (1-3)	Country (1-3)	Region (1-3)
E24	CO_2 sinks			
E22	Energy consumption			
E25	Fresh water consumption			

In the ranking the value one corresponds to the most important damage cause influencing the impact category. Tables above display three different levels of answers: *EU, Country, Region*. Every level indicates in parenthesis the maximum number of ranks. As an example I can consider the 'rank question' E1; here positions are three, namely concerning the factors A, B, C. If the evaluation would start from a MS level, without considering the regional one, the available positions would be four. The assumption on which the ranking system relies on is that environmental issues are regulatory matter of the European Communities (European Community, 1957) and consequently evaluations on regulations aiming at tackling environmental problems through common market mechanisms should be judged by experts at EU level.

Two factors affecting the same categories could receive the same rank; this would be represented in the calculation system by the same weight; in any case the sum of all weights influencing the same category must have a value of one.

The scoring question E34 concerning animal welfare is part of the cultural heritage capital damage category because, among many other categories, the latter is the one closer to the overlapping field between the environmental problems and the social problems (ethical issues). The question E34 is part of EU IA guidelines 2009 and it is included in the questions' section Environment.

IMPACT DIRECTION

The question has a ranking function and does not lead to a score; consequently there is no impact direction.

ANSWERS

Number to write in each cell indicating the relevance of a damage cause in affecting the category.

FUNCTION

The question contributes with the relative answer to the composition of the Environment Domain impact output for the Regional, MS and EU level and to the aggregation of data from the regional level to the EU level.

SYSTEM BOUNDARIES ON WHICH THE E1 – E5; E16; E21; E33 QUESTION'S EFFECT OPERATES

Since the model can add up positive and negative impacts for all scoring questions from E6 to E34 in the aggregation process, E1 – E5; E16; E21; E33 can be asked at a regional level as well as at a national one within the answers limit indicated in tables of the previous page. The process could work by asking at the EU level which factors, of E1 – E5; E16; E21; E33 questions, influence the most the Environment Domain. If expertise, knowledge and time allow the user to submit E1 – E5; E16; E21; E33 to regional level experts the final impact reliability would increase.

ANSWER SOURCES

Sources for E1 – E5; E16; E21; E33 questions could be:
- technical division manager of the European environmental agency;
- independent research institute specialized in Environmental Impact Assessment;
- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies.

A – Ecosystem quality damage: E6 – E15; E30 – E32

Questions codes of figure 2.2 highlight how every question relates to a specific damage category and damage cause. The 'ecosystem quality' damage category's impact output is result of the score of the following sub-categories:

    a)   acidification / Eutrophication (E6,E7,E8);

    b)   ecotoxicity (E9, E10);

    c)   land occupation / transformation (E11, E12, E13, E14, E15);

    d)   environmental risk (E30, E31, E32);

'Ecosystem quality' contains the idea that non-humans species should not suffer from disruptive changes of their populations and geographical distribution. I consider:

- 'a' as 'change of nutrient level and acidity in soils due to depositions of inorganic substances such as sulphates, nitrates and phosphates occurring mainly through air and water';

- 'b' as 'percentage of all species present in the environment living under toxic stress (PAF)';

- 'c' as 'area prevented from returning to its natural conditions (land occupation) and 'area converted from one state to another irreversibly';

- 'd' as 'increased likelihood or scale of impacts deriving from fire, explosions, breakdowns, accidents, accidental emissions, GMO unauthorised dissemination, hydro geological instability, floods'.

IMPACT DIRECTION

The increase of damage causes in E6, E7, E8, E9, E10, E11, E14, E15, E31 and E32 produces a negative pressure on the Environment Domain. The increase of factors in E12, E13 and E30 produces a positive pressure on the Environment Domain.

QUESTIONS

E6 *Will the proposal increase, not influence or decrease the probability of ecosystem acidification / eutrophication due to nitrogen oxides (NOx)?*

E7 *Will the proposal increase, not influence or decrease the probability of ecosystem acidification / eutrophication due to sulphur oxides (SOx)?*

E8 *Will the proposal increase, not influence or decrease the probability of ecosystem acidification / eutrophication due to ammonia (NH3)?*

E9 *Will the proposal increase, not influence or decrease the probability of ecosystem ecotoxicity due to heavy metals bioaccumulation?*

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E10 *Will the proposal increase, not influence or decrease the probability of ecosystem ecotoxicity due to pesticides residues bioaccumulation?*

E11 *Will the proposal increase, not influence or decrease the amount of built up land?*

E12 *Will the proposal increase, not influence or decrease the amount of protected natural land (forestry, pastures)?*

E13 *Will the proposal increase, not influence or decrease migration routes, ecological corridors or buffer zones?*

E14 *Will the proposal increase, not influence or decrease soils erosion?*

E15 *Will the proposal increase, not influence or decrease salinity of soils?*

E30 *Will the proposal increase, not influence or decrease the prevention of fire, explosions, breakdowns, accidents and accidental emissions?*

E31 *Will the proposal increase, not influence or decrease the risk of unauthorised or unintentional dissemination of environmentally alien or genetically modified organisms?*

E32 *Will the proposal increase, not influence or decrease the damage magnitude provoked by natural disasters (hydro geological instability, floods)?*

ANSWERS AND RELATED IMPACT DIRECTION

E6 – E11, E14, E15, E31, E32

(c) Increases	score: -1 (negative effect on the environment)
(b) No influence	score: 0 (no effect on the environment)
(a) Decreases	score: 1 (positive effect on the environment)

E12, E13, E30

(a) Increases	score: 1 (positive effect on the environment)
(b) No influence	score: 0 (no effect on the environment)
(c) Decreases	score: -1 (negative effect on the environment)

FUNCTION

The question contributes with the relative answer to the final score on the domain.

SYSTEM BOUNDARIES ON WHICH THE FACTOR EFFECT OPERATES

The score of questions E30, E31, E32 should be considered only for the MS and European level excluding the regional level where usually no emergency crisis unit are in place. The scores of all other questions apply to all possible analysis levels.

ANSWER SOURCES

- technical division manager of the European environmental agency;
- independent research institute specialized in Environmental Impact Assessment;
- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies;
- environmental expert or engineer.

B – Cultural heritage capital damage: E17 – E20, E34

I consider cultural heritage capital:

1. the monuments of a region or country (E17, E18, E19);
2. the scenic value of landscapes (E20);
3. farming animals welfare (E34).

I derived the three impact categories from the EU IA guidelines 2009. The main causes of damage concerning the monuments and open air artefacts are considered in questions E17, E18, E19 and include the following pollutants: nitrogen oxides, sulphur oxides, and carbon dioxide (Bonanni & Cacace, 2006).

For 'Landscape' I mean an '*area perceived by people, whose character is the result of the action and interaction of natural and/or human factors*' (Council of Europe, 2000); damages to landscape modify negatively its significant or characteristic features, justified by its heritage value derived from its natural configuration and/or from human activity.

For what concerns animal welfare I refer to EC directive 58 of 1998 and more specifically to the Annex where definitions of proper treatments respecting farming animals are detailed.

IMPACT DIRECTION

The increase of damage causes in E17, E18 and E19 produces negative pressure on the Environment Domain. The increase of factors in E20 and E34 produces positive pressure on the Environment Domain.

QUESTIONS

E17 *Will the proposal increase, not influence or decrease the probability of monuments degradation due to nitrogen oxides (NOx)?*

E18 *Will the proposal increase, not influence or decrease the probability of monuments degradation due to sulphur oxides (SOx)?*

E19 *Will the proposal increase, not influence or decrease the probability of monuments degradation due to carbon dioxide (CO2)?*

E20 *Will the proposal positively affect, not influence or negatively affect the scenic value of protected landscape?*

E34 *Will the proposal positively affect, not influence or negatively affect the welfare of farming animals?*

ANSWERS AND RELATED IMPACT DIRECTION

E17 – E19

(c) Increases	score: -1 (negative effect on the environment)
(b) No influence	score: 0 (no effect on the environment)
(a) Decreases	score: 1 (positive effect on the environment)

E20, E34

(a) Positively affects	score: 1 (positive effect on the environment)
(b) No influence	score: 0 (no effect on the environment)
(c) Negatively affects	score: -1 (negative effect on the environment)

FUNCTION

The question contributes with its relative answer to the final score on the domain.

SYSTEM BOUNDARIES ON WHICH THE FACTOR EFFECT OPERATES

The score of questions E34 should be considered only for the European level excluding the regional level since animal welfare policy is discussed at EU level. The scores of all other questions apply to all possible analysis levels.

ANSWER SOURCES

- technical division manager of the European environmental agency;
- independent research institute specialized in Environmental Impact Assessment;
- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies;
- environmental expert or engineer.

C – Natural resources depletion: E22 – E25

Factors affecting natural resources depletion in the impacts measuring system are:

1. electricity consumption (E22);
2. fossil fuel as direct use consumption (E23);
3. minerals consumption (E24);
4. fresh water consumption (E25).

The impact on the environment given by this category relies on the idea that the nature's supply of non-living goods, which are essential to the human society, should be available also for future generations. By E23 I mean the consumption for direct use of gasoline, coal, methane, LPG. Questions E22, E23 and E25 should be measured per a single unit of product supplied. For E24 I refer to rare minerals necessary for the production process. Since minerals used along the supply chain can be of many kinds the question here is referred implicitly to the ones specific for the productive system of the country or the region analysed. For fresh water I mean water that has a mean annual salinity lower than 0,5 ‰ (EC, 2000). The four categories of impact derive from the EU IA guidelines 2009.

IMPACT DIRECTION

The increase of damage causes of E22 and E25 produces negative pressure on the Environment.
The increase of CO_2 sinks in E24 produces positive pressure on the Environment.

QUESTIONS

E22 *Will the proposal increase, not influence or decrease the national consumption of energy?*

E24 *Will the proposal increase, not influence or decrease the national CO2 storage capacity (forestry surface, pasture lands, dedicated CO2 sinks)??*

E25 *Will the proposal increase, not influence or decrease the national consumption of fresh water?*

ANSWERS AND RELATED IMPACT DIRECTION

E22, E25

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(c) Increases   score: -1 (negative effect on the environment)

(b) No influence   score: 0 (no effect on the environment)

(a) Decreases   score: 1 (positive effect on the environment)

E24

(a) Increases   score: 1 (positive effect on the environment)

(b) No influence   score: 0 (no effect on the environment)

(c) Decreases   score: -1 (negative effect on the environment)

FUNCTION

The question contributes with the relative answer to the final score on the domain.

SYSTEM BOUNDARIES ON WHICH THE FACTOR EFFECT OPERATES

The score of questions E22 - E25 applies to all analysis levels (EU, MS, Region).

ANSWER SOURCES

- technical division manager of the European environmental agency;
- independent research institute specialized in Environmental Impact Assessment;
- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies;
- environmental expert or engineer.

D – Market greening mechanisms: E26 – E29

I intend for market greening mechanisms a set of rules or practices that modify the regulatory framework and consequently the behaviour of economic actors along the supply chain; the factors I consider in this category are:

1. changes in taxation, certification, product, designed rules, procurement rules for environmental friendly product purchase promotion;
2. changes in taxation, certification, product, designed rules, procurement rules for environmental unfriendly product purchase promotion;
3. changes in the rules of capital investments, loans, insurance services for environmental friendly product purchase promotion;
4. changes in the rules of capital investments, loans, insurance services for environmental unfriendly product purchase promotion.

The four categories of impact derive from the EU IA guidelines 2009.

IMPACT DIRECTION

The increase of damage causes in E26, E28 produces negative pressure on the Environment.

The increase of factors in E27 and E29 produces positive pressure on the Environment.

QUESTIONS

E26 *Will the proposal incentivise, not influence or discourage the purchase of environmentally friendly goods and services through changes in taxation, certification, product designed rules, procurement rules?*

E27 *Will the proposal incentivise, not influence or discourage the purchase of environmentally unfriendly goods and services through changes in taxation, certification, product, designed rules, procurement rules?*

E28 *Will the proposal incentivise, not influence or discourage the purchase of environmentally friendly goods and services through changes in the rules of capital investments, loans, insurance services?*

E29 *Will the proposal incentivise, not influence or discourage the purchase of environmentally unfriendly goods and services through changes in the rules of capital investments, loans, insurance services?*

ANSWERS AND RELATED IMPACT DIRECTION

E27, E29

(c) Incentivise   score: -1 (negative effect on the environment)
(b) No influence   score: 0 (no effect on the environment)
(a) Discourage   score: 1 (positive effect on the environment)

E26, E28

(a) Incentivise   score: 1 (positive effect on the environment)
(b) No influence   score: 0 (no effect on the environment)
(c) Discourage   score: -1 (negative effect on the environment)

FUNCTION

The question contributes with the relative answer to the final score on the domain.

SYSTEM BOUNDARIES ON WHICH THE FACTOR EFFECT OPERATES

The score of questions E26 - E29 will be considered only for European level of analysis and impact because of European common market regulatory framework.

ANSWER SOURCES

- technical division manager of the European environmental agency;
- independent research institute specialized in Environmental Impact Assessment;
- technical division manager of national environmental agencies;
- technical division manager of regional environmental agencies;
- environmental expert or engineer.

Table 2.1a – Summary of Environment categories and relative impact contribution on the final score.

DOMAIN	ID QUESTION	CATEGORIES	QUESTIONS	ANSWERS	ANSWERS' IMPACT DIRECTION		FUNCTION	SPATIAL BOUNDARIES	POTENTIAL SOURCES
E - E N V I R O N M E N T	E6	Ecosystem acidification / eutrophication	Will the proposal increase, not influence or decrease the probability of ecosystem acidification / eutrophication due to nitrogen oxides (NOx)?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E7	Ecosystem acidification / eutrophication	Will the proposal increase, not influence or decrease the probability of ecosystem acidification / eutrophication due to sulphur oxides (SOx)?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E8	Ecosystem acidification / eutrophication	Will the proposal increase, not influence or decrease the probability of ecosystem acidification / eutrophication due to ammonia (NH3)?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E9	Ecosystem ecotoxicity	Will the proposal increase, not influence or decrease the probability of ecosystem ecotoxicity due to heavy metals bioaccumulation?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E10	Ecosystem ecotoxicity	Will the proposal increase, not influence or decrease the probability of ecosystem ecotoxicity due to pesticides residues bioaccumulation?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E11	Land occupation / transformation	Will the proposal increase, not influence or decrease the amount of built up land?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E12	Land occupation / transformation	Will the proposal increase, not influence or decrease the amount of protected natural land (forestry, pastures)?	Increase	a	1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	c	-1			
	E13	Land occupation / transformation	Will the proposal increase, not influence or decrease migration routes, ecological corridors or buffer zones?	Increase	a	1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	c	-1			
	E14	Land occupation / transformation	Will the proposal increase, not influence or decrease soils erosion?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			

Table 2.1b – Summary of Environment categories and relative impact contribution on the final score.

E - ENVIRONMENT	E15	Land occupation / transformation	Will the proposal increase, not influence or decrease salinity of soils?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E17	Cultural heritage capital damage	Will the proposal increase, not influence or decrease the probability of monuments degradation due to nitrogen oxides (NOx)?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E18	Cultural heritage capital damage	Will the proposal increase, not influence or decrease the probability of monuments degradation due to sulphur oxides (SOx)?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E19	Cultural heritage capital damage	Will the proposal increase, not influence or decrease the probability of monuments degradation due to carbon dioxide (CO2)?	Increase	c	-1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E20	Cultural heritage capital damage	Will the proposal positively affect, not influence or negatively affect the scenic value of protected landscape?	Positively affect	a	1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Negatively affect	c	-1			
	E22	Natural resource depletion	Will the proposal increase, not influence or decrease the electricity consumption in relation to a single product unit?	Increase	c	1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	-1			
	E23	Natural resource depletion	Will the proposal increase, not influence or decrease the consumption of fossil fuel (gasoline, coal, methane, LPG) for direct use in relation to a single product unit?	Increase	c	1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	-1			
	E24	Natural resource depletion	Will the proposal increase, not influence or decrease rare minerals consumption?	Increase	c	1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	-1			
	E25	Natural resource depletion	Will the proposal increase, not influence or decrease fresh water consumption in relation to a single product unit?	Extend	c	1	score	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Diminish	a	-1			

Table 2.1c – Summary of Environment categories and relative impact contribution on the final score.

E - ENVIRONMENT	E26	Market greening mechanisms	Will the proposal incentivise, not influence or discourage the purchase of environmentally friendly goods and services through changes in taxation, certification, product designed rules, procurement rules?	Incentivise	a	1	score	EU	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Discourage	c	-1			
	E27	Market greening mechanisms	Will the proposal incentivise, not influence or discourage the purchase of environmentally unfriendly goods and services through changes in taxation, certification, product, designed rules, procurement rules?	Incentivise	c	-1	score	EU	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Discourage	a	1			
	E28	Market greening mechanisms	Will the proposal incentivise, not influence or discourage the purchase of environmentally friendly goods and services through changes in the rules of capital investments, loans, insurance services?	Incentivise	a	1	score	EU	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Discourage	c	-1			
	E29	Market greening mechanisms	Will the proposal incentivise, not influence or discourage the purchase of environmentally unfriendly goods and services through changes in the rules of capital investments, loans, insurance services?	Incentivise	c	-1	score	EU	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Discourage	a	1			
	E30	Environmental risk	Will the proposal increase, not influence or decrease the prevention of fire, explosions, breakdowns, accidents and accidental emissions?	Increase	a	1	score	EU, Country	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	c	-1			
	E31	Environmental risk	Will the proposal increase, not influence or decrease the risk of unauthorised or unintentional dissemination of environmentally alien or genetically modified organisms?	Increase	c	-1	score	EU, Country	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E32	Environmental risk	Will the proposal increase, not influence or decrease the damage magnitude provoked by natural disasters (hydro geological instability, floods)?	Increase	c	-1	score	EU, Country	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Decrease	a	1			
	E34	Cultural heritage damage	Will the proposal positively affect, not influence or negatively affect the welfare of farming animals?	Positively affect	a	1	score	EU	European, national, regional environmental agency; Environmental engineer and expert
				Not influence	b	0			
				Negatively affect	c	-1			

Table 2.1d – Summary of Environment categories and relative impact contribution on the final score.

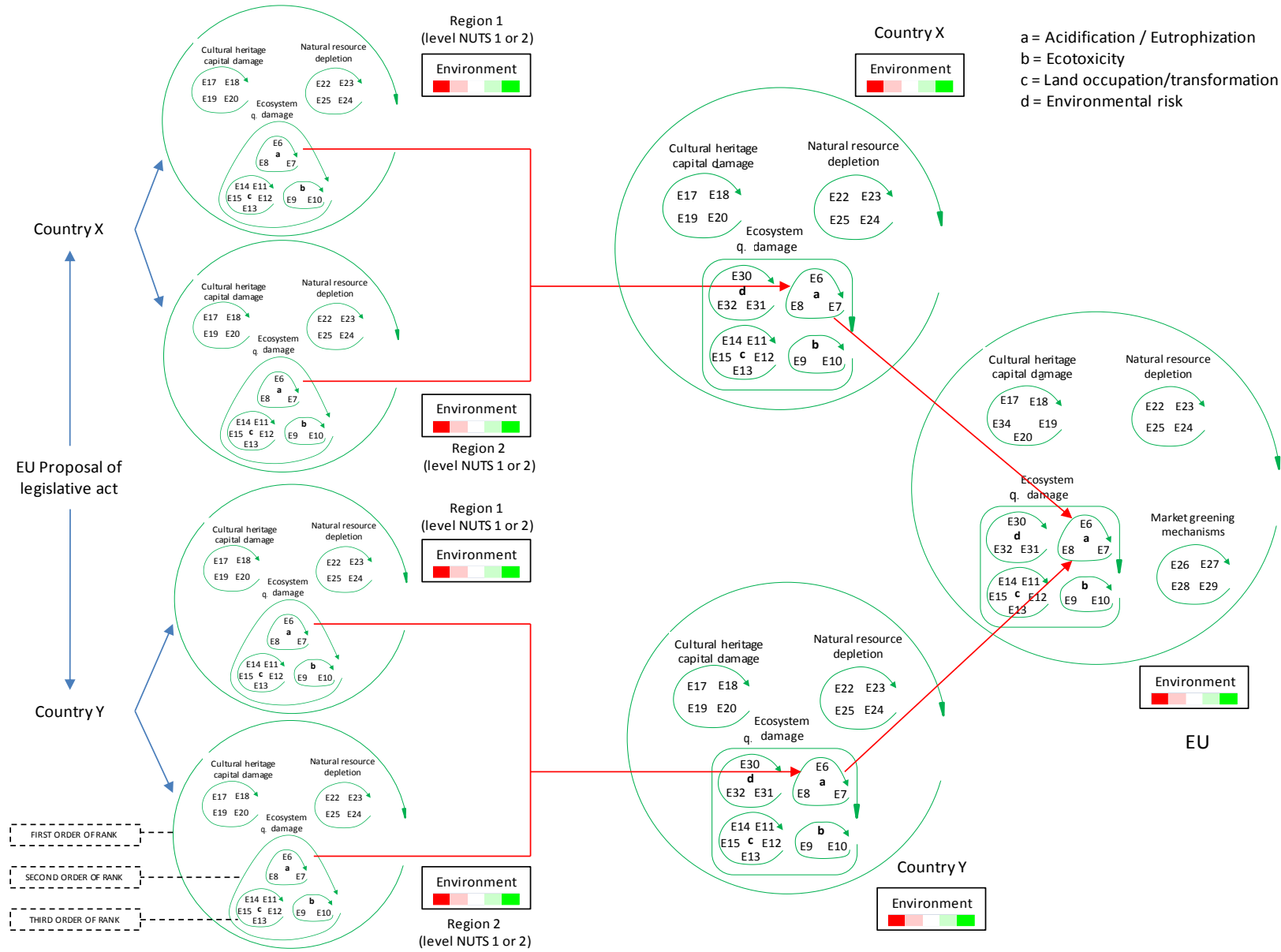| E N V I R O N M E N T									
	E1	Environment	Rank the following categories by importance in affecting the Environment	Ecosystem quality damage	A	-	rank	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Cultural capital damage	B	-			
				Natural resources depletion	C	-			
				Market greening mechanisms	D	-			
	E2	Ecosystem quality disruption	Rank the following categories by importance in contributing to Ecosystem quality disruption	Acidification / Eutrophication	a	-	rank	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Ecotoxicity	b	-			
				Land occupation / Transformation	c	-			
				Environmental risk	d	-			
	E3	Acidification / Eutrophication	Rank the following categories by importance in contributing to Acidification / Eutrophication	Nitrogen oxides (NOx)	E6	-	rank	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Sulfur oxides (SOx)	E7	-			
				Ammonia (NH3)	E8	-			
	E4	Ecotoxicity	Rank the following categories by importance in contributing to Ecotoxicity	Heavy metals bioaccumulation	E9	-	rank	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Pesticydes residues bioaccumulation	E10	-			
	E5	Land Occupation / Transformation	Rank the following categories by importance in affecting Land Occupation / Transformation	Built up land	E11	-	rank	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Protected natural land	E12	-			
				Migration routes, ecological corridors or buffer zones	E13	-			
				Soils erosion	E14	-			
				Salinity of soils	E15	-			
	E33	Environmental risk	Rank the following categories by importance in contributing to Environmental risk	Prevention of fire, explosions, accidental emissions	E30	-	rank	EU, Country	European, national, regional environmental agency; Environmental engineer and expert
				Unauthorised dissemination of GMO	E31	-			
				Natural disasters prevention (hydrogeological instability, floods)	E32	-			
	E16	Cultural heritage capital damage	Rank the following categories by importance in contributing to Cultural heritage capital damage	Nitrogen oxides (NOx)	E17	-	rank	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Sulfur oxides (SOx)	E18	-			
				Carbon dioxide (CO2)	E19	-			
				Landscape scenic value	E20	-			
				Animal welfare	E34	-			
	E21	Natural resource depletion	Rank the following categories by importance in contributing to Natural resource depletion	Minerals	E24	-	rank	EU, Country, NUTS1, NUTS2	European, national, regional environmental agency; Environmental engineer and expert
				Fossil fuel	E22-E23	-			
				Water	E25	-			

3. Environment impact assessment system

Figure 3.1 represents the impact assessment system of the Environment Domain. Main elements to consider in the assessment procedure are:

1. The boundaries of the territorial system in which impacts provoked by the regulation occur. The territorial system can be defined trough the output of the horizontal part of the model. In fact, connected to the enterprises classes' compliance, there is their localization. Consequently I know where impacts have effects on society. More precisely, this element defines the impact providers' unit (regions and countries) and therefore the impact aggregation structure. Here both impacts counting structure and aggregation principle derive from the productive system selected and the territory selected. The questions leading to a score are then asked in a small part to representatives of the industry and in a bigger part to regional or national environmental agencies and experts. The information concerning the productive system allow to aggregate impacts deriving from companies' compliance from a regional level to an EU level.

2. The answers' score; this element corresponds to one of the mathematical values leading to a final judgment on the domain's impact. In the diagram the answers, although not represented by arrows like in the other domain reports, should be considered linked to their relative questions represented by the following symbol: E6, E7, E8, E9, E10, E11, E12, E13, E14, E15, E17, E18, E19, E20, E22, E23 E24, E26, E27, E28, E29, E30, E31, E32 and E34. Differently than in diagrams of other Domains Reports the small arrows symbol is omitted to avoid confusion in the graphic representation.

3. The aggregation principles; The domain allows two aggregation principles. The first reflects the value preferences of the policy maker by assigning a weight to different categories forming the final Environment Domain impact. The second reflects the magnitude of the likely changes provoked by the new regulation through enterprises' compliance scale. The first aggregation principle is represented in the diagram by green arrows and the second one by red arrows. While the first aggregation principle is the result of answers for 'ranking questions' (E1, E2, E3, E4, E5, E16, E21, E25, E33), the second aggregation principle, as for Firm Competition domain, relies on the percentage of enterprises complying in respect of the superior level of aggregation; the assumption is that major impacts due to the changes of the productive system occur where the compliance scale is bigger.

Figure 3.1 – Diagram of the impact structuring path.

Region 1
(level NUTS 1 or 2)

Country X

a = Acidification / Eutrophization
b = Ecotoxicity
c = Land occupation/transformation
d = Environmental risk

Cultural heritage capital damage

E17 E18
E19 E20

Natural resource depletion

E22 E23
E25 E24

Ecosystem q. damage

E6
a
E8   E7

E14 E11
E15 c E12
E13

b
E9 E10

Environment

Country X

EU Proposal of legislative act

Region 2
(level NUTS 1 or 2)

Environment

Country Y

Environment

Market greening mechanisms

E26 E27
E28 E29

EU

FIRST ORDER OF RANK

SECOND ORDER OF RANK

THIRD ORDER OF RANK

Environment

Country Y

Environment

Environment

Appendix B: "Environment" Domain Report

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Before starting with the assessment system I need to know who address to obtain the answers leading to the final impact. This information is provided by the horizontal output of the model. Part of the inputs derives from the horizontal part questionnaire on likely compliance level from enterprises classes' representatives (questions E22, E23 and E25). Once I know which regions and countries are subjected to likely impacts, I can request the other parts of the inputs necessary for the impact assessment; I address then regional or national environmental agencies' experts to answer; below it is explained the procedure to obtain the answers:

a. I send a first mail asking for the participation to a Public Health impact assessment and explaining in broad lines the model functioning. After their possible confirmation, I explain also how the assessment process works, the time requirements to fulfil the answering task and the duties to honour. Experts welcoming the request and answering back within one week (specified in the mail) take part in the assessment process.

b. After one week, I send to selected experts of point 'a' the new regulation proposal and the information concerning the compliance level of their territory. I specify that within one week they receive a questionnaire with close-ended answers regarding impacts of the new regulation. In this time the expert should carefully read and analyse the regulation trying to visualize future changes requested by new rules.

c. After one week experts receive the questions to answer. If an order to answer the question should be respected, this is specified. They have a minimum of a month to provide their answers.

d. After obtaining experts' answers, I input them in the model and obtain the final impact indicators.

By means of diagram 3.1, I explain the path going from experts' inputs, to the achievement of the model output. The system assessment consists of three steps:

1. The rank of the most relevant categories in producing an environmental impact.

2. The answering of 'scoring questions' (from E6 to E15; from E17 to E20; from E22 to E24; from E26 to E32 and E34) providing the direction of the impact on the Environment Domain.

3. The aggregation of experts' information to obtain the output.

To explain the working of the system I can imagine of being in the point 'c' of the procedure, while obtaining the expert answers. In this point of the procedure the manager of the environmental agency technical department asks to his technical subordinates with specialized knowledge to read through the proposal. Afterwards he asks them to fulfil the step one of the assessment system, namely to rank

among categories provided, the most relevant ones in terms of proposal's consequences for their geographical area. Answers are collected through direct interviews, e-mails or an on-line page delivering the impact data to a server. In the latter case I can imagine a screen-shot like in figure 3.2.

Evaluate the following categories according to their contribution to the European **ecosystems' quality deterioration**. Therefore assign a weight by using the slider. The weight should not add up to 100.

Acidification/ eutrophication — 50

Ecotoxicity — 14

Land occupation/ transformation — 60

Environmental risk — 28

? 'Ecosystem quality' contains the idea that non-humans species should not suffer from disruptive changes of their populations and geographical distribution. We consider factors influencing ecosystem quality:
1. Acidification / eutrophication: change of nutrient level and acidity in soils due to depositions of inorganic substances such as sulphates, nitrates and phosphates occurring mainly through air and water.
2. Ecotoxicity: percentage of all species present in the environment living under toxic stress (PAF).
3. Land occupation / transformation: area prevented from returning to its natural conditions (land occupation) and area converted from one state to another irreversibly.
4. Environmental risk: increased likelihood or scale of impacts deriving from GMO unauthorised dissemination.

Figure 3.2 - Screen-shot to collect the input of the first step of the assessment process – second order of rank (Example).

Diagram 3.1 demonstrates that, starting from left to right, the impact output obtained from regional inputs requires at least three orders of ranking. The third order regards the relevance of the factors represented by the single 'scoring questions'. The second order of rank affects the relevance of the category grouping the factors of the third order of rank. This ranking step is the one of the screen in figure 3.2. E.g. After assigning the relative contribution of NOx, SOx and NH_3 to the regional acidification/ eutrophication process, it is necessary to set 'acidification/ eutrophication' importance in contributing to the regional ecosystem quality disruption in respect of the other three categories. In collecting the input from the experts, I use a top down ranking dynamic; namely I let them rank in a first moment, through a screenshot appearance sequence, the second order of rank (figure 3.2). Afterwards the expert assigns weights also to factors named by 'scoring questions' (figure 3.3).

Weigh the following categories according to their influence to **the acidification / eutrophication process of the European environmental system.**Therefore assign a weight by using the slider. The weight should not add up to 100.

40
Nitrogen oxides (NOx)
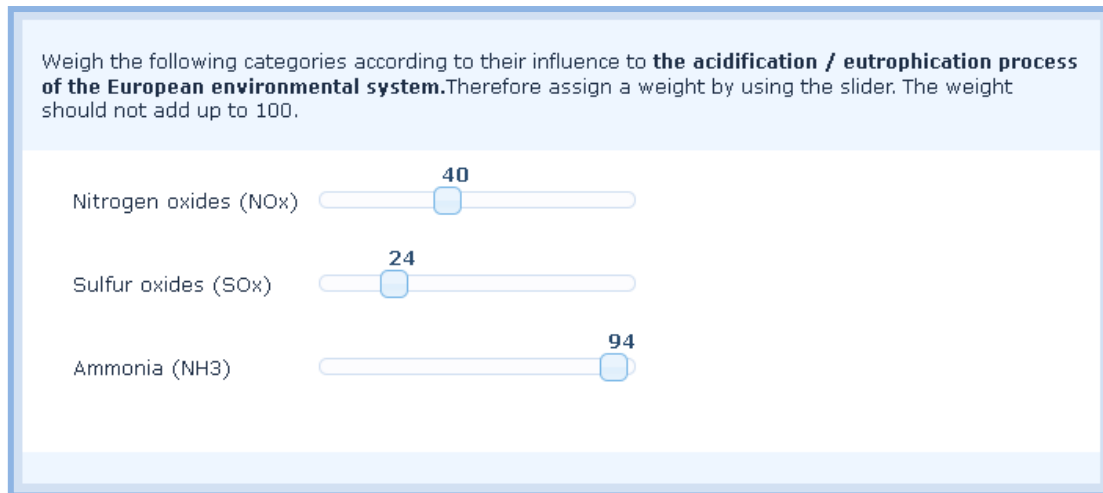
24
Sulfur oxides (SOx)

94
Ammonia (NH3)

Figure 3.3 – Third order of rank (screen-shot example).

The first level of rank consists of the rank of the main categories contributing to the Environment Domain impact; one can notice from figure 3.1 that, at the regional level, the first level of rank applies to the following categories: 'ecosystem quality damage', 'cultural heritage capital damage' and 'natural resource depletion'. At the country level, there are still the same three categories. Differently, for the second order of rank I add to the Ecosystem quality damage the category 'environmental risk'. At the European level, I still have the same categories of the country level plus the category 'market greening mechanisms' (figure 3.4).
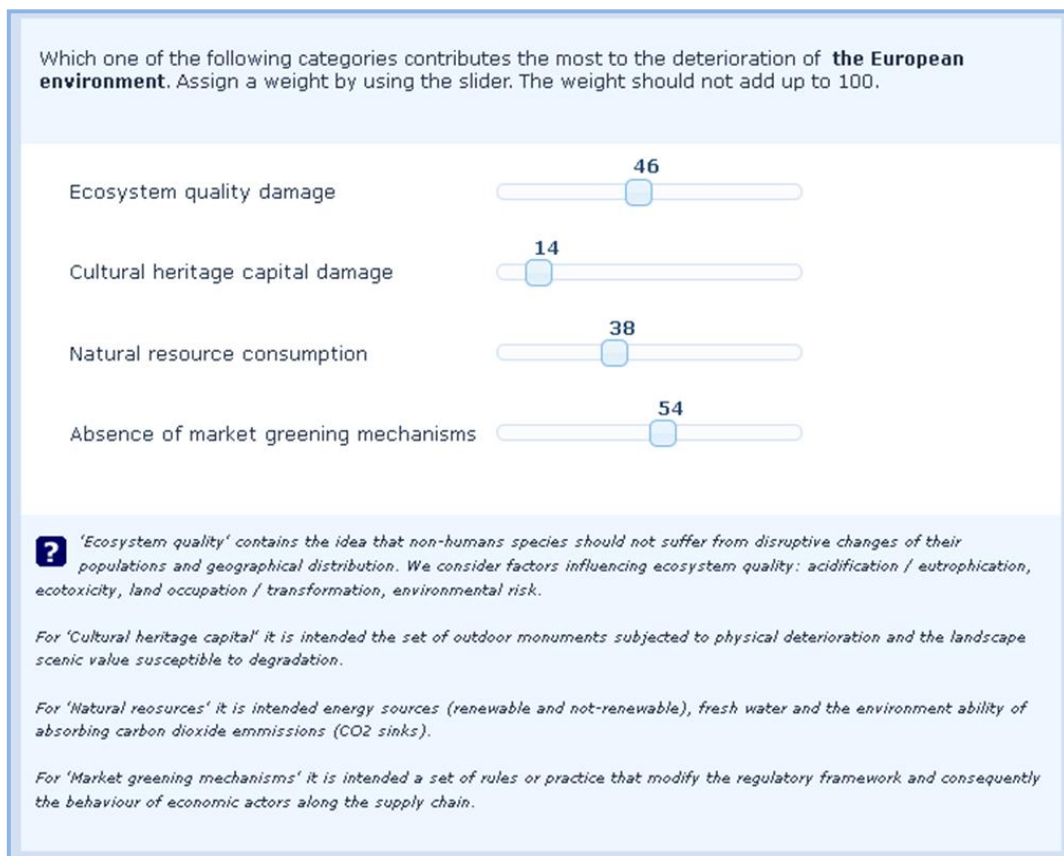

Which one of the following categories contributes the most to the deterioration of **the European environment**. Assign a weight by using the slider. The weight should not add up to 100.

46
Ecosystem quality damage

14
Cultural heritage capital damage

38
Natural resource consumption

54
Absence of market greening mechanisms

'Ecosystem quality' contains the idea that non-humans species should not suffer from disruptive changes of their populations and geographical distribution. We consider factors influencing ecosystem quality: acidification / eutrophication, ecotoxicity, land occupation / transformation, environmental risk.

For 'Cultural heritage capital' it is intended the set of outdoor monuments subjected to physical deterioration and the landscape scenic value susceptible to degradation.

For 'Natural reosurces' it is intended energy sources (renewable and not-renewable), fresh water and the environment ability of absorbing carbon dioxide emmissions (CO2 sinks).

For 'Market greening mechanisms' it is intended a set of rules or practice that modify the regulatory framework and consequently the behaviour of economic actors along the supply chain.

Figure 3.4 – First order of rank at EU level (screen-shot example).

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Through the first rank order I can obtain the final output of the domain, namely the visualization of the impact direction. When the policy maker requires an evaluation at a European level, I ask for the first order of rank only at the EU level; in this case it is not necessary, for the calculations and the aggregation process, to obtain intermediate evaluations of final impact outputs of the Environment Domain derived from countries or the regions. Differently, the second order of rank is an obligatory step at every level, although the evaluation remains for EU as a whole; exact the second order of impact results requires the aggregation through the information of enterprises' compliance. It follows from above that the third order of rank, concerning the scoring questions, is obligatory too.

Figure 3.5 - Selection of impact direction for acidification / eutrophication category (screen-shot example).

After obtaining the severity of every impact category, I ask information about the impact direction by means of 'scoring questions' (bottom of figure 3.5). Before providing the direction of the impact the expert has to read the legislative proposal; then he has to filter those factors that are influenced by the legislative proposal measure (top part of figure 3.5). Answers of the experts are automatically collected by the computing system and transferred to the elaboration files of the impact assessment system.

Through the whole answering process the expert is supported with labels explaining in a more defined way the meaning of the technical terms used in the survey (bottom of figure 3.4).

To obtain the impact of the Environment Domain the following steps are suggested:

1) list the possible experts and obtain their e-mail address:
   - environmental experts of regions and countries affected by the legislation proposal;
   - environmental expert representing the EU;

2) activate surveys (figure 3.6);

3) after one month download experts' answers and insert them in the elaboration file '06_Environment'. Every answer has a code that helps to find the right collocation within the spread sheet. The final result is shown in the excel file.
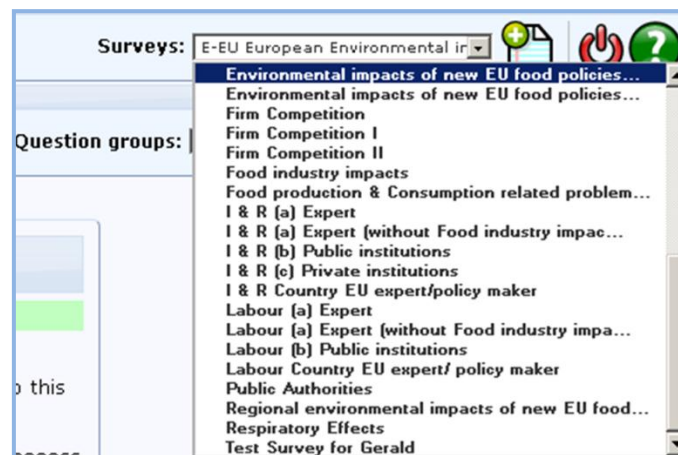

Figure 3.6 – Selection of the Environment Domain survey

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Appendix C: State of the art of the current Decision Support System software based on the impact assessment system approach.

Decision Support System requirements:

- Microsoft Windows XP or Windows Vista or Windows 7 operative system.
- Microsoft Access and Microsoft Excel – Microsoft Office 2010 Professional.
- Acrobat Reader – Adobe.
- LimeSurvey - open source software and related specific requirements (hosting server).
- MySQL ODBC 3.51 driver (free download).
- Browser: Mozilla Firefox – free download (suggested).
- Email management software: Mozilla Thunderbird – free download (suggested).

Three types of actors let the DSS system works, respectively the administrator (in black in figure 1), the user (in red) and the experts (in blue).

The first actor gives the user the access to the system providing him, by means of a password for the LimeSurvey software, the possibility to use or modify existing selected surveys. Through the surveys is possible to obtain the inputs from the experts to run the DSS. The administrator corresponds to the physical or juridical person owning the rights of use of the DSS.

The user or analyst is the person running the DSS. Given the easiness of the DSS functioning, the user could be directly the client or alternatively the decision/ policy maker.

The expert is the person, previously identified by the user, able to provide the judgments/ inputs for the system because of his specialized knowledge of a specific domain.

Eventually an external actor gives the start to the DSS use, namely the client interested in obtaining the output table results or in general an ex-ante impact evaluation on a series of actions or measures applicable to a defined socio-economic system. The client can act on request of the decision maker or it can be the decision maker itself.

To explain the structure of the DSS I refer to figure 1 and its three different planes: the 'Experts' opinions management system or DSS' plane (where the screenshots of the system of the DSS are displayed), the 'Expertise inputs' plane and the 'Elaboration files' plane (all with yellow background in figure 1).
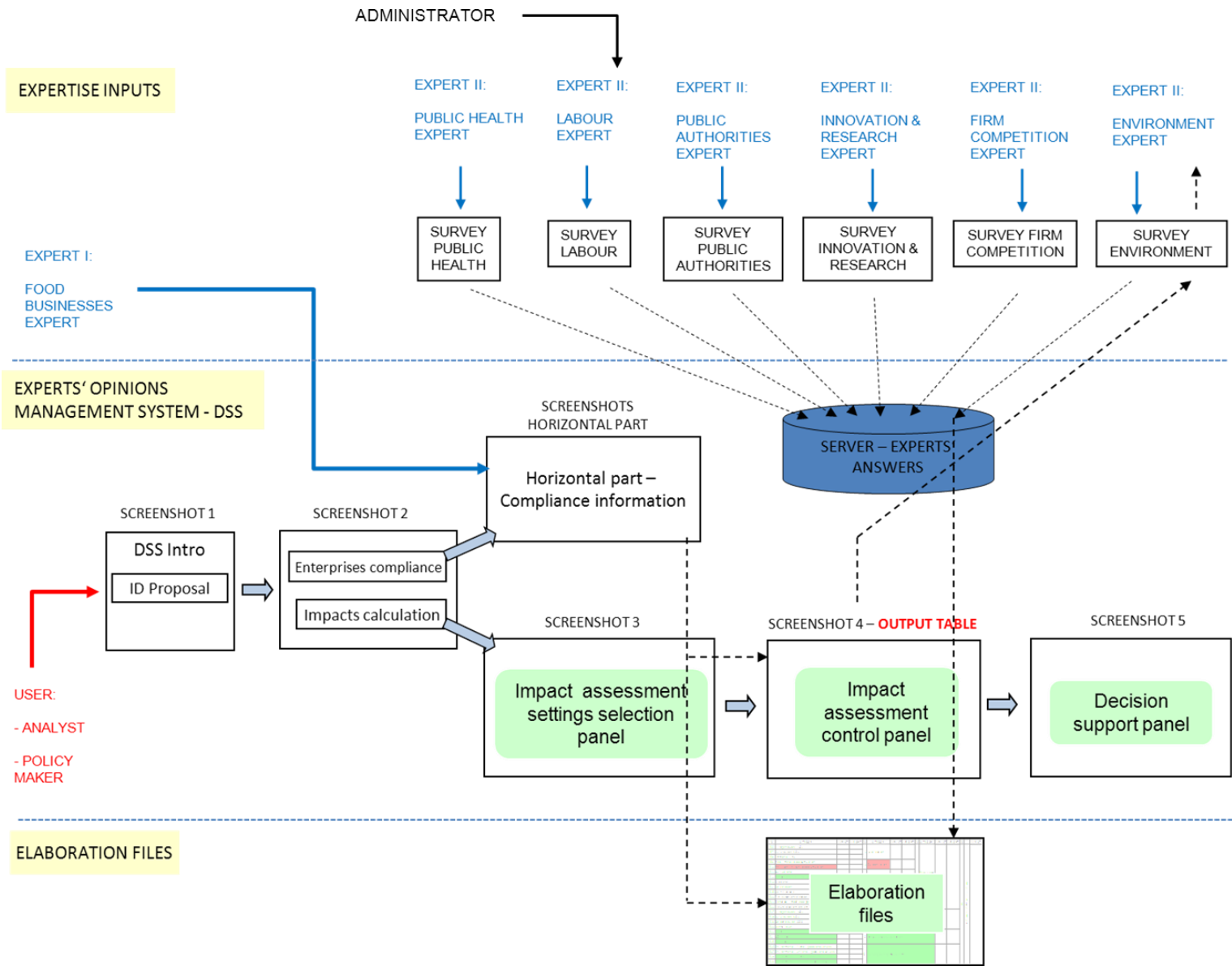
Figure 1: Structure of the information flow of the Decision Support System.

The DSS first step is done by the user by accessing the first screenshot of the DSS (figure 2). Here the user has to assign an ID to the whole evaluation process by writing the name of the proposal and the draft version; this ID is always displayed in all screenshots of the DSS.
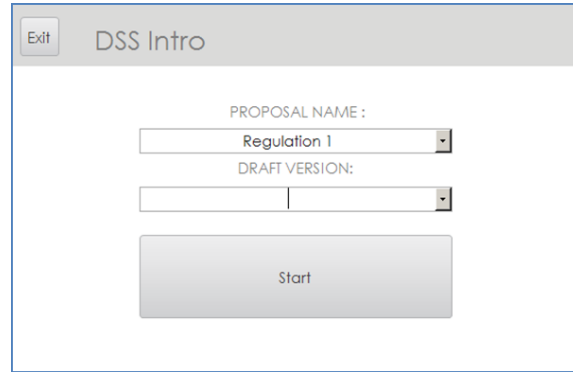

Figure 2: Initial screenshot of the DSS – Access to the DSS.

By clicking on 'Start' the user accesses the second screenshot (figure 3) where he has to decide whether he wants to obtain information concerning the compliance of the enterprises in respect of the proposal analysed, or he wants to ask directly for the experts' opinions to calculate and visualize the impacts. In the latter case, as the user did not go through the horizontal part of the DSS, hence has no information on the enterprises behaviour in the several MSs, the impact calculation will relies exclusively on a European level of expertise, corresponding to one expert per single domain of impact interviewed through the on-line survey software.
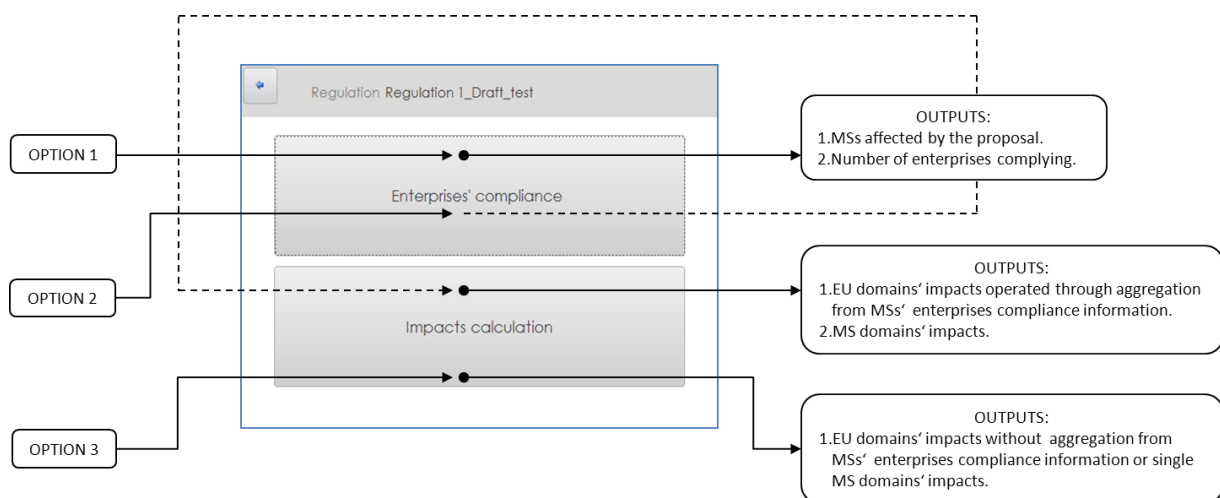

Figure 3: Second screenshot of the DSS.

By means of screenshot 2 (figure 1) I can point out the DSS flexibility: the user is left free to run only the enterprises' compliance analysis or to run only the impact calculation (with no reference to MSs' impacts and enterprises' compliance) or to use the enterprise' compliance information (Member States and number of complying companies) to run the calculation of the impacts.

Once clicked on the enterprises' compliance button I access the horizontal part of the DSS. Here I follow a series of arguments (figure 4) in order to obtain the final information corresponding to the number of enterprises complying by MS.

Here for the first time the user establishes a contact with the second type of actor, namely the expert for conduct of business. This part of the system allows only a direct interview approach to obtain the expert knowledge. At this stage of the DSS the user limits itself in questioning the expert as requested by the line of arguments in the screenshots.
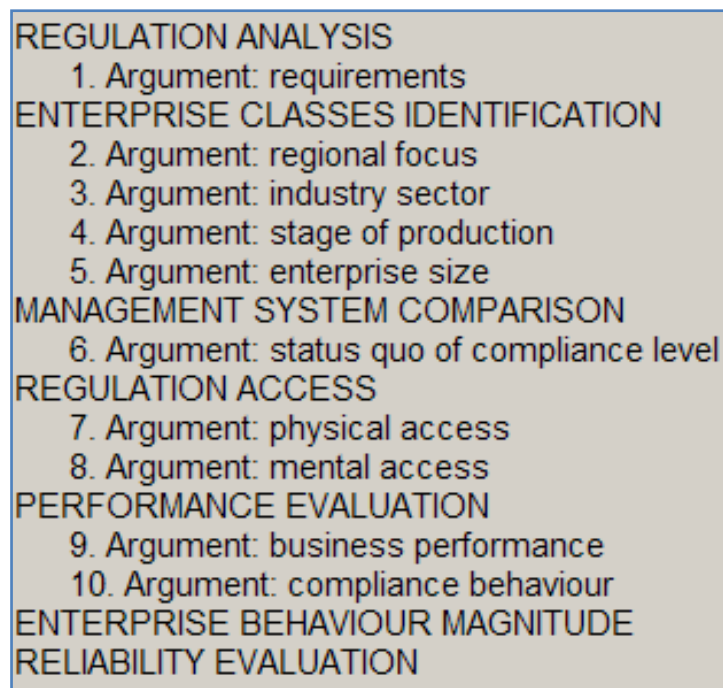
REGULATION ANALYSIS
    1. Argument: requirements
ENTERPRISE CLASSES IDENTIFICATION
    2. Argument: regional focus
    3. Argument: industry sector
    4. Argument: stage of production
    5. Argument: enterprise size
MANAGEMENT SYSTEM COMPARISON
    6. Argument: status quo of compliance level
REGULATION ACCESS
    7. Argument: physical access
    8. Argument: mental access
PERFORMANCE EVALUATION
    9. Argument: business performance
    10. Argument: compliance behaviour
ENTERPRISE BEHAVIOUR MAGNITUDE
RELIABILITY EVALUATION

Figure 4: Line of arguments used for the enterprises' compliance prediction (horizontal part of the DSS).

Every screenshot of this part of the DSS let the expert consider a single argument out of the many of figure 4. The procedure followed to obtain enterprises' compliance information refers to a single country and it can be run for every MS of the European Union. Many MS evaluations are stored with the single ID introduced in the DSS at the beginning of the whole assessment.

Basically the expert of conduct of business, after a first analysis of the measures of the legislative act, selects the MS, the food industry (in the DSS only European cereals industry data are currently usable for the impact assessment), the supply chain stages and the classes of enterprises (classified by size or number of workers) affected by the proposal. In figure 5 is possible to visualize the result of the selection.

Figure 5: Displaying of the results after the selection of the MSs, the industry, the stage of production and the enterprises classes.

Successively the expert evaluates whether or not the classes of enterprises previously identified are already complying with the proposal by being part of existing quality certification schemes issued by private or public bodies. Out of this selection are left the enterprises that should apply the requirements of the proposal; but can those enterprises physically access the proposal and are they able to interpret it correctly? The answer to the latter question is given by making the expert following the selection procedure of arguments seven and eight.

Finally the expert has to judge, with the help of a checklist (figure 6), how the proposal requirements influence enterprises key performance indicators. The last step gives the expert an overall view of the potential consequences of the proposal on the enterprises eventually leading him to a statement on the compliance of the latter.

By Requirements affected business areas	Key Performance Indicators						Willingness of compliance
	Sales	Costs	Customer satisfaction	Lead time	Appearance	Product safety	
Cultivation measures	+	+	-	+	-	--	70%
Occupational health and safety	0	+	--	0	+	+	0%
HACCP	0	-	--	--	--	--	10%
Storage	0	+	-	+	-	0	20%
Production	+	+	-	+	-	-	30%
							40%
							50%
							60%
							70%
							80%
							90%
							100%

Figure 6: Expert checklist of the 'enterprises' compliance' part of the DSS.

In figure 7 I can see the final Output of the enterprises' compliance part: namely the number of enterprises by class of workers that are willing to comply. This information will serve then the impacts calculation.

Regulation: **Regulation 1_Draft_test**
Analysed member state: **Austria**
Analysed industry sector: **Cereals and cereals products**

Stage of Production		Number of enterprises per stage of production	Number of enterprise per size class							
			size class	absolut	%	affected	already complying	willing to comply	without access	not willing to comply
Producer	Agricultural holdings growing cereals	75490	micro	25256	33%	YES	0%	0%	100%	0%
			small	29875	40%	YES	0%	70%	0%	30%
			medium	15211	20%	YES	0%	100%	0%	0%
			large	5147	7%	NO	0%	0%	0%	0%

Figure 7: Output of the DSS for the 'enterprises' compliance' part.

The same information can be displayed under the form of a graph that could be provided to the domains' experts of the 'impact calculation' part as support material for their answers.

The user can also ask information about the reliability of the answers provided by the expert and their importance (data's potential effect on specification) in eliciting the expert's final judgment of 'compliance' or 'not compliance' (figure 8).

In figure 8 I can see the last screenshot visualized by the user for the enterprises' compliance part. By clicking on the right corner button 'Save data and exit DSS' the user stop the assessment of the proposal; alternatively by clicking 'Save data and go back to the Start' the user is redirected to the screenshot 2.
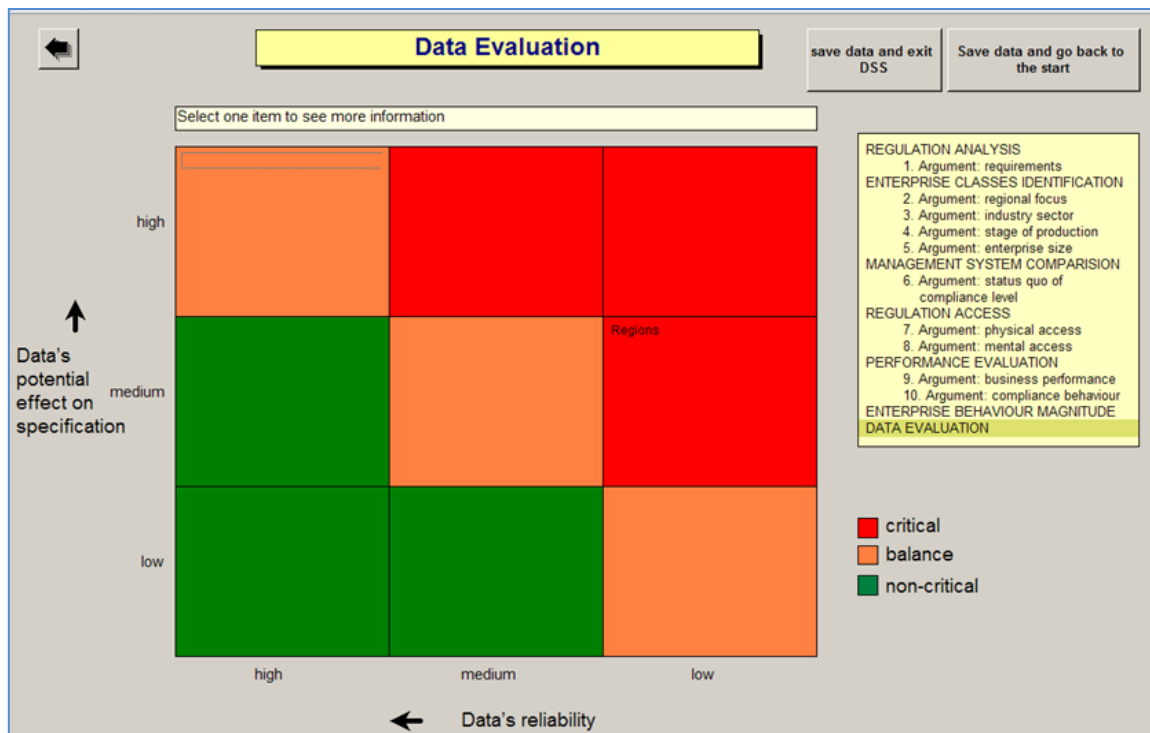
Figure 8: Last screenshot of the enterprises' compliance part of the DSS, where reliability and importance of the data provided by the expert are reported.

As reported in figure 1 the final output information of the horizontal part is stored by the DSS and successively used for the selection of the experts representing the Member States affected by the proposal and for the impacts' calculations. In the figure can be seen how the information remains in the 'Expert opinions management system' plane and at the same time flows from the latter to the 'Elaboration files' plane.

From screenshot 2 and by clicking the 'Impacts calculation' button the user enters the 'Impact assessment settings selection panel' (figure 9). By means of this new screenshot he can set-up the rest of the impact assessment and eventually the desired output table impacts results.

In the left side of the slide I can notice the column 'DOMAINS OF IMPACT'; below the column's head there are buttons with the output table's domains name. By moving the pointer on the button a short definition of the domain appears in the bottom of the screenshot; the definition remains as long as the pointer remains on the button area. By clicking the button is displayed the Domain Report: a PDF document reporting the definition of what is indicated by the system for that domain, the categories and subcategories of impact, the information aggregation, the calculation process and the sources used.

Regulation Regulation 1_Draft_test

SETTINGS SELECTION DIRECTION

DOMAINS OF IMPACT	RESULTS DISPLAYED IN THE OUTPUT TABLE			INPUTS COLLECTION LEVEL			INPUTS COLLECTION MODE			
	IMPACT ON EUROPE	IMPACT ON MEMBER STATES	IMPACT ON REGIONS	EUROPEAN EXPERT	MEMBER STATES EXPERTS	REGIONS EXPERTS	ON-LINE	PRINT-OUT	DIRECT INTERVIEW	
PUBLIC HEALTH	☐	☐	☐	☐	☐	☐	○	○	○	confirm
LABOUR	☐	☐	▣	☐	☐	▣	○	○	○	confirm
PUBLIC AUTHORITIES	☐	☐	☐	☐	☐	☐	○	○	○	confirm
INNOVATION & RESEARCH	☐	☐	▣	☐	☐	▣	○	○	○	confirm
FIRM COMPETITION	☐	☐	▣	☐	☐	▣	○	○	○	confirm
ENVIRONMENT ✓	☑	☐	☐	☑	☑	☐	⦿	○	○	confirm

For Environment we intend:
"A set of biological, physical and chemical parameters influenced by man, that are conditions to the functioning of man and nature. These conditions include Human Health, Ecosystem Quality and sufficient supply of Resources". (Goedkoop Mark, 2001)

Start

Figure 9: Impact assessment selection panel – screenshot 3 of the DSS.

I suggest the user, at his first run of the model, to read reports of the domains of which he wants to obtain the impacts.

Following the settings selection direction from left to right I see three different columns' headings: 'RESULTS DISPLAYED IN THE OUTPUT TABLE', 'INPUTS COLLECTION LEVEL' and 'INPUTS COLLECTION MODE'.

By meansof the selection's options of the first column, the user can choose for every domain the type of output he wants from the DSS, hence visualized by the output table. The choice for the current DSS version is limited to the impact visualization for Europe and for Member States, although the system has been developed for regional output visualization for Public Health, Public Authorities and Environment Domain; this is mainly due to a lack of statistical data concerning the variable number of enterprises by size at a regional level (the National Statistics Institute of some European countries could not provide them for privacy reasons).

Through the second column it is possible to select the inputs collection level desired, therefore the user can choose if he wants a highly disaggregated information collection or not.

Finally the third column allows the user to select the way he wants to obtain the information from the experts. This functionality can be useful depending on the time and the resources upon which the user is requested to provide the analysis' results.

At the end of the three columns' options' selection, the button 'confirm' informs the user about the feasibility of the analysis he set-up via the outputs-inputs combinations of the control panel: if the selection is proofed feasible by the system, after clicking 'confirm' a green sign appears on the domain's button.

Once the green sign appears the user can click on 'Start' and proceed to the 'Impact assessment control panel' (figure 10). Every domain selected has its own 'Impact assessment control panel'; the latter can be activated by clicking on the domain label on top of the screenshot.
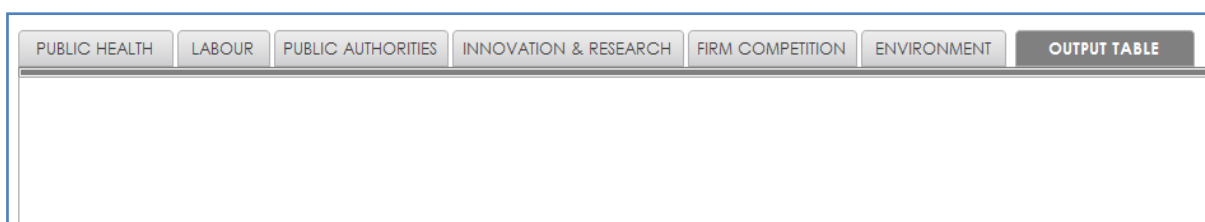

Figure 10: Impact assessment control panel – screenshot 4 of the DSS.

The 'Impact assessment control panel' consists of a series of six different screenshots, plus the output table, with the function of leading the user through the experts' contact information management and allowing him to obtain the output table results. In order to easily explain the next steps of the DSS procedure I focus on the example of the impact calculation of a single domain: the Environment.

In Step 1 (figure 11) the user fills some records with the environmental expert data. At this point of the DSS procedure the software use the information collected through the horizontal part of the DSS and generates, by row, as many contact forms as the number of Member States previously selected. In order to proceed with Step 2 all records should be filled! If the latter condition is matched, by clicking on the 'Control' button, the user obtains the 'complete' checkbox ticked off automatically and can go on.

Figure 11: Step 1 of screenshot 4 of the DSS: form for the storage of expert contact data.

In Step 2 the user visualizes two buttons: 'SEND VIA EMAIL' or 'PRINT' (figure 12). These are self-excluding and activated depending on the 'INPUTS COLLECTION MODE' selection the user operated in the 'Impact assessment settings selection panel'. By clicking on 'PRINT' the user will obtain the print view of the email to invite the environmental expert in taking part to the survey; the survey answers' values are necessary for the impact calculation.
Alternatively, by pushing 'SEND VIA EMAIL', the default email program of the personal computer opens an email with the text template for the survey invitation.
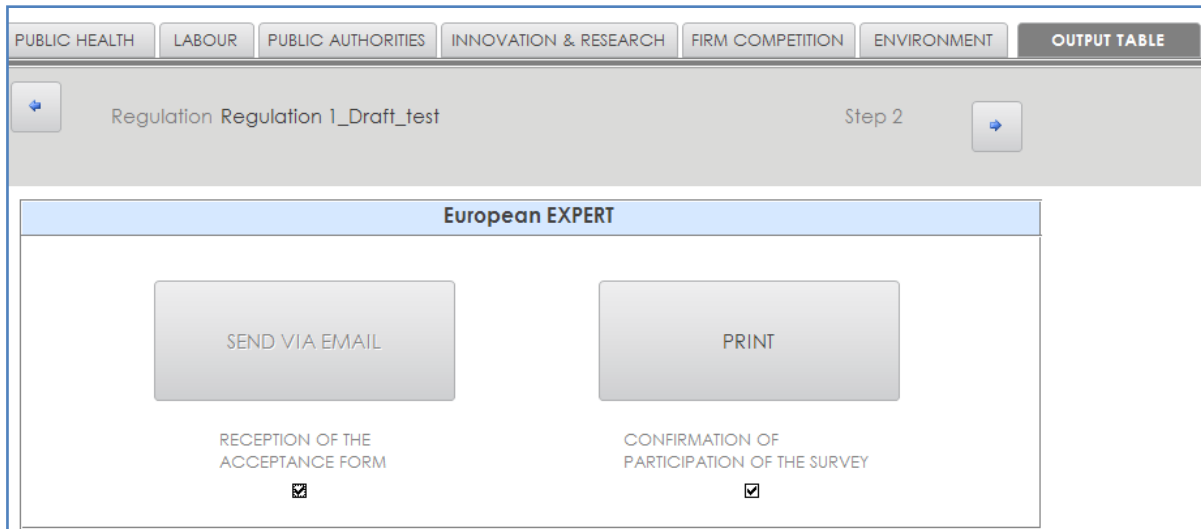
Figure 12: Step 2 of screenshot 4 of the DSS: invitation form for the expert.

In both cases, on reception of the survey acceptance form and of the expert participation confirmation, the user has to tick off the relative check boxes in order to go ahead with Step 3.

In Step 3 the user is simply asked to fill again the information requested for Step 1, but this time referred to the person answering the questionnaire; this is due to the possibility that the latter differs from the one that already received the survey participation request. Once identified and obtained the contact of the expert answering the survey, I can proceed with Step 4 (figure 13).
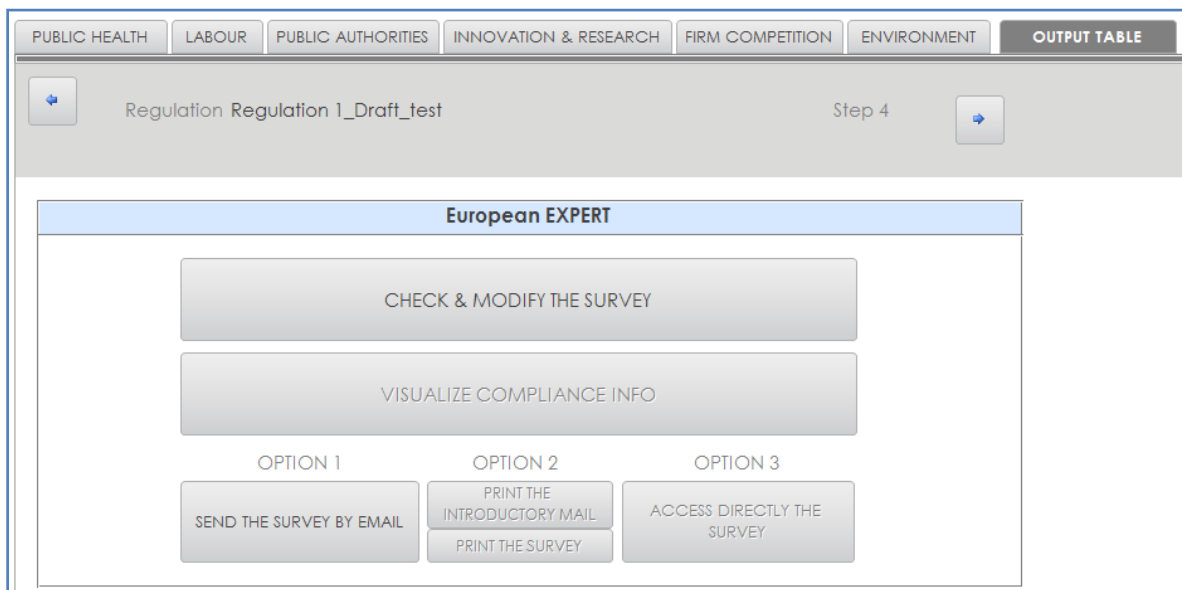

Figure 13: Step 4 of screenshot 4 of the DSS: survey for the expert.

In this step the users can visualize, check and modify the survey before sending the last email with the web link to access the on-line survey, or before sending the mail with the printed version of the survey.

If in the 'INPUTS COLLECTION MODE' selection the user chose direct interview, the DSS displays only Step 1, Step 2 and directly Step 4; again this choice would exclude the others, resulting in the activation of the single button 'ACCESS DIRECTLY THE SURVEY' of Step 4.

By clicking on 'CHECK AND MODIFY THE SURVEY' of Step 4 the DSS opens the login page of LimeSurvey software (figure 14).
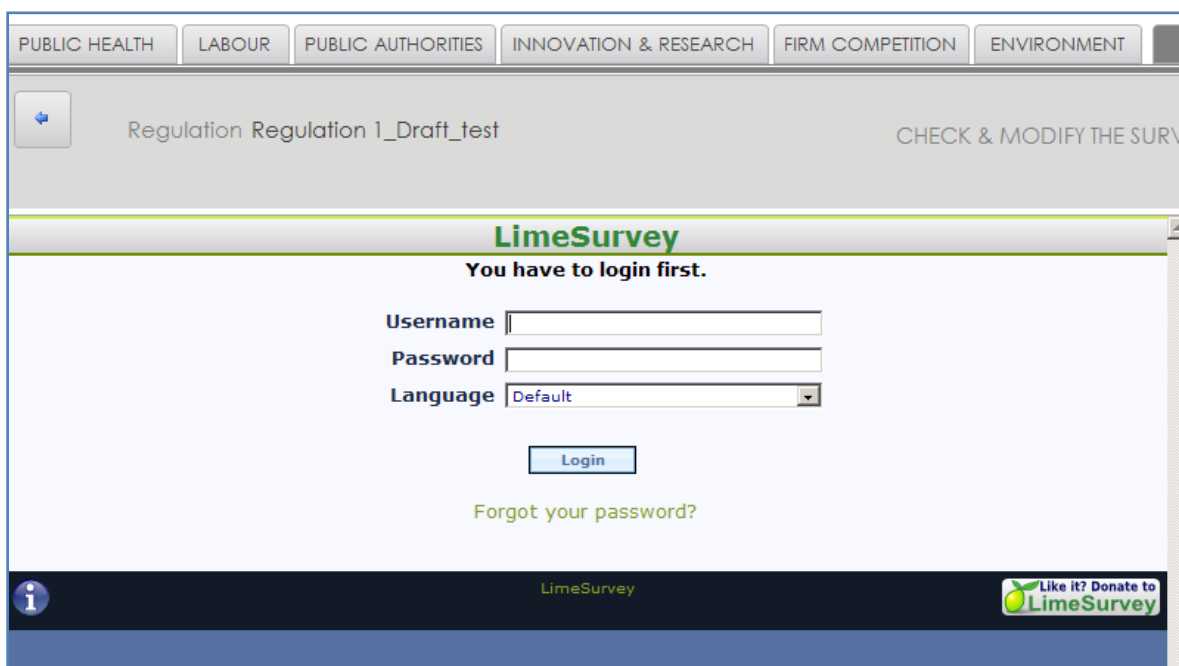
Figure 14: LimeSurvey login webpage.

The user has to obtain Username and Password of this web-page from the administrator before he starts the whole impact assessment process.
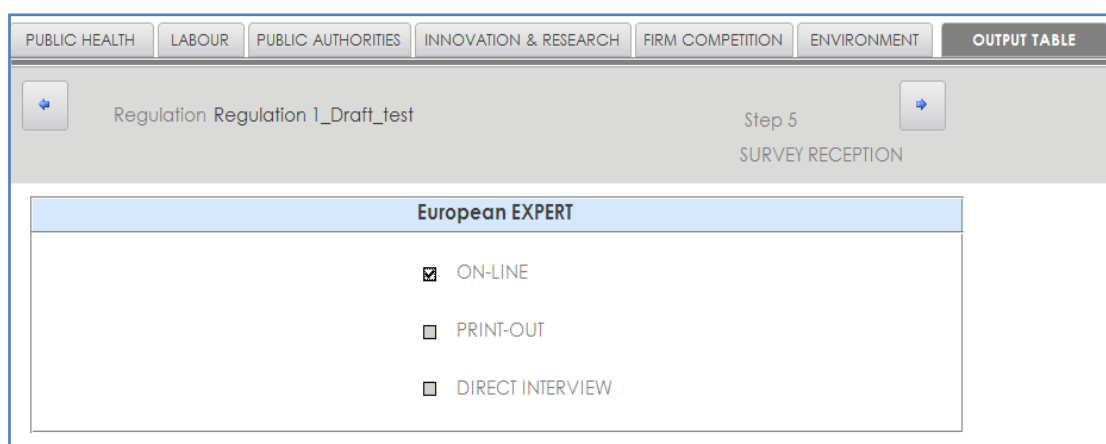
If the User runs the email option the DSS automatically selects the type of survey and the relative link to be accessed.

In the background of the DSS (figure 1) the information flows from the 'Experts' opinions management system' plain to the 'Expertise inputs' plain. Basically Microsoft Access asks the server, by means of LimeSurvey software, to transmit the right survey type to the right email address. In fact there are many survey types for every domain and each of them responds to

one potential output-inputs combination selected by the User. All the surveys are hence stored in an external server.

Once the environmental expert accesses the survey, fill it and submit it, the LimeSurvey software generates a database of the expert's answers in the server. The DSS let then communicate the server database with Microsoft Access file and the impact calculations are executed in the elaboration files of the 'Elaboration files' plain.

From Step 4 then the user can directly move on to Step 5, where ticked off check boxes are displayed to signal the environmental expert's answers submission (figure 15).

Figure 15: Step 5 of screenshot 4 of the DSS: survey reception check-point form.

From Step 5 the User can finally visualize the impact assessment results in the output table (figure 16). This is possible by clicking once on the right corner of the Step 5 screenshot.

If the user selected as input the option MEMBER STATE in the 'Impact assessment settings selection panel', then he has the possibility to investigate the contribution of the single MS to the European impact by clicking on the domain. A pop-up window appears with the option to split the European impact or by Member State (figure 17), or by determinant/ category of environmental impact (figure 18).

From left to right of figure 16 I can observe many features of the output table screenshot: the presence of a notebook divided in the sections 'RELEVANT IMPACT ISSUES' and 'SOLUTIONS AND POTENTIAL PROPOSAL CHANGES', the domains table, the reference code and on the right side the legends necessary for the comprehension of the impacts results.
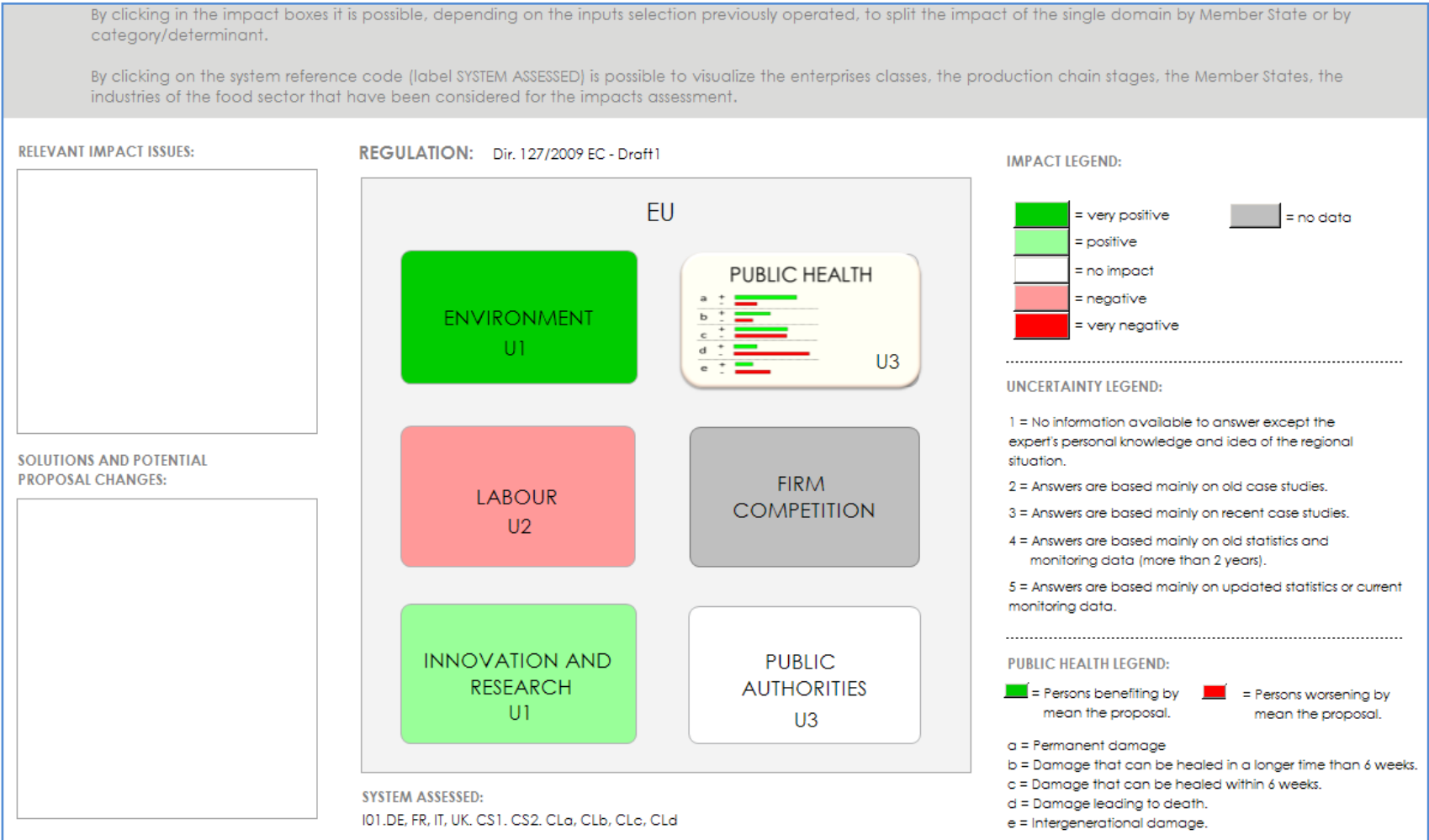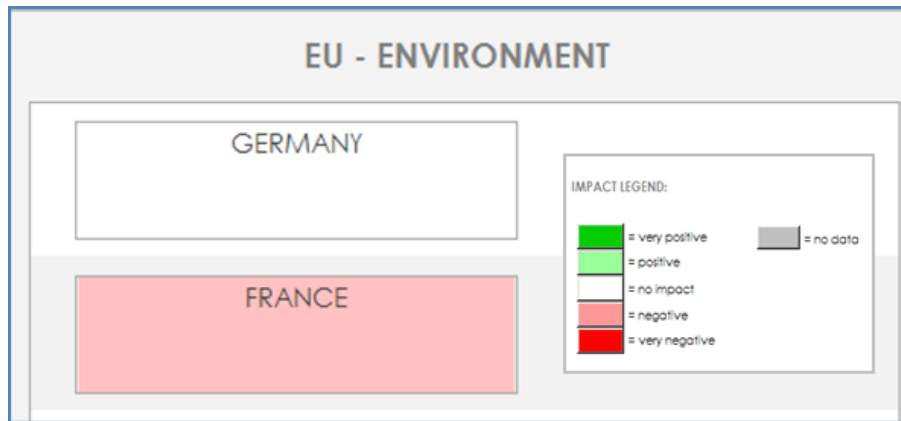
Figure 16: Output table – screenshot 4 of the DSS.

By clicking in the impact boxes it is possible, depending on the inputs selection previously operated, to split the impact of the single domain by Member State or by category/determinant.

By clicking on the system reference code (label SYSTEM ASSESSED) is possible to visualize the enterprises classes, the production chain stages, the Member States, the industries of the food sector that have been considered for the impacts assessment.

RELEVANT IMPACT ISSUES:

SOLUTIONS AND POTENTIAL PROPOSAL CHANGES:

REGULATION: Dir. 127/2009 EC - Draft1

EU

ENVIRONMENT
U1

PUBLIC HEALTH

a
b
c
d
e
U3

LABOUR
U2

FIRM
COMPETITION

INNOVATION AND
RESEARCH
U1

PUBLIC
AUTHORITIES
U3

SYSTEM ASSESSED:
I01.DE, FR, IT, UK. CS1. CS2. CLa, CLb, CLc, CLd

IMPACT LEGEND:

= very positive   = no data

= positive

= no impact

= negative

= very negative

UNCERTAINTY LEGEND:

1 = No information available to answer except the expert's personal knowledge and idea of the regional situation.

2 = Answers are based mainly on old case studies.

3 = Answers are based mainly on recent case studies.

4 = Answers are based mainly on old statistics and monitoring data (more than 2 years).

5 = Answers are based mainly on updated statistics or current monitoring data.

PUBLIC HEALTH LEGEND:

= Persons benefiting by mean the proposal.   = Persons worsening by mean the proposal.

a = Permanent damage
b = Damage that can be healed in a longer time than 6 weeks.
c = Damage that can be healed within 6 weeks.
d = Damage leading to death.
e = Intergenerational damage.
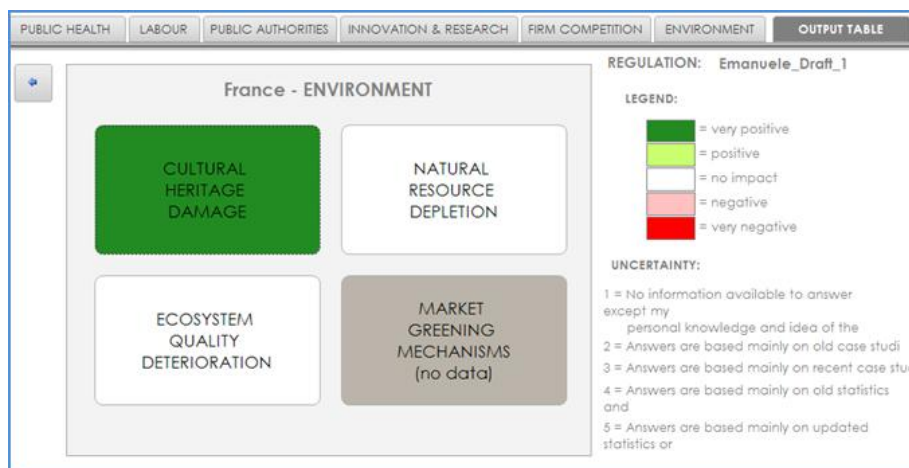
Figure 17: Impact by Member State.

Figure 18: Impact by determinant or category of impact.

By visualizing an impact colour signalling an alarming situation on a European level, MS level or determinant level the User or his client would not be able to really locate the source of the problem deriving from the proposal's impacts. It is for this reason that the DSS allows to access Step 6 (figure 19).
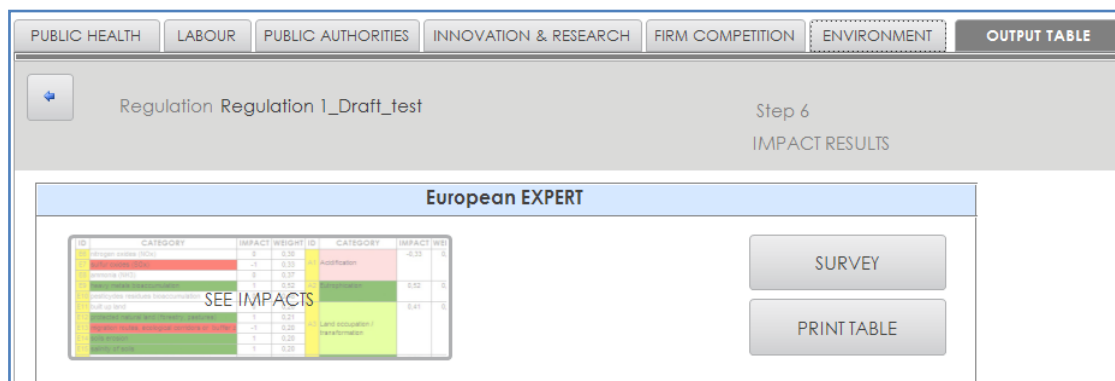

Figure 19: Step 6 of screenshot 4 of the DSS – Access to a detailed impact view.

Here the User can click on the button 'DISPLAY IMPACT DETAILS' (in the figure 'SEE IMPACTS') and consequently obtain access to an impact table (figure 20) where all categories, by which the expert analysed the proposal's effects, are related to their impact judgement.

From the table it is possible to trace back the negative impacts sources on a clearer detail level (in blue in figure 20); moreover I can see how much weight the expert gave to every impact category (in red in figure 20) and if the impact direction is positive or negative. Here as well are present two notebook sections to let the User or the client mark some aspects of the evaluation's results.

Through the notebook the user, in accord with the client, should write down key words or short sentences to be successively discussed following the order given by the last screenshot of the DSS (figure 21). The outcomes of the discussion should serve as basis, starting point, for the writing of the second draft of the proposal, where new measures mitigating the negative impacts are on place.

Figure 21: Screenshot 5 of the DSS – Decision Support Panel.

PUBLIC HEALTH | **LABOUR** | **PUBLIC AUTHORITIES** | **INNOVATION & RESEARCH** | **FIRM COMPETITION** | **ENVIRONMENT** | **OUTPUT TABLE**

Regulation Regulation 1_Draft_test

Step 6
IMPACT RESULTS

ID	CATEGORY	IMPACT	WEIGHT	ID	CATEGORY	IMPACT	WEIGHT	ID	CATEGORY	MPACT	WEIGHT	ID		IMPACT
E6	nitrogen oxides (NOx)	-1	0,43	A1	Acidification	-0,43	0,22	A	Ecosystem damage	0,10	0,286	E	ENVIRONMENT	-0,48
E7	sulfur oxides (SOx)	0	0,29											
E8	ammonia (NH3)	0	0,29											
E9	heavy metals bioaccumulation	0	0,68	A2	Eutrophication	-0,32	0,24							
E10	pesticydes residues bioaccumulation	-1	0,32											
E11	built up land	0	0,11	A3	Land occupation / transformation	0,38	0,26							
E12	protected natural land (forestry, pastures)	1	0,12											
E13	migration routes, ecological corridors or buffer z	1	0,25											
E14	soils erosion	-1	0,26											
E15	salinity of soils	1	0,27											
E30	fire, explosions,breakdowns, accidents	1	0,31	A4	Environmental risk	0,63	0,28							
E31	genetically modified organisms dissemination	1	0,33											
E32	damage magnitude of natural disasters	0	0,37											
E17	nitrogen oxides (NOx)	0	0,23	B	Cultural capital damage	-0,28	0,286							
E18	sulfur oxides (SOx)	-1	0,26											
E19	carbon dioxide (CO2)	1	0,25											
E20	scenic value	-1	0,26											
E22	energy	-1	0,32	C	Natural resource damage	-1,00	0,429							
E24	CO2 sinks	-1	0,34											
E25	fresh water c.	-1	0,34											

Figure 20: Step 6 of screenshot 4 of the DSS – Detailed impact view.

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Emanuele Novelli is a research associate at the Department for Business Management, Organization and Information Management at the Institute for Food and Resource Economics at the University of Bonn, Germany. While his education background concerns the management of the agri-food systems and rural development, his current research interests regards the sustainability of the agri-food supply networks and more specifically quantitative methods for environmental accounting (Ecological Footprint, Carbon Footprint, Life Cycle Assessment, Emergy analysis and Regulatory Impact Assessment). In the last years, thanks to his participation to the European Research Project MoniQA (Monitoring and Quality Assurance in the Food Supply Chain), he deepened his knowledge concerning strategic management and decision making with a particular focus on qualitative methods for regulatory impact assessment systems, food safety evaluation and decision aid. Moreover teaching activities concerned the use of linear programming for planning and decision making and decision support systems for agri-food supply networks actors.

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