System for Environmental and Agricultural Modelling; Linking European Science and Society

Training materials for different categories of users

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Partners involved: WU, LU, CIRAD

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Logo's main partners involved in this publication

Sixth Framework Programme

SEAMLESS integrated project aims at developing an integrated framework that allows ex-ante assessment of agricultural and environmental policies and technological innovations. The framework will have multi-scale capabilities ranging from field and farm to the EU25 and globe; it will be generic, modular and open and using state-of-the art software. The project is carried out by a consortium of 30 partners, led by Wageningen University (NL).

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Disclaimer 1:

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When citing this SEAMLESS report, please do so as:

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Objective within the project

The aim of this PD is to structure the training material on SEAMLESS. In PD7.5.1 a modular structure including the crucial elements was developed and courses were proposed. Based on iterations with partners, the collected training material is structured in this deliverable and can be used for courses on SEAMLESS. In the Appendix, training material per module is included, which will be used for a course syllabus, for the help file in the Graphical User Interface (GUI) of SEAMLESS-IF, and will be linked to the SEAMLESS website.

General Information

Task(s) and Activity code(s):	T7.5
Input from (Task and Activity codes):	many
Output to (Task and Activity codes):	T7.6, A7.6.1-A7.6.3
Related milestones:	M7.6.1

Executive summary

The SEAMLESS integrated project has developed a computerized, integrated and working framework to assess and compare, ex-ante, alternative agricultural and environmental policy options. This deliverable structures and compiles training material on SEAMLESS, mainly focusing on external users. External users can be policy makers and researchers. The training material should present the state-of-the-art on the Triple I (Integrated framework, Individual components, Infrastructure software) of SEAMLESS-IF and should allow 1) policy makers to understand how SEAMLESS-IF can be used for making ex-ante policy assessment, and 2) researchers to use and develop SEAMLESS-IF tools for their own research. As training for researchers will be more extensive, the training material mainly focuses on this group of users.

SEAMLESS training material is based on a modular structure. The underlying principle is that several modules can be flexibly combined together and some specific ones can be added depending on the course duration, intensity and the audience to easily produce 'à la carte' courses. Three courses have been developed, two for policy makers (2 hours, one day) and one for post-graduates (one week), and these can be considered as examples of how to use the SEAMLESS learning modules to create a course.

The first post-graduate course is organized in November 2008. A brochure, poster and flyers including the objectives, course set-up, preliminary programme and registration information have been developed. Besides a series of plenary presentations by speakers, a number of interactive activities will allow participants and speakers to discuss general and detailed issues. Lecturers are asked to prepare a 30-40 minutes presentation and a proposition, question or assignment to stimulate discussion. Group work in smaller groups will ensure interactions among students, and working towards a common aim in the end of the week.

For use in the course as a syllabus, but also for use in the Graphical User Interface (GUI) of SEAMLESS-IF, training material is collected per module. This training material is collected in the Appendix of this deliverable.

Scientific and societal relevance

The SEAMLESS integrated project developed a computerized, integrated and working framework to assess and compare, ex-ante, alternative agricultural and environmental policy options. Many scientists in a wide range of European countries have contributed to the development of the framework. The SEAMLESS project will end in 2009. Much effort has been put into developing a generic and flexible structure, in order to allow SEAMLESS-IF to be open for further use and developments. The framework will be tested for several applications within the project, but the expected end-user and stakeholder involvement in the scenario determination and the use of the tool has only occurred to a limited extent. The development of training material is critical in ensuring the continuation and further development of SEAMLESS-IF and the individual components beyond the project. The training material is developed for policy experts, integrative modellers and agricultural modellers and thus has both societal and scientific relevance.

Course organization

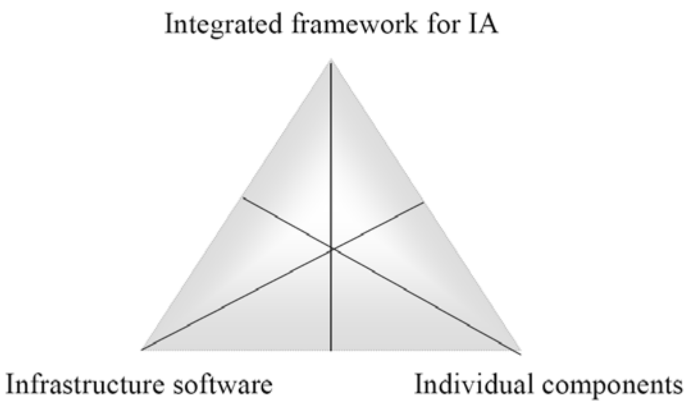
1 Introduction

The SEAMLESS integrated project developed a computerized and integrated framework (SEAMLESS-IF) to assess and compare, ex-ante, alternative agricultural and environmental policy options, allowing:

- Analysis at the full range of scales (farm to EU and global), whilst focusing on the most important issues emerging at each scale;
- Analysis of the environmental, economic and social contributions of a multifunctional agriculture towards sustainable rural development and rural viability;
- Analysis of a broad range of issues and agents of change, such as climate change, environmental policies, rural development options, effects of an enlarging EU, international competition and effects on developing countries.

The project runs from 2005 till 2009. In this period, SEAMLESS-IF is developed and tested for several practical applications, such as the Nitrate Directive and Trade Liberalization. The three main outputs of the project are the so-called Triple I of SEAMLESS (Figure 1.1).

Figure 1.1: Triple I concept of SEAMLESS with three main outputs



1. Integrated framework for impact assessment (IA)
   SEAMLESS-IF is a framework that allows integrated assessments of agricultural systems at multiple scales (from field, farm, region to EU and global) through linking standalone components and provides analytical capabilities for environmental, economic, social and institutional aspects of agricultural systems. SEAMLESS-IF has been developed as a component-based system and is aimed to facilitate synthesis of scientific knowledge in the domain of agriculture and its environment beyond the specific setting of the project.
2. Infrastructure of software enabling model linkage
   SeamFrame, the software architecture for SEAMLESS-IF, consists of the following components: modelling environment, project manager, processing environment and the domain manager. SeamFrame allows the linkage of standalone models and data bases such that they can be used in integrated assessments, and the end-user applications (e.g. graphical user interface, tool for delivering output). SeamFrame uses an ontology to structure domain knowledge and semantic meta-information about components of

SEAMLESS-IF in order to facilitate retrieval and linkage of knowledge in the components (i.e. models, indicators and databases).

3. Individual stand-alone, knowledge components. (models, data and indicators).
   Individual components consist of an extensive database, indicator systems and a large number of models.

Many scientists in a wide range of European countries have contributed to the development of SEAMLESS-IF. Much effort has been put into developing a generic and flexible structure, in order to allow SEAMLESS-IF to be open for further use and developments. The framework will be tested for several applications within the project, but the expected end-user and stakeholder involvement in the scenario determination and the use of SEAMLESS-IF has only occurred to a limited extent. The development of training material is critical in ensuring the continuation and further development of SEAMLESS-IF and the individual components beyond the project. Although there has been much collaboration between researchers, for many specific components ands also with regard to the overall framework only few people have detailed knowledge.

From 2006-2008 several training activities have been organized. These trainings were primarily targeted at partners within the project. The developers of the models have been giving workshops for the researchers that test and use the models for applications. These workshops were focused on the linkage with other models and the database, and the place in the overall SEAMLESS-IF. Trainings were generally organized ad-hoc.

This deliverable structures and compiles training material on SEAMLESS, mainly focusing on external users. External users can be e.g. policy makers and researchers. The training material should present the state-of-the-art on the Triple I of SEAMLESS-IF and should allow 1) policy makers to understand how SEAMLESS-IF can be used for making ex-ante policy assessment, and 2) researchers to use and develop SEAMLESS-IF tools for their own research. As training for researchers will be more extensive, the training material mainly focuses on this group of users.

In PD7.5.1 a compilation was made of the crucial elements to be incorporated in the training material for SEAMLESS-IF. Based on discussions with partners in the project, this deliverable presents the final structure and organization of training material. In Chapter 2 the focus of the training material is indicated and in Chapter 3 the modular structure is presented. Chapter 4 summarizes the type of training material that is or will be developed, Chapter 5 focuses on the development of courses for policy makers and Chapter 6 on the post-graduate course. Chapter 7 summarizes how the training material will be structured on-line. A detailed description of each module is available in the Appendix in the form of a course syllabus.

2 Users and aim of training material

2.1 The users of the SEAMLESS training material

The SEAMLESS training material is developed for three groups of trainees. The level of complexity of the training material increases from policy experts to agricultural modellers.

- **First level – policy experts**: These trainees are policy makers who have limited time available to go deeper into what lies behind SEAMLESS-IF. In this category it is possible to include anybody with knowledge of European agri-environmental issues, who has heard of SEAMLESS-IF and would like to know if/how this tool can be used for making an ex-ante policy assessment.
- **Second level – integrative modellers/advanced policy experts**: These are people with some scientific, modelling and IT knowledge who know what SEAMLESS-IF is, but would like to know more about the concepts behind and how it operates. Among those users are SEAMLESS project participants who know the specific detail they are working on, but lack a broader understanding of the entire project; PhD and MSc students in relevant fields; researchers not yet involved in the project or involved in other projects; and interested policy experts from specialist agencies such as EEA and JRC.
- **Third level – agricultural modellers**: These are researchers mainly interested in specific components of SEAMLESS-IF. They have interest in integrated assessment and modelling, and in how SEAMLESS-IF operates, but mainly for understanding how their own specific research links to this. They want to develop operational skills on one or several specific component. They are motivated users who are ready to invest time and energy to acquire knowledge and skills, for instance on the SEAMLESS database, or the FSSIM model development. We have to assume that these users already master the technical skills required for the specific component of SEAMLESS they are studying.

2.2 The aim of the SEAMLESS training material

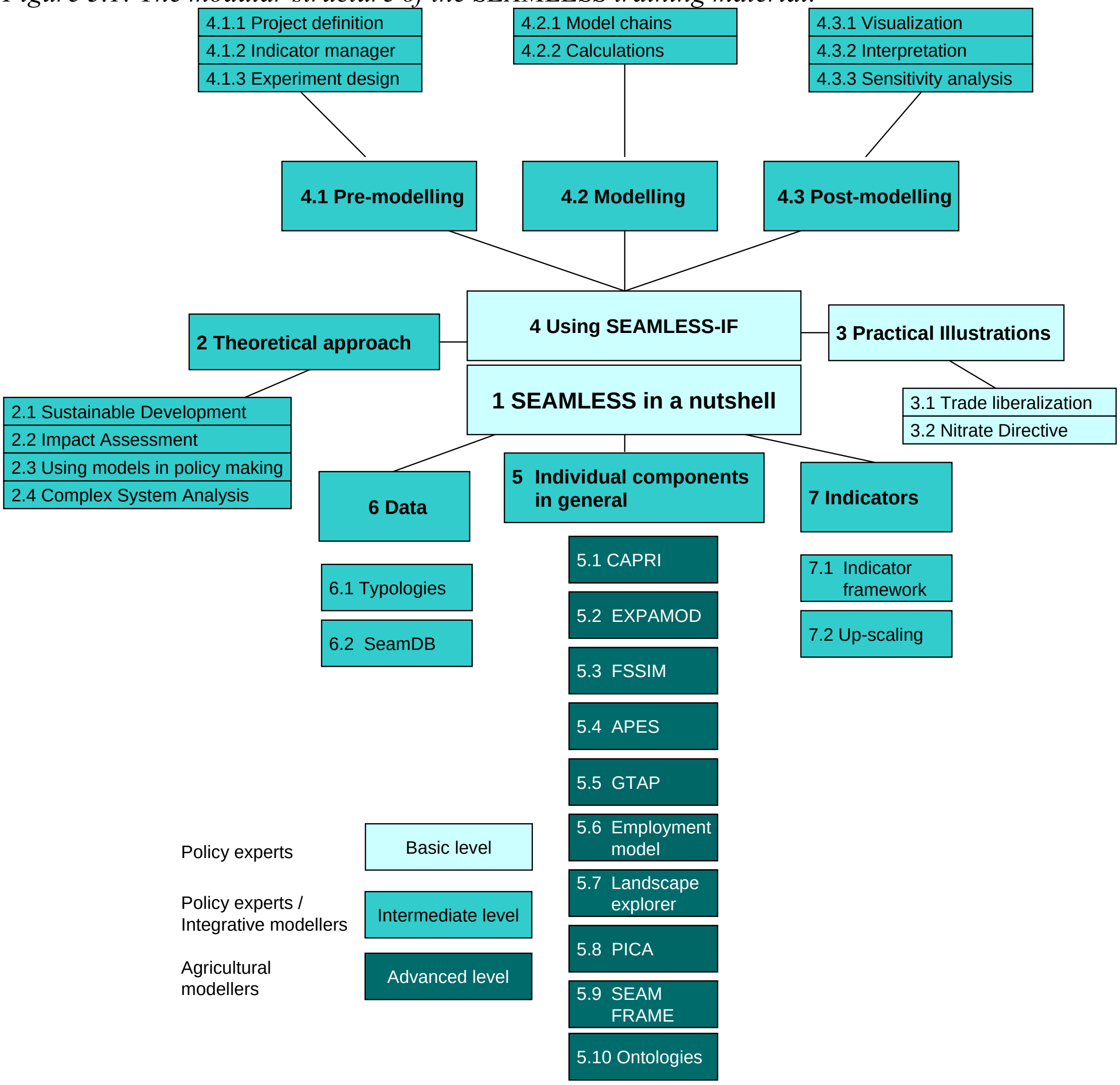
The aims of the SEAMLESS training material are:

1) to develop skills to use the SEAMLESS-IF
2) to gain theoretical understanding of the concept lying behind and approaches used in SEAMLESS-IF
3) to understand how integrated assessment and modelling can support ex-ante impact assessment and decision-making
4) to understand how own specific research relates to an integrated assessment and modelling perspective

3 Modular structure of training material

The crucial elements of knowledge that are incorporated in the SEAMLESS training material are summarized in a modular structure of crucial knowledge elements (Figure 3.1). This modular structure was presented in PD7.5.1 and is slightly adapted during the development of training material. Each of the modules is to be understood as a semi-independent piece of information and learning material.

Figure 3.1: The modular structure of the SEAMLESS training material.



The underlying principle is that several modules can be flexibly combined together and some specific ones can be added depending on the course duration, intensity and the audience to easily produce 'à la carte' courses. The courses described in Chapter 5 and 6 of this document can be considered as examples of how to use the SEAMLESS learning modules to create a course.

Each module will contain both theoretical and practical aspects. For some modules (e.g. module 1, 3 and 4) the theory and practice balance can be different between policy experts and integrative/agricultural modellers.

4 The type of training material

4.1 Set up of training material

The training material is based on the modular structure of crucial knowledge. The training material together composes a “pedagogic toolkit” containing documents, multimedia elements and instructions to either attend a course or teach it to a group of students.

The material consists of:

1. **Short written information material:** For each module a short document of around 1.5 pages is produced. These information pages are included in the Appendix of this deliverable. These information pages will be incorporated in the Graphical User Interface (GUI) and will together with the SEAMLESS-IF manual help users of SEAMLESS-IF to understand what the tool can do. The information pages are also the basis of a course syllabus. They can also be printed as flyers if used in a dissemination situation including further a list of references and further reading.
2. **A list of references and further reading:** Besides the 1.5 page information material, a list of references and further reading is included, that can guide the trainee.
3. **Power point presentations:** For most modules a lecture in the form of an animated and sonorized power point (ppt) is produced using a SEAMLESS template. It is expected that in the courses end of 2008 / beginning 2009 it will be possible to make a ppt that can be used beyond the project. The sonorized power points will be used as e-learning material and can be downloaded from the external SEAMLESS website. They may also be linked to the SEAMLESS GUI or another specific training platform.
4. **Exercises:** For most modules exercises are developed that link to the information material and power point presentations. These exercises can be used in the SEAMLESS courses. They will also be available on the external website, as e-learning material, for researchers and students that are interested in learning about SEAMLESS. The exercises are prepared such that they complement and clarify the information material and power point presentations. For example, exercises for module 4 (Using SEAMLESS-IF) should focus on the structure of the Graphical User Interface (GUI) and how to go through the different steps of SEAMLESS-IF to do impact assessment.
5. **Description of requirements to use component:** The 1.5 page includes a general description of the module and course organized by WP7 focus on general understanding of SEAMLESS-IF. For advancement in SEAMLESS-IF after the project duration and development of new applications, it is necessary to have a good understanding of the requirements for each module. A description of the background knowledge, data, software, model skills and time needed to use a component within or outside SEAMLESS-IF can inform future users. Also the sensitivity of the models, specific problems should be reported.
6. **Specific training activities:** When specific training activities have been or will be organized, announcements, programs and objectives will be collected.

4.2 SEAMLESS Training activities

Training activities structured and organized by WP7 are focused on obtaining general understanding of SEAMLESS-IF. Developing training material for specialists (third level – agricultural modellers) on e.g. coding of models or software solutions is not part of the training activities that WP7 focuses on. The training material collected can form a basis for giving advanced courses on specific modules.

Three main courses including a course syllabus and student and teacher instructions are developed:

a. a two hours course for policy makers

b. a one day course for policy makers

c. a one week course for researchers

The 2 hours and the one-day courses are mainly aimed at policy makers and will consist of short lectures with some hands on exercises (Chapter 5). The one-day course will mainly focus on selection of indicators and viewing results. The one and two week courses are aimed at PhD candidates, researchers and integrative modellers and will consist of lectures, group works, application examples and exercises (Chapter 6).

Courses on specific modules are organized, but not officially by WP7 of SEAMLESS. When there is a need for courses on specific modules, these can be organized ad-hoc. The training material collected can be used, and after a course is organized, the course material can be added to the SEAMLESS training material. For example, in autumn 2008 a course on bio-economic modelling considering FSSIM is organized for the LUPIS project and others interested (www.lupis.eu).

5 Training for policy makers

5.1 Two hour course

An important objective of SEAMLESS-IF is to assist policy-makers in decision-making. Policy-makers and other stakeholders have been involved in the development of SEAMLESS-IF, but only to a limited extent. In the development phase much effort has been put in the technical development and linking of models. The validity of results did not yet get much attention. Therefore discussing the development with stakeholders was difficult. Now SEAMLESS-IF is being finalized and has been tested for several applications, results can be discussed with stakeholders.

Policy makers and other stakeholder do not need detailed information on SEAMLESS-IF. An informative presentation of 2 hours should be targeted at showing the relevance of SEAMLESS-IF for policy-making. The 2-hour course will only consider Module 1-SEAMLESS in a nutshell.

In PD7.5.1 (Alkan Olsson et al., 2007) the contents of all modules have been described; for a complete overview the reader is referred to that deliverable. The content of '**Module 1 – SEAMLESS in a Nutshell**' should focus on:

Targeted groups for the training: Policy Experts / Integrative Modellers
Learning objectives: At the end of this lesson, the trainee will understand the methodology of SEAMLESS-IF and what it can be used for
Content of the module: • A short information document of around 1.5 pages • A list of references for further reading • An animated and sonorized power point presentation • A short video (7 mins) describing SEAMLESS in general
Subtopics: Why SEAMLESS? Ex-ante Impact Assessment Sustainable development Pre-modelling Modelling (quick overview of models) Post-modelling Show results of example (i.e. Nitrate Directive) Reliability: Why trust the results? What else could SEAMLESS do? What can SEAMLESS not do?

5.2 One day course

The one-day course is mainly developed for policy makers, but may also be relevant for other stakeholders, researchers or students. The one-day course will mainly focus on selection of indicators and viewing results.

Schedule:

Time		Title	Module
9.00-9.15	Introduction	Welcome	
9.15-10.45	Lecture	SEAMLESS in a Nutshell	1
10.45-11.00	Coffee		
11.00-12.00	Lecture	Using SEAMLESS-IF	4
12.00-13.00	Lecture	Practical Illustration: Nitrate Directive	3
13.00-14.00	Lunch		
14.00-15.30	Group work	Pre-modelling	4.1
15.30-15.45	Tea		
16.00-17.00	Practical	Using SEAMLESS-IF	4

The same lecture on SEAMLESS in a Nutshell as the one for the 2-hour course can be used for the one-day course. The contents of Module 3, 4 and 4.1 are described in PD7.5.1. In the Appendix information material is included per module. The afternoon includes group work, in which the trainees are doing a role-play of the pre-modelling phase. Here they will discuss a problem and define the context, select indicators and define scenarios. This problem can be the Nitrate Directive, but also a specific issue important for the trainees. After the group work there is the opportunity to get to know the Graphical User Interface (GUI) of SEAMLESS-IF. A manual including exercises will be provided and the trainees can use their own example to play with the GUI and view results.

6 Postgraduate course

6.1 Course location and organization

The first SEAMLESS course 'Integrated Assessment of Agriculture and Sustainable Development' will be organized in Wageningen, The Netherlands, from 16-22 November 2008. Information on the objectives and contents of the course are described in the course brochure, which is attached below in this Chapter. This brochure is on-line available at www.pe-rc.nl under: Courses and Activities / PE&RC Post Graduate Courses.

A summarized version of this brochure will be distributed as a poster and as flyers. The course brochure focuses on information important for students. Information important for lecturers and other SEAMLESS partners is described in section 6.3.

In PD7.5.1, a preliminary programme was developed for the course. This programme was adapted based on discussions with partners. The preliminary programme as presented in the brochure has been discussed with the lecturers; likely some changes will take place, but the general structure is agreed upon. The structure of the first course may serve as an example for follow up courses in other places or at later stages. A second postgraduate course is already planned in winter 2008/2009 in the Czech Republic (Activity 7.6.3).

The course is organized by WP7 partners in collaboration with the PE&RC C.T. de Wit graduate school (Production Ecology & Resource Conservation) in Wageningen. Other SEAMLESS partners and the Mansholt Graduate School of Social Sciences in Wageningen will also distribute the brochure and contribute to the costs if own students participate.

The location of the course is the Patio, Costerweg 5, Wageningen. A large lecture room (for 50 persons) is available, a lecture room for around 25 persons, one for around 10 persons, and two or three smaller rooms are additionally available for discussions. Lunches and dinners can be served here as well. The Patio is in walking distance of the centre and the WICC hotel, where most lecturers and participants will likely stay during the night.

A website will be created were students can download the syllabus including information for all SEAMLESS modules (See Chapter 7 and Appendix). This website will also give links to references and further reading, and to power points and exercises when available. As a first step, training material will be distributed through the BlackBoard electronic facilities (EDUWeb) of Wageningen University. The address is https://edu2.web.wur.nl/. Restricted access can be given to participants of the course, and materials with copyrights can also be downloaded from these pages. Participants and lecturers will get a log in name and password at least 2 weeks before the start of the course. At a later stage, this material can be transferred to the external SEAMLESS website.

6.2 Course Brochure

SEAMLESS Course

Integrated Assessment of Agriculture and Sustainable Development

Dates: 16-22 November 2008

- Introduction
- General Information
- Programme
- Course fee
- Registration
- Information

INTRODUCTION

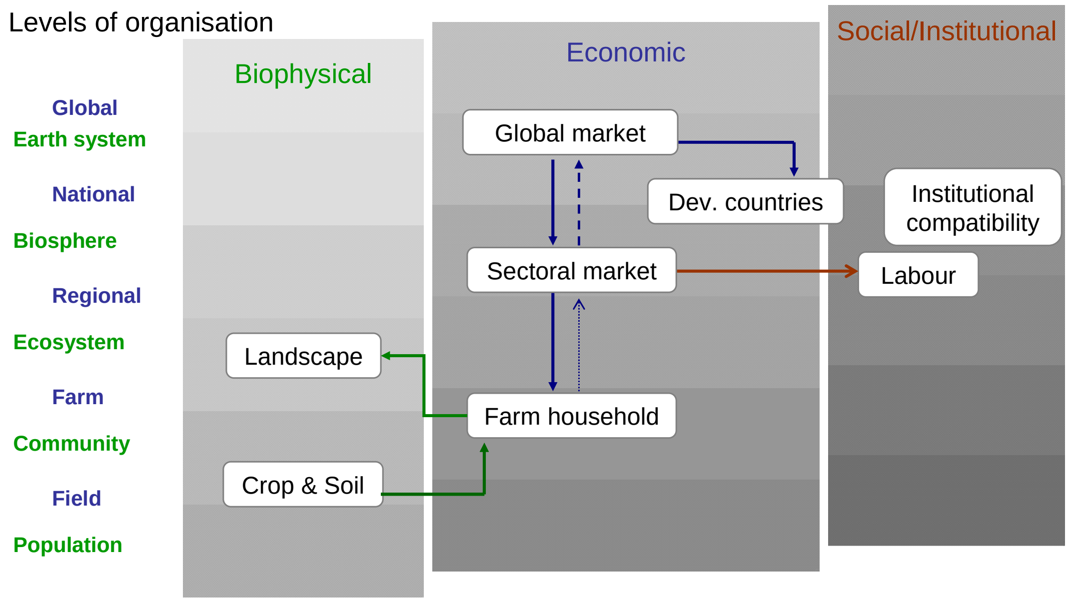
Currently the world is experiencing unrest in the international food market. Increasing demands, both in quantity and quality, with a dip in produce in several regions as result of lower outputs, shifts to biofuel production at the expense of food production and stock market speculations, are resulting in sharp increases in the price of food. At the same time the agricultural world is being confronted with changing societal demands, the increasing consequences of climate change on the systems viability and sustainability, and with environmental concerns.

Concerns about these issues have put sustainability in agricultural development prominently on policy agendas. There has been a shift from supporting agricultural production towards policies supporting sustainable (rural) development in a broader sense. Hereby important drivers of change in agricultural systems, such as globalisation, liberalization and climate change, request integrated analyses considering the full set of natural, economic, social and institutional aspects of sustainability. Also, the analyses should address multiple scales, i.e. field, farm, region, market and global levels. Such integrated assessment of agricultural systems requires integration of knowledge from different disciplines.

Over the past years, a large European research consortium has developed an integrated modelling framework to support analysis of relationships between agricultural systems and sustainable development: SEAMLESS-IF (System for Environmental and Agricultural Modelling; Linking European Science and Society – Integrated Framework; www.seamless-ip.org). The SEAMLESS-IF is a computerized integrated framework to assess and compare ex-ante, alternative agricultural and environmental policy options, allowing:

- Analysis at the full range of scales (farm to EU and global), whilst focusing on the most important issues emerging at each scale;
- Analysis of the environmental, economic and social contributions of a multifunctional agriculture towards sustainable rural development and rural viability;
- Analysis of a broad range of issues, such as climate change, environmental policies, rural development options, effects of an enlarging EU, international competition and effects on developing countries.

Figure 6.1: SEAMLESS-IF integrates models from different disciplines and levels of organization



COURSE OBJECTIVES AND SET-UP

The objectives of the course are:

1) to present concepts for integrated assessment of agricultural systems
2) to gain theoretical and practical understanding of the methods, models and tools used in integrated assessment of agricultural systems
3) to understand how integrated assessment and modelling can support ex-ante impact assessment and decision-making processes
4) to understand how own specific research relates to an integrated assessment and modelling perspective

In the course, SEAMLESS-IF and its research tools are used as an example to present how concepts and models can be integrated to address complex agricultural systems and sustainable development. The course is problem orientated, so all lectures are linked to practical applications, such as the Nitrate Directive or Trade Liberalization. Models important for these practical applications will be presented and discussed, but gaining detailed understanding of specific components is not the objective of this course. At the end of the course participants will understand how an integrated research framework and the individual research components contribute to integrated assessment of a problem and how this may contribute to decision-making.

Besides a series of plenary presentations by speakers, a number of interactive activities will allow participants to discuss general and detailed issues with the specialists and other participants. Participants are expected to actively contribute to the course by leading discussions and presenting outputs of parallel workshop sessions.

GENERAL INFORMATION

Target group:	PhD students, post-docs
Group size:	36 participants
Course duration	7 days
Language	English
Number of credits	2 ECTS
Organizers	Pytrik Reidsma, Martin van Ittersum, Johanna Alkan Olsson, Jerome Quest, Sara Brogaard, Irina Bezlepkina
Location	Wageningen

PRELIMINARY PROGRAMME

Sunday 16 November 2008

Time		Title
16.00-17.00	Registration	
17.00-18.00	Ice-breaker (drinks in Patio)	
18.00-19.30	Dinner (in Patio)	
19.30-19.45	Pytrik Reidsma (Plant Production Systems, WUR)	Welcome and general introduction
19.45-20.30	Martin van Ittersum (Plant Production Systems, WUR)	SEAMLESS in a nutshell

Monday 17 November 2008

Time		Title
9.00-10.00	Jacques Wery (INRA, Montpellier)	Practical Illustration: Nitrate directive and conservation agriculture
10.00-10.15	Coffee	
10.15-11.15	Irina Bezlepkina (LEI, WUR)	Using SEAMLESS-IF: Pre-modelling, Modelling, Post-modelling
11.15-11.30	Coffee	
11.30-12.30	Frank Ewert (Institute of Crop Science and Resource Conservation, University of Bonn, Bonn)	Theoretical Approach: Sustainable Development, Complex System Analysis, Integrated Assessment
12.30-13.30	Lunch	
13.30-14.30	Marijke Kuiper (LEI, WUR)	Practical Illustration: Trade liberalization / G20 proposal
14.30-14.45	Tea	
14.45-17.00	Group work	Practical Illustrations & Pre-modelling
17.00-18.00	Sander Janssen (Plant Production Systems, WUR)	Pre-modelling
18.00-18.30	Drinks (in Patio)	
18.30	Dinner (in Patio)	

Tuesday 18 November 2008

Time		Title
9.00-10.00	Johanna Alkan Olsson (Lund University, Lund)	Indicators
10.00-10.15	Coffee	
10.15-11.15	Thomas Heckelei (Institute for Food and Resource Economics, University of Bonn, Bonn)	Modelling
11.15-11.30	Coffee	
11.30-12.30	Jan Erik Wien (Alterra, Wageningen)	Software framework for integrated assessment
12.30-13.30	Lunch	
13.30-15.00	Exercises	Using SEAMLESS-IF
15.00-15.15	Tea	
15.15-18.00	Group Work	Modelling
18.00-18.30	Drinks (in Patio)	
18.30	Dinner (in town, H41)	

Wednesday 19 November 2008

Time	Parallel Sessions	
9.00-12.30	Hatem Belhouchette, Jacques Wery, (INRA, Montpellier), Guillermo Flichman (IAMM, Montpellier)	Practical application & modelling: Nitrate Directive and conservation agriculture
		Lectures and practicals focusing on model chain crop & soil – farm household
9.00-12.30	Marcel Adenauer, Guillermo Flichman, Marijke Kuiper, Thomas Heckelei	Practical application & modelling: Trade liberalization / G20 proposal
		Lectures and practicals focusing on model chain farm household – extrapolation–sectoral market – global market
10.30-10.45	Coffee	
12.30	Bert Rijk	Short introduction to the excursion
13.00		Departure by bus (Betuwe Express) Points of attention in the landscape
13.30		Arrival at: EKO-boerderij **De Lingehof** • Lunch • Presentation by André Jurrius (organic arable famer co-operating with an organic dairy farm)
15.30		Departure by bus
15.45		Arrival at: PPO Fruit Research Station **Randwijk** • Presentation by Jan Buurma (Researcher at LEI)

17.15		Return to Wageningen by bus
18.00		Arrival in Wageningen
18.00-18.30	Drinks (in Patio)	
18.30	Dinner (in town, Toledo)	

Thursday 20 November 2008

Time	Parallel Sessions	
9.00-15.00	Hatem Belhouchette, Jacques Wery, Guillermo Flichman	Practical application & Modelling: Nitrate Directive and conservation agriculture
		Lectures and practicals focusing on model chain crop &soil – farm household
9.00-15.00	Marcel Adenauer, Guillermo Flichman, Marijke Kuiper, Thomas Heckelei	Practical application & Modelling: Trade liberalization / G20 proposal
		Lecturers and practicals focusing on model chain farm household – extrapolation – sectoral market – global market
10.30-10.45	Coffee	
12.30-13.30	Lunch	
15.00-15.15	Tea	
15.15-18.00	Group Work	Modelling
18.00-18.30	Drinks (in Patio)	
18.30	Dinner (in Patio)	

Friday 21 November 2008

9.00-10.00	Martin van Ittersum	Post-Modelling
10.00-10.15	Coffee	
10.15-11.15	Christian Schleyer (Humboldt University, Berlin)	Institutional Compatibility Assessment
11.15-11.30	Coffee	
11.30-12.30	Christian Schleyer	Practical Institutional Compatibility Assessment
11.30-12.30	Group Work	Modelling & Post-modelling
12.30-13.30	Lunch	
13.00-18.00	Group Work	Modelling & Post-modelling
15.00-15.15	Tea	
18.00-18.30	Drinks (in Patio)	
18.30	Dinner (in Patio)	

Saturday 22 November 2008

10.00-13.00	Group presentations	
13.00-14.30	Lunch and farewell	

COURSE FEE

PE&RC PhD and Participants from the SEAMLESS consortium	€ 150,-
Other PhD students and staff of Wageningen University	€ 400,-
All other participants	€1200,-

REGISTRATION

Please register by sending an email to the PE&RC secretariat (office.pe@wur.nl), providing the following information:

- name of the course you want to participate in:
- your name:
- your email-address:
- status: PhD student // post-doc // else:
- name of your graduate school (when applicable):
- whether you have an approved education plan (TSP): yes // no
- your research group, institute or department:
- your address (For WUR, the internal bode number)
- For WUR participants: the financial project number on which the fee must be booked (if you don't know, please ask the secretary of your research group):
- For Non-WUR, the address to which the invoice of the course fee must be sent
- Background: agronomy // crop ecology // soil sciences // agricultural economics // environmental sciences // else:
- Motivation for participating:
- Preference for parallel sessions: Nitrate Directive // Trade Liberalization
- Any special dietary requests (i.e. vegetarian):

Full registration only occurs once you have provided us with the requested information as stated above. You will then receive an official registration confirmation by one of the course organizers.

For further information please contact:

Dr. P. Reidsma
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or

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SEAMLESS in a nutshell

In short, SEAMLESS-IF facilitates translation of policy questions into alternative scenarios that can be assessed through a set of indicators that capture the key economic, environmental, social and institutional issues of the questions at stake. The indicators in turn are assessed using an intelligent linkage of quantitative models. These models have been designed to simulate aspects of agricultural systems at specific scales, i.e. point or field scale, farm, region, EU and world. Application of the models requires pan-European databases for environmental, economic and social issues. Some indicators, particularly social and institutional ones, will be assessed directly from data or via a post-model analysis.

The smooth linkage of models designed for different scales and from biophysical and economic domains requires software architecture, and a design and technical implementation of models that allows this. The software backbone of the project, SeamFrame, serves that purpose. SeamFrame is also developed to facilitate re-use, maintenance and documentation of models.

The project has been set up in response to a research and policy need formulated by the European Commission.

The SEAMLESS consortium consists of the following partners:

Acronym	Name
WU	Wageningen University
INRA	INRA
CIRAD	CIRAD
UBER	Humboldt University of Berlin
ZALF	Centre for Agricultural Landscape and Land Use Research
CRA	Agricultural Research Council
JRC	Joint Research Centre of the EC
UMB (NLH)	Norwegian University of Life Sciences
LU	Lund University
IDSIA	Insituto Dalle Molle di Studi sull 'Intelligenza Artificiale
PRI	Plant Research International
LEI	Agricultural Economics Institute
Alterra	Alterra
UNEW	Centre for Rural Economy, University of Newcastle
SGGW	Warsaw Agricultural University
ILE ASCR	Institute of Landscape Ecology
VUZE	Research Institute of Agricultural Economics
LUEAB	Lund University Education AB
UBonn	University of Bonn
IAMM	Mediterranean Agronomic Institute
UEvora	University of Évora
NUI GALWAY	National University of Ireland
AntOptima	AntOptima
IER	Institut d'Economie Rurale
UVM	University of Vermont
Cemagref	CEMAGREF
UNIABDN	University of Aberdeen
UEDIN	School of Geosciences , University Edinburgh
UoC	University of Copenhagen

The following partners deliver lecturers in the course: Alterra (Wageningen UR), Humboldt University of Berlin, INRA (Montpellier), Mediterranean Agronomic Institute (Montpellier), LEI (Wageningen UR), Lund University, Wageningen University, University of Bonn.

For more information on SEAMLESS see: www.seamless-ip.org

6.3 Information for lecturers

6.3.1 Course objectives

As mentioned in the brochure, the objective of the course is not to train students in using SEAMLESS-IF. The main objective is to gain theoretical and practical understanding of the methods, models and tools used in integrated assessment of agricultural systems. In this course, we use SEAMLESS-IF as an example of a tool. The course is not a set of technical lectures, but is problem orientated. This implies that all lectures are linked to practical applications, such as the Nitrate Directive or Trade Liberalization. Models important for these practical applications will be presented and discussed, but gaining detailed understanding of specific components is not the objective of this course. At the end of the course participants will understand how an integrated research framework and the individual research components contribute to integrated assessment of a problem and how this may contribute to decision-making.

6.3.2 Set up of a lecture

The course set up is based on the modular structure as presented in Figure 3.1 In total, 10 lecturers focusing on a specific module will be given (Table 6.1).

Table 6.1: Lectures in the post-graduate course focusing on a specific module

Module	Name	Lecturer in Wageningen, 2008
1	SEAMLESS in a nutshell	Martin van Ittersum
2	Theoretical approach	Frank Ewert
4	Using SEAMLESS-IF	Irina Bezlepkina
3	Practical Illustration: Nitrate Directive	Jacques Wery
3	Practical Illustration: Trade Liberalization	Marijke Kuiper
4.1	Pre-modelling	Sander Janssen
7	Indicators	Johanna Alkan Olsson
4.2	Modelling	Thomas Heckelei
5.9	SEAMFRAME: Software framework for IA	Jan-Erik Wien
4.3	Post-Modelling	Martin van Ittersum
5.8	PICA: Institutional Compatibility Assessment	Christian Schleyer

Each of these lecturers will take one hour. The main contents of each of these modules are described in PD7.5.1 (Alkan Olsson et al., 2007). Important to note is that the lectures should not be one hour of presentations, but specifically aimed at stimulating discussion. The lecturers are asked to prepare:

- A presentation of 30-40 minutes
- Stimulation of discussion based on a proposition, question or assignment

The presentations given in Wageningen, November 2008, will be recorded (audio, not video) for e-learning material and may later be distributed via the SEAMLESS website. In WP7 narrated power point presentations are collected for a set of generic training material on SEAMLESS. Although for most of the modules many presentations are available, no 'final' products are available yet. The lecturers are asked to prepare a presentation based on the available presentations, including the latest progress and considering the general objectives of the module as presented in PD7.5.1 (Alkan Olsson et al., 2007).

For the development of the e-learning material it is requested to send a draft presentation one week before the course. This will allow smooth recording during the presentation (to check for the number of slides, animations etc.). A few minutes before the presentation a final ppt should be given to the person recording the e-learning material, so he/she can record audio and slides simultaneously.

The second part of the lecture should stimulate discussion and interaction between the lecturers and the students, and should also be a basis for the group work in the afternoons. Per lecture, 3 or 4 students (depending on the total number) are asked specifically to read the available information (in the syllabus, as attached in the Appendix of this PD; including references for further reading) and to think about the proposition, question or assignment the lecturer has provided *before the start of the course*. These 3 or 4 students will start the discussion based on what is provided by the lecturer, but they will also formulate their own questions and propositions. Together, this should form the basis of a lively discussion between the lecturer and the whole group of students. By assigning all students to a specific lecture, the involvement of all students is stimulated. Although all students are stimulated to interact in each lecture, a small group of students is specifically asked to do so.

6.3.3 Parallel sessions

In SEAMLESS-IF a modelling framework has been developed, linking models applied at different scales (field, farm, regional, national, continental, global) and in different dimensions (environmental, economic, social, institutional). These models are linked to a database, including different types of data, and they can produce a broad range of indicators. For students it will be insightful to learn about the different type of models, their inputs and outputs, and how they link to each other. However, presenting each model one by one may result in an unstructured set of presentations. Per model only about one hour would be available, and the required content would be difficult to define. The background of students will likely be different, implying that basic information is needed for some students, while only detailed information will be interesting for other students.

Therefore, the presentations of models and linkages between them will be presented in the context of a practical application. Two parallel sessions will be organized, one focussing on the Nitrate Directive, another one focusing on Trade Liberalization. Both applications consider different models, data and indicators. Before the start of the course, students are asked to give their preference for one of the parallel sessions. With a maximum of 36 students, per parallel session around 18 students will be present.

Programs that are more specific have been developed for the parallel sessions. They consider lecturers, and group work. It is anticipated that the groups (see section 6.3.4) will be linked to specific parallel sessions, and the time devoted to the practicals and evaluation of the practical illustrations is therefore flexible.

In these parallel sessions there will not be time to define an experiment and run all the models. Pre-cooked scenarios will be defined for the course and the concepts, models and interpretation will be evaluated.

The parallel sessions consider a combination of modules. They are structured around (3) Practical applications, but also go into detail in (4) Using SEAMLESS-IF, a selection of the (5) Individual components, (6) Data and (7) Indicators.

Program for the Regional application

Hatem Belhouchette, Jacques Wery, Guillermo Flichman

Time		**Title**
Monday		
9.00-10.00	Jacques Wery	Practical illustration: Application of a Crop-Farm-Indicators modelling chain to assess the impact of the EU nitrate directive in the Midi-Pyrenees region. *Module 3.2* *What is the Nitrate Directive?* *Why is Integrated Assessment needed?* *Why is SEAMLESS-IF a good tool to assess the Nitrate Directive and agro-environmental policies?* *Definition of the regional application in SEAMLESS* *Methodology (models, data and farm types)* *Results (indicators)*
Wednesday		
9.00-9.30	Hatem Belhouchette	APES, an agricultural production and externalities simulator for evaluated for assessing and vineyard crops in two French regions. *Module 5.4*
9.30-10.00	Guillermo Flichman	FSSIM, main assumptions and procedure for model evaluation. *Module 5.3*
10.00-10.30	Group work	Multi-criteria assessment of the nitrate directive scenario in the Midi-Pyrenees region. *On the basis of the simulations done previously*
10.30-10.45	Coffee	
10.45-11.30	Group work	Continuation multi-criteria assessment
11.30-12.30	Group work	Building new scenarios to reduce nitrate leaching and water consumption in a context of price and climate variability. *This work should answer the following questions:* *1- What are the main expectation on farm response?* *2-Which variable(s)/parameter(s) should be changed and in which model?* *3- Which indicator(s) should be selected?*

Thursday		
9.00-10.30	Hatem Belhouchette + group work	Definition of alternative activities and simulation of yield and externalities using the APES model. *The alternative activities are defined from the scenarios identified on Wednesday. Simulations will be done only for some activities.* *Individual component (5.4), data (6), indicators (7), link to other models (4), practical application (3.2).*
10.30-10.45	Coffee	
10.45-12.30	Guillermo Flichman + group work	Simulation of scenarios using the FSSIM models application to the Nitrate Directive. *Simulation will be done only for one farm type (or two) and some activities.* *Individual component (5.3), data (6), indicators (7), link to other models (4), practical application (3.2).*
12.30-13.30	Lunch	
13.30-15.00	Group work	Multi-criteria analysis of the new scenarios

Program for the Global application

Marcel Adenäuer, Marijke Kuiper, Thomas Heckelei, Guillermo Flichman

Time		**Title**
Monday		
14.00-15.00	Marijke Kuiper	Integrated assessment of trade liberalization *Module 3.1.* *What are the trade liberalization and the G20 proposal?* *Why is Integrated Assessment needed?* *Why is SEAMLESS-IF a good tool to assess trade liberalization and the G20 proposal?* *Definition of the global application in SEAMLESS* *Methodology (models, data and farm types)* *Results (indicators)*
Wednesday		
9.00-9.30	Marijke Kuiper	Macroeconomic modelling with the backbone model chain in SEAMLESS-IF *Why do we need integrated assessment?*
9.30-10.30	Marcel Adenäuer	CAPRI – a core backbone model *Module 5.1: Introduction to the CAPRI modelling system*
10.30-10.45	Coffee	
10.45-12.30	Marcel Adenäuer + group work	Simulating trade liberalisation with CAPRI *Group work on analysing model results with the CAPRI stand alone version. Smaller groups will make a short power point presentation on existing simulations including the following points:* *1- Scenario definition.* *2- What are your expectations on effects on agriculture.* *3- Presentation of key results.*

Thursday		
9.00-9.30	Guillermo Flichman	FSSIM, main assumptions and procedures for model evaluation *Module 5.3*
9.30-10.00	Marcel Adenäuer	EXPAMOD, the link between FSSIM and CAPRI *Module 5.2*
10.00-10.30	Marijke Kuiper	SEAMLESS IF and the trade liberalisation Test Case. *An introduction to the SEAMLESS Guided User Interface (GUI).* *Trade liberalization (3.1), Modelling (4.2), Individual components (5.1, 5.2, 5.3, 5.5), Data (6), Indicators (7).*
10.30-10.45	Coffee	
10.45-12.30	Marcel Adenäuer + group work	SEAMLESS IF and the trade liberalisation Test Case. *Group work on analysing results with SEAMLES-IF. Smaller groups will make a short power point presentation on existing simulations including the following points:* *1- Scenario definition.* *2- Which indicators do you want to assess.* *3- Presentation of key results.* *4- Comparison of results to the CAPRI stand alone ones.*
12.30-13.30	Lunch	
13.30-15.00	Group work	Continuing and presentation and discussion of results.

6.3.4 Group work & Practicals

The aim of the group work is mainly to discuss the topics that are presented during the day in a smaller group. Smaller groups will enable more interaction. During the week the group of students also have a common goal, i.e., to set up and interpret a possible application, along which they discuss the various topics.

Sunday night the students will be grouped into groups of 4-6 students. At registration, students are asked to indicate preference for the Nitrate Directive of Trade Liberalization; three groups will focus on the first and three on the latter, and on Wednesday and Thursday they will follow different parallel sessions. The groups will not be continuously tutored by one person, but a few people are continuously available and lecturers are asked to be available for discussion.

Group work always refers to work in groups of 4-6 students, while practicals refer to common exercises, which can be done individually or in small groups.

In the one week course there is relatively little time to go into detail in the models. Information and some pre-cooked scenarios needs to be available, so students can finalize a case study (at least conceptually) without having to do detailed simulation runs.

Day 1. 14.45-17.00: Practical Illustration & Pre-modelling (Group work)

Available tutors: Pytrik Reidsma, Hatem Belhouchette, Jacques Wery, Johanna Alkan Olsson, Robert Fischer, Patrik Wallman. Possible: Martin van Ittersum, Sander Janssen, Marijke Kuiper, Irina Bezlepkina, Frank Ewert, Jan-Erik Wien.

- Getting to know each other: background and interest in course
- Reflections on lectures: SEAMLESS in a Nutshell, Using SEAMLESS-IF, Practical Illustrations
- Discussions with the aim to understand the purpose of SEAMLESS-IF
- Why are the Nitrate Directive and/or Trade Liberalization typical examples for Impact Assessment of Agriculture and Sustainable Development?
- Which other problems can be addressed with SEAMLESS-IF?
- Specify a case study to address this week: 1) Nitrate Directive / Trade Liberalization specified based on group discussions: pre-cooked scenarios are available for specific experiments for these practical applications, 2) a new type of application, e.g. a climate change scenario, biofuels or a high price scenario: not all information is available to run experiments in SEAMLESS-IF, students focus on discussions on how (components of) SEAMLESS-IF can be adapted to address this case study
- Focus is on the pre-modelling phase: problem, scale, context, indicators, outlook, policy options, etc

Day 2. 13.300-15.00 Using SEAMLESS-IF (Practical)

Organized by: Irina Bezlepkina.

Available assistance: Pytrik Reidsma, Hatem Belhouchette, Jacques Wery, Johanna Alkan Olsson, Robert Fischer, Patrik Wallman.

- Computer exercises
- Manual may be used, complemented with course specific exercises
- To understand the logic of SEAMLESS-IF
- Related to practical application selected by the group

Day 2. 15.15-18.00 Modelling (Group work)

Available tutors: Pytrik Reidsma, Hatem Belhouchette, Johanna Alkan Olsson, Robert Fischer, Patrik Wallman. Possible: Jacques Wery, Sander Janssen, Jan Erik Wien, Irina Bezlepkina.

- Reflections on lectures: Indicators, Modelling, Software framework
- Based on pre-modelling steps make link to modelling: which models are needed for the case study, are the current versions applicable, is the data available.
- General ideas on which models may be relevant, who will further explore what
- When modelling steps further defined, come back to pre-modelling
- Decide on ’group ontology’
- If relevant, students can split up and read literature or play with SEAMLESS-IF to enhance understanding of components

Day 3 & 4. During the day (Practicals/group work)

Organizers: *regional application* Hatem Belhouchette, Guillermo Flichman; *global application* Marcel Adenauer, Marijke Kuiper, Guillermo Flichman.

Available assistance: Pytrik Reidsma, Irina Bezlepkina, Robert Fischer, Patrik Wallman.

- General exercises to get to know the models
- Guide the students through application: data, indicators, etc

Day 4. 15.00-18.00 Modelling (Group work)

Available tutors: Pytrik Reidsma, Hatem Belhouchette, Marcel Adenauer, Guillermo Flichman, Robert Fischer, Patrik Wallman, Jan-Erik Wien

- Discuss relevance of models presented for the practical application (nitrate directive or trade liberalization)
- What did we learn?
- Discuss relevance of models presented for the case study defined by the group
- Discuss adaptations needed in case study set up
- Use models to extent possible in these days: pre-cooked scenarios or conceptual
- If relevant, students can split up and read literature or play with SEAMLESS-IF to enhance understanding of components

Day 5. 11.30-12.30 Institutional Compatibility Assessment (Practical)

Organizer: Christian Schleyer

- Workshop on PICA tool

Day 5. 11.30-18.00 Post-modelling (Group work)

Available tutors: Pytrik Reidsma, Hatem Belhouchette, Jacques Wery, Martin van Ittersum, Christian Schleyer, Robert Fischer, Patrik Wallman, Jan-Erik Wien.

- Reflections on lectures: Post-modelling, Institutional compatibility assessment
- Finalize modelling steps: run pre-cooked scenarios or define conceptual approach
- Evaluation of results for sustainable development: which indicators are important to evaluate, is the indicator framework appropriate, can SEAMLESS-IF address all dimensions important for the case study problem
- Discuss usefulness of SEAMLESS-IF for case study: relevance, data, models, indicators, applicability, reliability, complexity, stakeholders, scientific advancement, etc.
- Discuss usefulness of triple I for own research: Integrated framework for IA, individual components, infrastructure software
- Prepare presentation: case study and discussion

Day 6. 10.00-13.00 Group presentations (Plenary)

Available tutors: Pytrik Reidsma. Possible: Jacques Wery, Hatem Belhouchette, Martin van Ittersum, Patrik Wallman.

- Per group 13 minutes presentation, 7 minutes discussion
- 10.00-10.40 Two presentations
- 10.40-11.00 Coffee

- 11.00-11.40 Two presentations
- 11.40-12.00 Coffee
- 12.00-12.40 Two presentations
- 12.40-13.00 Plenary discussion
- Discuss case study approach: models, data, indicators needed and usefulness of triple I of SEAMLESS
- Discuss concepts, model linkages, application, interest, link with own research

6.3.5 Case studies in groups

The approaches for analysing case studies in the group work are relatively open. The aims of the group work sessions are described above; how the groups use this time and where they put the focus is up to the students. Half of the case studies will be related to the Nitrate Directive and three related to Trade Liberalization. If the group wants to finalize an assessment, including results on specific indicators, they are limited to what is available in the SEAMLESS-IF GUI at the moment of the course. Pre-cooked scenarios will be available for both applications, but these are pre-defined experiments.

If the group is more interested in exploring other experiments, different regions, different scales, explore the relevance of the models, investigate what would be needed, it is also possible to do this. The group work should be useful for the participants following the course, so it is adaptable to the needs of the participants. They can focus their discussions more on whether the models in SEAMLESS-IF are applicable for another case study, for example on climate change. Is more data needed, changes in model structure, etc?

6.3.6 Presence of organizers and lecturers

To ensure the integration of the lectures, group work and practicals, it is preferable that lecturers stay longer than the scheduled time for a lecture. Inviting SEAMLESS partners only for tutoring groups seems hardly feasible, so it is anticipated that lecturers are available in the afternoon for discussions in the groups. The groups can work on their own and do not need tutors that work with one group only, but some extra input will be very useful. The availability of lecturers for tutoring during group work is indicated in section 6.3.4.

6.3.7 How to ensure satisfaction?

In order to achieve satisfaction with trainees, four main aspects are important (Keller, 1987): drawing Attention (A), showing the Relevance (R), increase the students Confidence (C) and achieve Satisfaction (S).

Motivation (Attention) is crucial for any learning process. However, motivation based on something that could be interesting alone is not enough; the motivation needs to be enhanced with a belief of Relevance. It should be clear why a particular topic is interesting to learn. Thirdly, there should be Confidence that achieving particular goals is possible. If a trainee is not confident that that he/she can achieve a particular task within the available time with the knowledge or skills he/she possesses, motivation will decrease. Important here is to clearly define the time needed to fulfil a task. Finally, it is important that trainees experience satisfaction for the course. If they like what they do, are challenged but not too much, they will continue learning.

In the postgraduate course these different requirements can be linked to the steps in the course as follows:

A = Current problems related to agricultural production and sustainability (food security, prices, environmental pollution, climate change) + GUI of SEAMLESS-IF

R = Practical illustration: How SEAMLESS-IF can address specific problems

C = Improve understanding of scientific basis: the trainee should obtain enough learning material to be able to address this problem conceptually and understand why and how the SEAMLESS modelling framework is used

S = Something is finished (e.g. modelling exercise or conceptual model of problem) and enough information to continue

The group work and exercises should thus be relevant, interesting and challenging for the students to keep them motivated. There should be a clear structure and enough information available, so the students can finalize something and feel satisfied at the end of the week.

6.3.8 Course evaluation

Evaluation of the course is important for other SEAMLESS training activities. An evaluation form is developed (see following pages). This evaluation form will be distributed at the end of the week, and will be put on the website (EduWeb, Wageningen University or SEAMLESS external website; see 6.3.1).

EVALUATION FORM INTEGRATED ASSESSMENT OF AGRICULTURE AND SUSTAINABLE DEVELOPMENT
16 - 22 November 2008

The Education Committee of the C.T. de Wit Graduate School for Production Ecology & Resource Conservation (PE&RC) and the SEAMLESS consortium invites you to fill in this form about the course you have followed. The information will be used to check and improve the quality and explore alternatives. The evaluation form is anonymous. After filling in the form please give it to the course lecturer (Pytrik Reidsma) or send it to: PE&RC bode 183 (Atlas building, room B.107)

PERSONAL
What is your present status?
O PhD student
O Postdoc
O Staff member WUR
O Researcher in SEAMLESS consortium
O Else, namely:

Gender?
O male
O female

Nationality?
O Dutch
O European other than Dutch
O African
O South American
O American
O Asian

INFORMATION
How where you informed about the course?
O by a poster at my institute/university
O by a flyer distributed by my institute/university
O by direct mail
O via internet
O Else, namely:

Please put a cross in the box of your rating (also in all other questions concerning ratings) !

Please answer the following questions on a scale from 1-5, 1 = not at all, 5 = very much

rating	**1**	**2**	**3**	**4**	**5**
Was the information about the course supplied on posters, flyers, mailings and internet sufficient					
Did the course meet your expectations based on the information?					

LECTURER(S) // TEACHING METHODS // COURSE MATERIALS
Please answer the following sets of questions with regard to the course lecturers on a scale from 1-5.
1 = very bad, 5 = very good OR 1 = not at all, 5 = very much

COURSE SET-UP

Please answer the following questions on a scale from 1-5, 1 = not at all, 5 = very much

rating	1	2	3	4	5
Did you appreciate the combination of lectures, practicals and group work?					
Do you think the course programme was coherent?					
Did the lectures give a proper basis for the group work?					
Did you appreciate the group work?					
Was there enough time to learn about issues you were interested in?					
Did you appreciate the 2 days devoted to practical applications (Nitrate Directive and Trade Liberalization)?					
Did you appreciate the closing day in which participants were asked to discuss case studies and relate the course contents to their own work?					

COURSE CONTENT

Please, give (on a scale of 1-5) an overall rating for the different subjects treated during the course. 1 = poor, 5 = very good. Please rate the subject in the 1st row, and the lecturer in the 2nd row.

	rating	1	2	3	4	5
Sunday 16: SEAMLESS in a nutshell (van Ittersum)	subject					
	lecturer					
Monday 17: Theoretical approach (Ewert)	subject					
	lecturer					
Monday 17: Using SEAMLESS-IF (Bezlepkina)	subject					
	lecturer					
Monday 17: Nitrate Directive (Wery)	subject					
	lecturer					
Monday 17: Trade Liberalization (Kuiper)	subject					
	lecturer					
Monday 17: Pre-modelling (Janssen)	subject					
	lecturer					
Tuesday 18: Indicators (Alkan-Olsson)	subject					
	lecturer					
Tuesday 18: Modelling (Heckelei)	subject					
	lecturer					
Tuesday 18: Software framework (Wien)	subject					
	lecturer					
Tuesday 18: Exercises Using SEAMLESS-IF (Bezlepkina)	subject					
	lecturer					
Wednesday 19 & Thursday 20: Practical application: Nitrate Directive	subject					
(Belhouchette)	lecturer					
(Wery)	lecturer					
(Flichman)	lecturer					
Wednesday 19 & Thursday 20: Practical application: Trade Liberalization	subject					
(Adenauer)	lecturer					
(Heckelei)	lecturer					
(Flichman)	lecturer					
Friday 21: Post-modelling (van Ittersum)	subject					
	lecturer					
Friday 21: Institutional Compatibility Assessment (Schleyer)	subject					
	lecturer					

FACILITIES AND CATERING

Please answer the following questions on a scale from 1-5. 1 = very bad, 5 = very good

rating	**1**	**2**	**3**	**4**	**5**
How do your rate the quality of the main lecture room?					
How do your rate the quality of the other rooms?					
How do you rate the catering?					

OPEN QUESTIONS (please give a short answer)

Although the course set-up was broad, did you get enough detailed information?

Did you miss any subjects and if so, which?

What is the single most important item you learned during this course?

What actions are you going to perform based on this course?

Are you considering to use SEAMLESS methodologies in your study?
O yes
O no

If yes:
Which methodologies?

How?

On which subject?

At what scale?

Currently the course does not end with an exam. Would you appreciate to finish the course with a short exam so you can test your knowledge level and hence know where the gaps of knowledge are in relation to the field you are working in?

Any further comments or suggestions?

OVERALL

Please answer the following questions on a scale from 1-5. 1 = very bad, 5 = very good OR 1= not at all, 5 = very much

rating	**1**	**2**	**3**	**4**	**5**
Was your starting level appropriate for the course?					
Did this course meet your expectations?					
Do you think this course will be beneficial to your PhD study?					
Do you think this course will be beneficial to your future career?					
How do you rate the course in total?					

THANK YOU!

7 SEAMLESS training material on-line

The objective is to eventually have structured training material on SEAMLESS on the external SEAMLESS website. The website should include general information that guides trainees and secondly, specific information per module.

Content website:

1. SEAMLESS reports on training	PD7.5.1, PD7.5.2 - 7.5.3, PD7.6.1
2. SEAMLESS training activities	
a. Post-graduate courses	General info, dates, links
b. Courses for policy makers	General info, dates, links
c. Courses on specific training activities	General info, dates, links
3. Training material per module	
a. Modular structure	Figure with links
b. Syllabus	PD7.6.1
c. Modular information	Syllabus info, further reading, ppt, exercises, requirements, activities (collected during the courses on CDs)

The modular information includes the information as indicated in section 4.1. Before the course in November 2008 in Wageningen, the training material will not be on the external website. The training material will be collected and put on EduWeb (Wageningen Blackboard: https://edu2.web.wur.nl/) first. This portal is not publically available, trainees and lecturers obtain a log in name and password to download and upload information. After the course, this will be re-organized, completed, and put on the external SEAMLESS website.

The further reading needed for the different modules is indicated in the Appendix. This includes SEAMLESS deliverables, journal articles, book chapters and websites. Not all SEAMLESS deliverables are publically available and journal articles have copyrights. In EduWeb it is possible to upload these references, so trainees can download them. For the external SEAMLESS website this is to be discussed.

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Appendix

Training material on SEAMLESS is structured by modules. Here, a short description is given for all modules. This information is the basis for the training activities. It will be included in the syllabus for the post-graduate course 'Integrated Assessment of Agriculture and Sustainable Development', which will be organized in 2008. The information per module will also be linked to the Graphical User Interface (GUI) of SEAMLESS-IF, in the help file.

The main authors of the information materials are included per module. Besides the first author, generally many SEAMLESS partners have contributed to the different modules; sometimes all are specifically mentioned, sometimes only the authors of the information material are mentioned. All material is adapted by the authors of this deliverable. In a later stage, descriptions for modules can be updated if required.

References and further reading will be collected as much as possible and included in the training material (website). For the syllabus, a table with acronyms will be included.

Per module, sub-themes are sometimes added. In principle, sub-themes can be added to all modules.

The course syllabus will include:

1) Table of contents
2) Table of acronyms
3) Programme
4) Modular information

Table of Acronyms

Acronym	Description
AEnvZ	Agro-Environmental Zones
APES	Agricultural Production and Externalities Simulator
API	Application Programming Interface
AVE	Ad Valorem Equivalents
C	A programming language
CAP	Common Agricultural Policy of the European Union
CAPRI	Common Agricultural Policy Regional Impact analysis
CGE	Computable general equilibrium model
CIA	Crucial institutional aspects
CMO	Common Market Organisations
CSE	Consumer Support Equivalents (policy instrument)
CropSyst	Cropping System Simulation Model
CSFD	Controlled sequential fractional-factorial design
DG	Directorate General of EU
DG-AGRI	Directorate General of EU - Agriculture
DOE	Design of simulation experiments
CONOPT	A solver in GAMS
EAA	Economic Accounts for Agriculture
EC	European Commission
EU	European Union
EU27	27 countries in the EU in 2008
EUROSTAT	Statistical Office of the European Communities
EXPAMOD	Extrapolation Model (extrapolation between FSSIM and CAPRI)
FADN	Farm Accountancy Data Network
FAOSTAT	Food and Agriculture Organization of the United Nations Statistics
FORTRAN	A programming language
FSS	Farm Structural Survey
FSSIM	Farm System Simulator
FSSIM-AM	Farm System Simulator – Agricultural Management
FSSIM-MP	Farm System Simulator – Mathematical Programming
FT	Farm type
G20	Group of 20 developing countries
GAMS	General Algebraic Modeling System
GOF	Goal Oriented Framework (indicator framework)
GTAP	Global Trade Analysis Project
GUI	Graphical User Interface
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
IA	Impact Assessment
IAM	Impact Assessment Modelling
IM	Integrative Modeller
IPCC	Intergovernmental Panel on Climate Change
L	factor
LDC	Least Developed Country
LFA	Less-Favoured Area
NPK	Nitrogen, Phosphorus, Potassium
NUTS	Nomenclature of Territorial Units for Statistics (in EUROSTAT)
OECD	Organisation for Economic Co-operation and Development

OpenMI	Open Modeling Interface and Environment
PE	Policy Expert
PICA	Procedure for Institutional Compatibility Assessment
PSE	Product Support Equivalents (policy instrument)
RIA	Regulatory Impact Assessment
SD	Sustainable Development
SEAMCAP	SEAMLESS version of CAPRI
SEAMFRAME	SEAMLESS software framework
SEAM:GUI	SEAMLESS Graphical User Interface
SEAMLESS	System for Environmental and Agricultural Modelling; Linking European Science and Society
SEAMLESS-IF	SEAMLESS – Integrated Framework
SEAMLESS-IP	SEAMLESS – Integrated Project
Seam:PRES	SEAMLESS presentation tool
SIA	Sustainability Impact Assessment
SLE	Seamless Landscape Explorer
SOFA	Seamless OpenMI Framework Architecture
TRQ	Tariff Rate Quota
WFS	Web Feature Service
WTO	World Trade Organization
XML	Extensible Markup Language

Course Manual

1 SEAMLESS in a nutshell

Joost Wolf and Martin van Ittersum

Introduction

European agriculture and rural areas face rapid changes in response to agreements to liberalize international trade, the introduction of novel agro-technologies, changing societal demand towards food and rural areas, and climate change. Efficient and effective agricultural and environmental policies are needed to support sustainability of European agriculture and its contribution to sustainable development of society at large. Assessing the strengths and weaknesses of new policies and innovations prior to their introduction, i.e., *ex-ante integrated impact assessment*, is vital to target policy development for sustainable development.

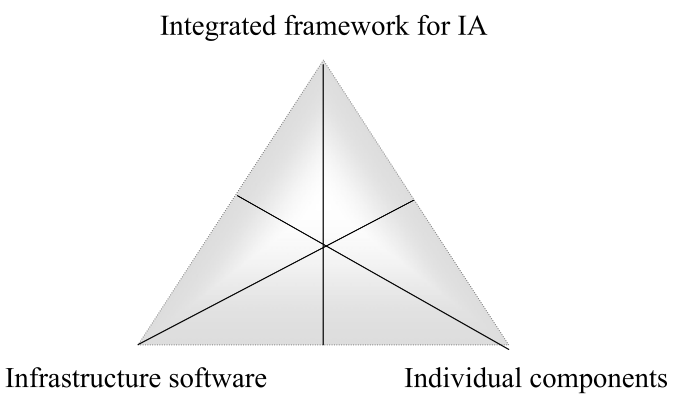
SEAMLESS (System for Environmental and Agricultural Modelling; Linking European Science and Society) is an Integrated Project within the 6th EC Framework Research programme (www.seamless-ip.org) and develops a computerized, Integrated Framework (SEAMLESS-IF) to analyse agricultural and environmental policy options and questions. SEAMLESS-IF enables assessment of indicators that capture the key economic, environmental and social issues of the questions at stake. The framework tool uses innovative software architecture which enables *ex-ante integrated assessment* at the full range of scales (from global to the field scale).

Overall scientific approach

SEAMLESS-IF is a generic and flexible framework which is achieved through a modular set-up with stand-alone knowledge components linked and integrated through an advanced software infrastructure. The three main outputs of the project, i.e. the so-called *triple I* of SEAMLESS (Figure 1.1) are:

1. Integrated framework for impact assessment;
2. Infrastructure of software enabling model linkage;
3. Individual stand-alone knowledge components (models, data and indicators). This includes existing and newly developed models simulating for instance crop growth, farm behaviour and agricultural markets.

Figure 1.1: Triple I concept of SEAMLESS with the three main outputs



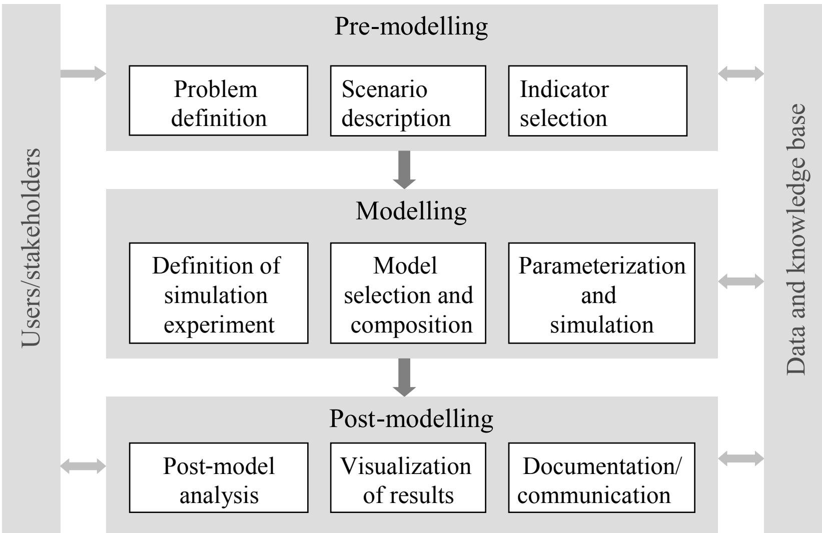
Development of SEAMLESS-IF via individual components linked through software infrastructure has clear advantages in terms of maintenance, extensibility, transparency and documentation. The three *Is* each have value for different types of users, such as the European Commission, international and national policy making agencies and the scientific community.

Specific scientific approaches

1. Integrated framework for impact assessment:

SEAMLESS-IF is a framework that allows integrated assessments of agricultural systems at multiple scales (from field, farm, region to EU and global) through linking standalone components and provides analytical capabilities for environmental, economic, social and institutional aspects of agricultural systems (Figure 1.2). SEAMLESS-IF has been developed as a component-based system and is aimed to facilitate synthesis of scientific knowledge in the domain of agriculture and its environment beyond the specific setting of the project.

Figure 1.2: Integrated assessment procedure using SEAMLESS-IF, with pre-modelling, modelling and post-modelling phase



2. Individual components (for more detail see module 5.1-5.10):

These consist of an extensive database, indicator systems and a large number of models (Figure 1.3). Key models in SEAMLESS-IF are APES, FSSIM, EXPAMOD and CAPRI. The models simulate different aspects of the system at different levels of organization and scale (from field with APES to EU with CAPRI).

APES (Agricultural Production and Externalities Simulator) is a modular simulation model for calculating agricultural production and the externalities.

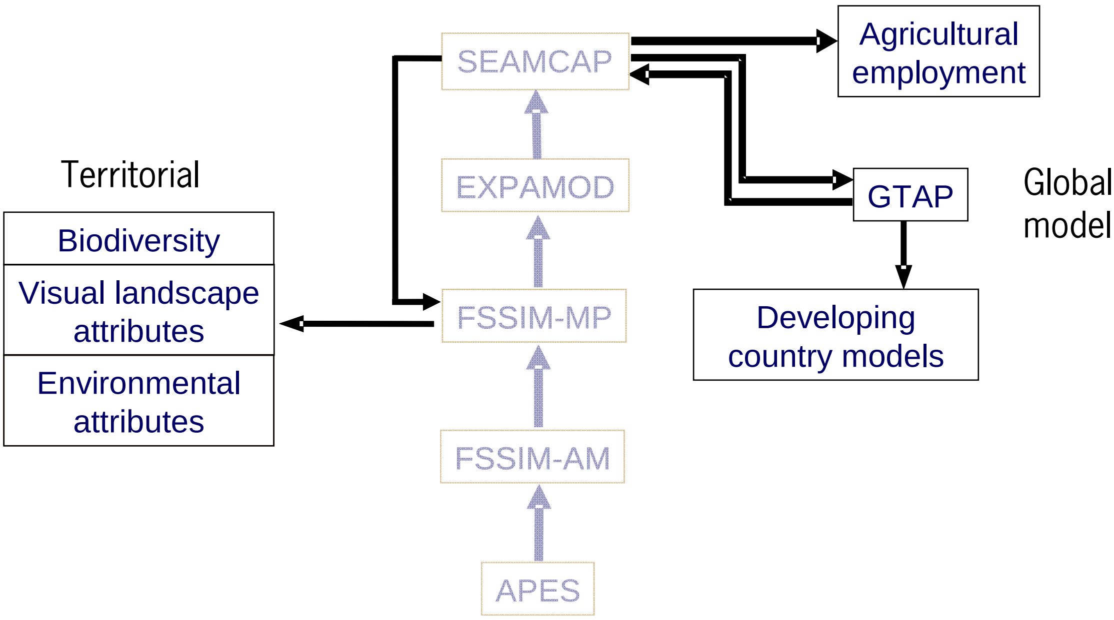
FSSIM (Farm System Simulator) is a farm model for quantifying the integrated agricultural, environmental and socio-economic aspects of farming systems, partly using the output from APES.

EXPAMOD (Extrapolation Model) is used for up-scaling the outcomes from FSSIM to the European scale.

CAPRI (Common Agricultural Policy Regional Impact Analysis), an existing model but adapted to SEAMLESS-IF, is a comparative static equilibrium model providing information on price-supply relationships, solved by iterating supply (from EXPAMOD) and market modules, and applied to the agricultural sector of the European Union.

Other models that simulate landscape change and its visualization, economic change in developing countries, and change in employment in EU rural areas, and do Institutional Compatibility Assessments of policies (i.e. PICA) and Global Trade Analyses (i.e. GTAP model), are also linked to SEAMLESS-IF.

Figure 1.3: An overview of all quantitative models for integrated assessment in SEAMLESS. The vertical (grey) chain is the so-called backbone model chain. Source: Van Ittersum et al., 2008



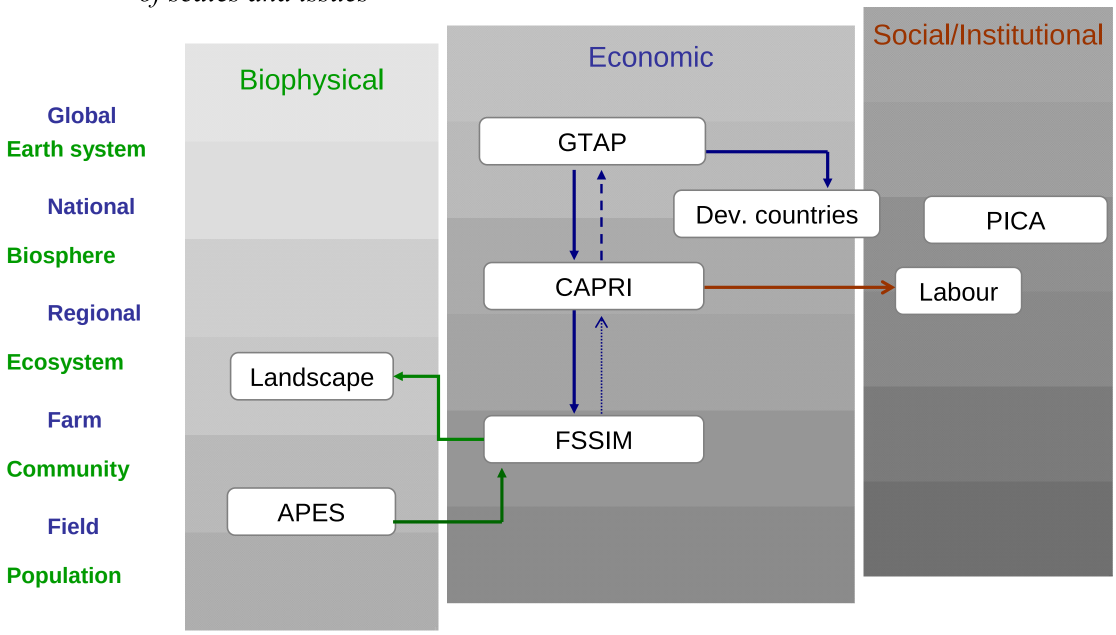
3. Infrastructure software:

SeamFrame, the software architecture for SEAMLESS-IF, consists of the following components: modelling environment, project manager, processing environment and the domain manager. SeamFrame allows the linkage of standalone models and data bases such that they can be used in integrated assessments, and the end-user applications (e.g. graphical user interface, tool for delivering output). SeamFrame uses an ontology to structure domain knowledge and semantic meta-information about components of SEAMLESS-IF in order to facilitate retrieval and linkage of knowledge in the components (i.e. models, indicators and databases).

Applications of SEAMLESS-IF

Analyses with SEAMLESS-IF are done at the full range of scales (from farm to EU and global) and varying time horizons, whilst focusing on the most important issues emerging at each scale (Figure 1.4). Main issues are the environmental, economic and social consequences of implemented policies on agricultural and rural development and viability. SEAMLESS-IF, for example, may be applied for analysing the consequences of the Nitrate Directive for respectively representative arable and dairy farms in Belgium, for regions in Belgium, and for the EU as a whole, with respect to nitrate leaching, farm income and rural employment.

Figure 1.4: Schematic representation of SEAMLESS-IF components over the possible range of scales and issues



References and further reading

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2 Theoretical approach

2.1 Sustainable Development

Lennart Olsson

The Challenge

The social and human effects on Planet Earth have during the past decades escalated to a stage that some would call the Anthropocene, i.e. a geological epoch when Humans are the dominant force shaping and reshaping the planet (Crutzen, 2002). In the Anthropocene era, key environmental parameters have moved well outside the range of millennia scale natural variability and entered a non-analogue state (Crutzen and Steffen, 2003). An increasing number of environmental problems, such as climate change, have also advanced to a level where human welfare is directly and immediately threatened, while others, like the case of biodiversity losses, pose more of potential future threats to humanity. Rittel and Webber (1972) have labelled environmental problems of this complex and pervasive kind *wicked problems*. Wicked problems are persistent not only because the solutions are not yet there but also because they have incomplete, contradictory, and changing requirements; and solutions to them are often difficult to identify because of complex interdependencies. While attempting to solve a wicked problem, the solution of one of its aspects may reveal or create another, even more complex problem. Furthermore, the problems span local to global scales and several generations, and are characterised by lags and inertia, masking important causes and effects. As a consequence, our current social and political institutions are not well suited to tackle these issues (UNEP, 2007). But the fact that different perspectives on sustainable development range from pro-market liberals to anti-market social greens (Harris et a., 2001; Clapp and Dauvergne, 2005) (Harris et al., 2001; Clapp and Dauvergne, 2005) is itself a sign that achieving sustainability for our ecological, social, and economic systems has become all but a universal value. How to get there is of course a matter of heated debate.

Agriculture and land-use are increasingly a major concern in the context of sustainable development. As an economic sector, it is responsible for providing vital necessities out of seemingly finite resources in a world of ever-increasing population. Furthermore, they employ relatively vulnerable sections of the population that either are protected at considerable cost in most developed countries or are subject to considerable risk of hardship in most of the developing world. Beyond these pressing general considerations, land use is a considerable economic activity in its own right that affects a wide range of other issues. Notable among these is the issue of climate change where alternative land uses have differential impacts in contributing to greenhouse gas emissions but also offer opportunities for abatement as sinks or by providing alternative renewable energy sources (biomass, bio-liquid fuels etc). Agriculture and land-use also have a major impact on the natural environment by making demands on scarce land and water resources and by affecting biodiversity.

The Pillars of Sustainability

Sustainable development is often said to rest on three pillars – social, economic and environmental. The meaning of these pillars is that the development must be balanced in order to promote social development (such as wellbeing, equity and social cohesion), economic development (such as poverty eradication, employment and economic security) and a healthy environment for current and coming generations. Policies promoting sustainable development must strive at integrating all these aspects. There is of course a heated debate regarding to what extent these pillars are equally important. Diverging opinions about the importance of the pillars are usually due to different time perspectives and/or political preferences. A fourth pillar of institutional sustainability is sometimes added. The meaning of this is that the development must ensure good governance, which in itself is an important prerequisite of the other pillars.

Thresholds

The landscape in which agriculture is practiced can provide a range of benefits to people. In addition to agricultural products, such as food, fibre and energy, these include clean and regular water supply, recreation, biological diversity and the protection of communities from hazards. External pressures, such as excessive use of fertilizers and other agro-chemicals or over-use, may influence the landscape and diminish the level or quality of the benefits that it provides. Eventually people may judge that a critical point has been reached, and that the reduction in benefit is no longer acceptable or tolerable. Such a critical level can best be described as an environmental limit (Haines-Young et al. 2006). Certain limits can be regarded as thresholds beyond which irreversible damage to the landscape may occur. An important goal of sustainable development is to maintain natural resource systems above such limits.

Trade-offs

The concept of trade-offs is important in the context of sustainable development. Trade-offs might be inevitable but should ideally be explicit and carefully decided upon. The trade-offs might be spatial, temporal or sectoral. What trade-offs are acceptable is often a question about ethics. The current agricultural policy in EU is often criticized due to unacceptable spatial trade-offs (subsidies in EU are harming agriculture in developing countries), temporal trade-offs (the high intensity of agriculture is endangering bio-diversity as well as deteriorating soils which is detrimental for future generations) and sectoral trade-offs (agricultural practices might be at odds with aesthetic and recreational values).

References and further reading

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2.2 Impact Assessment

Ann-Katrin Bäcklund

Introduction

The increasing interest for impact assessment (IA) activities in European policy making can be traced back to the Lisbon Strategy of 2000 where the European Union set itself the goal of becoming the most competitive and dynamic knowledge-based economy in the world. In its endeavour to achieve this goal, a core priority is to implement a better law making process in the union and in the member states. A way to achieve a better knowledge base for new regulations is to submit policy proposals for impact assessment. Great aspirations are tied to IA as a tool that will affect communication and unity in European politics in general and sustainability politics in particular.

What is Impact Assessment

Policy assessments appear under several, partly overlapping, activities and concepts. The term *Regulatory impact assessment* (RIA) covers a general framework of principles for how to investigate possible outcomes of one, or a range of policy options. Rules for ex-ante assessment of proposed legislation exist in many member states. Special regulations about *Sustainability impact assessment* (SIA) are also common in many countries. Initially the EC used the concept *Integrated* or *Extended* Impact Assessment, but now only employs the straightforward concept *Impact Assessment*, which indicates that there shall not be any assessments that are less integrated or less extended than others.

Hence the concepts RIA or IA mean some kind of ex-ante assessment, which considers economic effects of a policy and if possible social and sustainability aspects. Usually some kind of stakeholder consultation is required during the process. However, both in the EC and in member states the scope, methods and procedures used can vary considerably according to the political context and the issue at hand, from qualitative descriptions, to more research based approaches.

Impact Assessment in the EC

Since 2003 a formal IA is *required* for all regulatory proposals and negotiation guidelines for international agreements included in the Commission's Work Programme (COM, 2002). The IA shall address "*the full effects of a policy proposal including estimates of its economic, environmental, and social impacts*". There is also a systematic guideline for how the DGs shall proceed with the assessment work.

IA practices in the EC

The IA work performed in the Commission has shifting practices. Nevertheless, the recommendations given in the Guidelines are making inroad in the work performed. When participating in assessment work initiated by the Commission it is recommended to read the Guidelines (SEC 2005(791)). The plans (Roadmap) for how a specific assessment will be pursued, is published on Secretariat General's portal. It is quite likely that the procedures gradually will spread to administrations in member countries.

In the Roadmap the different policy options to be assessed are established, the data available determined. An outline of possible future monitoring and evaluation arrangements shall also be provided.

There is an assessment leader appointed at the DG responsible for the policy under development, whose role is to coordinate the assessment project, draw up the lines for the work, supervise the work of contracted expertise, perform the stakeholder consultations and finally draw together arguments and conclusions in an assessment report. The assessment report is later annexed to the Commission's policy proposal.

To carry out the task assessment leaders can engage consultants to support their work. Contractors can be hired to perform major parts of an assessment or help with specific tasks like setting up relevant data. Consultants can be invited to suggest methods to be used in the assessment, but more often, the tools or methods to be applied are already specified in the call for tender. Consultants' work is supervised by the assessment leader as the final responsibility for the product lies with the DG.

The need for transparency

When the Commission proposes a regulation the DG's argumentation for the policy recommendation in the proposal has to come across very convincing to decision makers and the public. The DG officers are under strong pressure from lobby groups which ask questions about the knowledge base for the recommendation made. It is therefore underlined by the interviewed that the transparency of the modelling process is very important. The models, the model chains and the assumptions made have to be understood by the assessment leaders in order for them to be able to explain and defend the conclusions made. Also the Commission's Guidelines repeatedly advise the assessment leader to "flag-up uncertainties and assumptions in their final report" The need for simplification might be a source of conflict between the ambitions of a scientific modeller and an IA leader.

References and further reading

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2.3 Using models in policy making: the SEAMLESS approach

Johanna Alkan Olsson, Ann-Katrin Bäcklund, Joost Wolf, Pytrik Reidsma, Sara Brogaard, Marie Taverne, Jean-Paul. Bousset, Jaques Wery and Martin van Ittersum

Introduction

Impact assessment (IA) is gradually making inroad in European policy making. European agriculture and rural areas face rapid changes in response to agreements to liberalize international trade, the introduction of novel agro-technologies, changing societal demand towards food and rural areas, and climate change. Efficient and effective agricultural and environmental policies are needed to support sustainability of European agriculture and its contribution to sustainable development of society at large. Assessing the strengths and weaknesses of new policies and innovations prior to their introduction, i.e., *ex-**ante integrated assessment***, is vital to target policy development for sustainable development.

The European Commission places great aspirations on the IA system as a way to achieve better policy and law making but *also* as a tool for improved legitimacy of government and increased consensus in European politics. This is reinforced by opening up for the possibility of stakeholders to influence every step of the work process. In order to increase the credibility and legitimacy of the assessments, which have been questioned, there is a call for using more science based methods. As a result there is an increasing interest in using modelling tools to support assessment work (Bäcklund et al. 2009). However, the use of science based models in a decision process is not always straightforward (Alkan Olsson, 2005, 2007). The reasons for this are multiple, but mainly linked to the different agendas, cultures and dynamics of the political respectively scientific communities.

The SEAMLESS project has developed a computerized framework to assist impact assessments of agricultural and environmental policies across a range of scales (Van Ittersum et al. 2008). To develop this tool the researchers in the project have engaged in a participatory process with potential users. This included a more formal way through the so called User Forum meeting every six months and specific evaluation sessions performed through so called test cases throughout the duration of the project as well less formal ways, i.e. through personal interviews, e-mails, and targeted meetings on specific issues. The aim of this interaction has been to increase the user friendliness of the tool.

When analysing the interaction between science & technology and the policy process the criteria of credibility, salience, and legitimacy are frequently used (Cash et al. 2003). *Credibility* concerns the scientific adequacy of evidence and arguments. *Salience* concerns the relevance, appropriateness, usefulness and timing of the information. *Legitimacy* is achieved when the production of knowledge has been conducted in an unbiased way and has treated opposing views and interests in a fair manner. This short introduction will based on the above mentioned concepts analyse some experiences collected during the SEAMLESS stakeholder interactions to highlight some issues that are important to have in mind when using models as a basis for policy making.

Use of modelling tools and outcomes by EU policy makers

Policy developers are not rarely reluctant to use models as a basis for policy making as will briefly be described below there are many and interlinked reasons for their scepticism. Policy developers comments on the developed tool were generally of two types, i.e. requests concerning the technical performance of the tool and strategic comments. The technical comments were often possible to meet by development of the components of the tool, workflow for IA and the Graphical User Interface. The strategic comments have a more profound political dimension linked to the above mentioned three concepts, highlighting the differences in agendas, culture and dynamics of the political and scientific communities. When analysing the stakeholder strategic comments using the concepts Credibility, Salience and Legitimacy it becomes evident that these attributes are tightly coupled and efforts to enhance one may lead to trade offs with the others.

Credibility

When the Commission proposes a regulation, the DG's argumentation for the policy recommendation that accompanies the proposal has to come across very convincing to decision makers and the public. The DG officers are under strong pressure from lobby groups which ask questions about the knowledge base for the recommendation made. It is therefore underlined by several of the policy developers SEAMLESS have been interacting with that the transparency of the modelling process is very important. "*As we are constantly questioned by interest groups our assessments have to be transparent – concise and detailed!*" Advanced analysis has in some cases been perceived as more confusing than helpful. This doesn't mean that the modelling is weak, but that it is not comprehensible and therefore not useful for the officer in charge. Another important issue raised is that the models, the model chains and the assumptions made have to be understood by the assessment leaders in order for them to be able to explain and defend the conclusions made.

The issue of uncertainty of the modeling outcome is very important to the users, particularly when dealing with politically hot issues. A participant stated: "*If I do not get precise information how could I otherwise motivate the results to an angry stakeholder phoning me up*". To deal with this demand we engaged with users to assess their perspectives as to uncertainty analysis (Gabbert et al, 2009). However here in lies the dilemma to he need for simplification might be a source of conflict between the ambitions of a scientific modeller and the IA leader.

Salience

The approached policy developers also argued that is important that tools give answers to *policy relevant questions*. Similarly, it was argued that it is important that these tools do not produce too much or irrelevant information. The continued stakeholder interactions have been a way to identify this demand. However, the models used in SEAMLESS have a particular scope which to a certain extent can be enlarged but for some issues additional models are needed or science simply lacks the methods to provide an analysis.

Legitimacy

In order to meet the demand for legitimacy a tool has to be flexible as to what to assess. It must be possible to incorporate stakeholders' views and be sensitive to the political process. It was also essential that a tool assisting in IA is transparent, i.e. it should be easy understandable how the assessment has been done and what the underlying assumptions are. The participants repeatedly expressed their concern for lack of transparency of the modeling system. One official argued that "*Scientists are lining up arguing that they have a new model that can assist me in assessing this or that. If I am not able to understand the underlying assumptions of a model how could I judge which model to use?"* Legitimacy is achieved when the production of knowledge has been conducted in an unbiased way and has treated opposing interests in a fair manner. If the modeling system is a black box, where assumptions and other critical parameters are not clear and understandable, the outcome might not be perceived as legitimate. We have dealt with this demand in SEAMLESS through spending significant resources on a transparent user interface, extensive documentation of each of the models, a possibility to use and assess each of the models standalone and providing access to intermediate results of an analysis performed through a model chain. At some stage of the IA process the results will be subject to public examination. This examination will by nature be politically as opposed to scientifically motivated.

Concluding remarks

Impact assessment is at the core of European policy making and has an aim that is wider than merely to provide a knowledge base for political decision making. It is also a tool for a political communication process and better regulation in Europe. Although SEAMLESS-IF is a relatively complex tool, much effort has been put into developing a user friendly Graphical User Interface which should allow researchers and policy makers to interact and assess policies reducing possible obstacles created in the three above mentioned areas. Assessment tools cannot only be regarded as technical/scientific applications but also as tools for communication between science and policy (Bäcklund et al. 2009). As a consequence when working as a modeler or a scients assisting in a model aided policy development it is therefore crucial to bear in mind the potential conflicts and dilemmas that may occur. To improve the usability of these types of tools it is essential that model users increase their understanding of the social and institutional dynamic and conflicting interests and cultures of policy developers by categorising the potential dilemmas in three categories, credibility, Salience and Legitimicy is a start to increase this awareness.

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2.4 Complex system theory

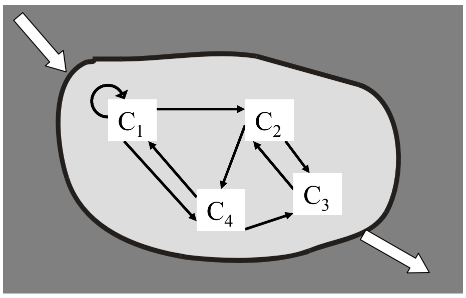
Frank Ewert

Systems thinking and theory

Systems' thinking has evolved as a result of the increasing complexity of problems that could not be addressed with more traditional, e.g. analytical approaches. The theory assumes that no matter how complex or diverse the world is, it will always be possible to find different types of organization in it. It investigates both the principles common to all complex entities, and the (usually mathematical) models which can be used to describe them (Heylighen and Joslyn, 1992). Systems' thinking is applied in a wide range of fields from industrial enterprises and armaments to esoteric topics of pure science (von Bertalanffy, 1976).

A system is defined as a group of independent but interrelated elements comprising a unified whole that is relatively autonomous, self-organising, viable, sustainable and performing. The systems concept includes: boundary and therefore system-environment composed of other systems, input and output and components (Bossel, 1989; Heylighen and Joslyn, 1992), (Figure 2.1). A living system performs due to processes and relationships among components. In addition, hierarchy, goal-directedness and information are also considered as part of the systems concept (Heylighen and Joslyn, 1992). System theory with application to agricultural systems has been significantly progressed by the work of De Wit (Leffelaar, 1999).

Figure 2.1: Schematic representation of a system within a given environment with boundary, components (C1…C4) and processes and relationships (bold arrows) among components. Interactions with the environment are through inputs and outputs (white arrows)



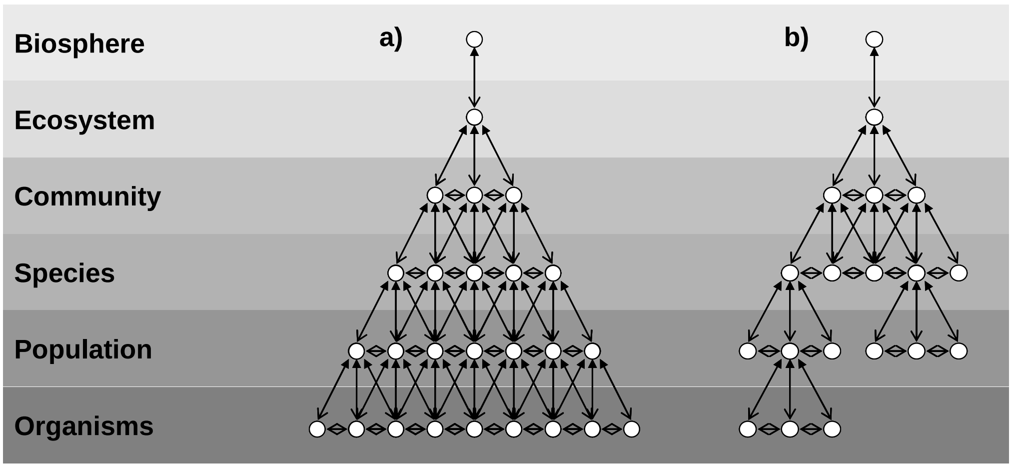
Complexity and hierarchy

The notion of complexity is vague and indicates that a system has many (the term is relative and changes with time) components and relationships among these components. In a complex system, the whole is more than the mere sum of its parts implying that understanding of the components of a system is not sufficient to understand its overall behaviour. Other important features of complex systems are that relationships among components are non-linear and contain feedback loops; they are nested and open systems with boundaries that are difficult to determine. Complex systems are highly structured and are very sensitive to the initial conditions. Important types of complex systems are (1i) chaotic, (2) complex adaptive and (3) non-linear systems.

Analysis of complex systems faces the problem of integrating knowledge from different disciplines (biophysics and socio-economics) and levels of the organisation. Hierarchy theory offers a concept for the investigation of systems that operate on several spatio-temporal scales. It is a dialect of general systems theory and has emerged as part of a movement towards a general science of complexity. It focuses on levels of organization and issues of scale and the perspective of the observer of the system plays an important role. An example for hierarchical systems is the biological organisation as commonly used in ecology and environmental sciences with levels such as organism, population, community, landscape etc. (Figure 2.2). Hierarchical systems have an organisational structure that refers to the shape of a pyramid, with each row of objects linked to objects directly beneath it (Figure 2.2a). Thus, at a given level of resolution, a system is composed of interacting objects/components (i.e., lower-level entities or sub-systems) and is itself a component/object (or sub-system) of a larger system (i.e., higher level entity). Such nested systems are commonly called holarchic systems with holons representing the objects/components of the system. For the analysis of such systems it is not always required to account for the full complexity; concentration on objects/components that are of particular importance for the behaviour of the system may suffice (Figure 2.2b). Scale issues are extremely important when analyzing complex systems. Proper scaling may decrease complexity (Parker et al., 2002) and several methods have become available (Ewert et al., 2006).

Integrated assessment and modelling has been suggested as a solution to the management of complex environmental systems. It is a way of systems thinking; a way to balance the different aspects (biophysical, institutional, social and economic) of the system (Harris, 2002). SEAMLESS-IF uses the concept of systems theory (Ewert et al., 2005).

Figure 2.2: Schematic representation of a hierarchical system with a) fully or b) partially nested sub-system.



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3 Practical illustrations

3.1 Trade Liberalization

Application of the SEAMLESS-IF model chain to assess market level economic policies: effects of WTO trade liberalization on Europe

Marcel Adenauer, Marijke Kuiper, Kamel Louhichi

Definition of the application

An application in SEAMLESS-IF is the analysis of a set of realistic scenarios derived from economic, policy and technological changes. The application is first determined by the scale at which the policy is assessed (which can reach from field to global level), which determines the model chain to be used. Then the scenarios to be assessed are translated into a set of experiments (runs of the model chain). The experiments define external driving forces, the biophysical context and policy parameters.

In the practical illustration 'Trade Liberalization: G20 proposal' the effect of agricultural policies on agricultural markets is analysed. We focus at EU market level and at economic policies (which contrasts with the focus on regional level and environmental policies in the Nitrate Directive example). The analysis centres around the effects that price changes exert on production of agricultural commodities at different levels (from farm type to global markets) and the changes in welfare suffered by consumers and producers as well as environmental effects.

Focusing on economic policies we keep the biophysical context fixed, i.e. we assume that only the currently used technologies are available. In terms of driving forces, we use the standard SEAMLESS baseline, which accounts for developments between the base year (2003) and the simulation year (2013) that occur irrespective of the policy scenario being considered.

Although the G20 application focuses on market level, we are also interested in changes occurring at regional level. Ideally, we would use the full FSSIM – EXPAMOD – SEAMCAP –FSSIM model chain (i.e., farm model – extrapolation – market model). However, at the time of writing only FSSIM and EXPAMOD were operational, restricting us to a top-down SEAMCAP – FSSIM analysis.

A top-down application in SEAMLESS-IF

The trade liberalization scenario focuses on the evaluation of a possible outcome of the ongoing World Trade Organization (WTO) negotiations (Doha Development Round) that aim at reducing international barriers to trade. The example aims at assessing the impact of changes in border protection on European agriculture, consumers of agricultural goods and the income from agricultural tariffs. The analysis is based on the "G20 proposal on market access" which provides a certain formula for the reduction in border protection depending on the initial level of protection and the developing status of a nation. The G20 is a group of developing countries that emphasizes that special and differential treatment for developing countries constitutes an integral part of all elements of the negotiation. In terms of ambition their proposal lies in between the proposals made by the EU and other (importing) countries protecting agriculture, and the proposals made by exporting countries like the US that aim at a strong reduction of agricultural trade barriers.

Policy parameters

The key policy parameters in our practical illustration need to translate the G20 proposal for a reduction in trade barriers into parameters with which the model chain can be run. We focus on two major elements in the proposal: reduction of tariffs and export subsidies. The proposal contains several other aspects, like exceptions for sensitive and special products. The criteria for assigning and implementing these exceptions are however not established yet and we therefore ignore these in this first application.

The reduction in tariffs depends on the country being considered. Although we focus on the impact on the EU we also need to take into account the changes in import tariff made by other countries since these will affect the international competitiveness of EU agricultural producers. Table 3.1 summarizes the reduction in tariffs in the different scenarios. For example, an initial EU tariff of 50% falls in the second band of the formula for developed countries and therefore a reduction percentage of 55% applies in the G20 proposal. Since an eventual outcome of the Doha round is the result of elaborate negotiations the G20 proposal is likely to change. We therefore also assess two sensitivity scenarios decreasing and increasing the reductions by 10 percent points. In the case of 50% initial tariff of the EU this would be a 45% and a 65% reduction for each of the sensitivity scenarios.

Table 3.1: Reduction in tariffs by scenario (G20 proposal, 10 % less than G20 proposal and 10% more than G20 proposal)

Reductions for developed countries (in %)				Reductions for developing countries (in %)			
Thresholds for tariffs[1]	G20	G20 - 10%	G20 + 10%	*Thresholds for tariffs*[1]	G20	G20 - 10%	G20 + 10%
0 ≤ 20	45	35	55	0 ≤ 30	25	15	35
20 ≤ 50	55	45	65	30 ≤ 80	30	20	40
50 ≤ 75	65	55	75	80 ≤ 130	35	25	45
>75	75	65	85	>130	40	30	50
Cap[2]	100	100	100	*Cap*[2]	150	150	150

[1] Tariffs are translated to Ad Valorem Equivalents (AVEs) to determine which reduction percentage applies.
[2] The cap is imposed after reduction: if tariffs exceed this number after implementing the reduction formula they are reduced to maximum 100% for developed and 150% for developing countries.

For the developing countries, reductions are lower because the four bands of tariffs are wider (for example the lowest band is from 0 to 30% whereas for developed countries it runs from 0 to 20%), because the reduction percentages are lower; and because the cap on tariffs after reduction is higher. This is characteristic of the Doha round negotiations where so called "special and differential treatment" of developing countries is key.

Apart from the tariff reductions the second element of the scenarios is the complete elimination of export subsidies. This elimination of subsidies was offered by the EU in exchange for concessions of the other negotiating parties and has been part of every proposal since the offer was made.

We therefore assess three scenarios (each consisting of a single experiment or model run): G20, G20 minus 10%, G20 plus 10%. In each experiment we fully eliminate export subsidies.

Results

Since the full model chain was not yet operational at the time of writing we ran a top-down model chain first assessing the impact of the G20 proposal at market and EU NUTS-2 level using SEAMCAP. We then assessed in more detail the economic and biophysical impact of the changes in market prices following from the SEAMCAP G20 analysis for the Midi-Pyrénées, using the FSSIM model for this region.

The SEAMCAP analyses indicate that in all scenarios agricultural income declines while consumers' welfare increases with an increase in the degree of liberalization (Table 3.2). In all cases, the loss in agricultural income and tariff revenues is compensated by increasing consumer's welfare, so that the total welfare in the agricultural sector increases.

Table 3.2: Welfare positions at EU25 level (absolute changes to baseline, million Euros)

	G20 -10%	G20	G20 +10%
Tariff revenues	-2387	-3667	-5457
Agricultural income	-9496	-11471	-13804
Money metric (consumer welfare)	16488	19985	24225
Total	4678	4936	4904

Source: SEAMCAP results

The regional distribution of the change in agricultural income varies around an average income reduction of 6% with a spread of -16% to -2.5%. These regional differences are determined by the mix of production activities. Meat prices decline most strongly in all scenarios leading to a stronger decline in agricultural income in meat producing regions.

Moving to the regional analysis for Midi-Pyrénées we also find a decline in agricultural income. The FSSIM model also allows us to assess the biophysical impacts at regional level, showing that alongside the income decline nitrate leaching and soil erosion increase, whereas pesticide use declines. Zooming in further to farm type level we find that the regional level results obscure the variation response at farm type level for cereals and oils seeds (Table 3.3). The increase in protein crops is due to the relative large price increase for pulses (4%) as a result of the G20-proposal.

Conclusions

The G20 proposal discussed in this example was the most recent version at the time of the second prototype of SEAMLESS-IF. The current negotiations converge on different tariff reduction percentages than in the G20 proposal but with the same thresholds and within the range tested by the sensitivity analyses.

Table 3.3: Changes in crop pattern by farm type in the G20 proposal (2013, % change to baseline scenario)

	Average farm	*Cereal farm type*	*Cereal / fallow farm type*	*Mixed farm type*
Cereals	-2	-3	0	0
Oil seeds	0	2	-3	-2
Protein crops	16	16	19	16
Fallow	0	0	0	0

Source: FSSIM results

Albeit limited to a top-down assessment of the impact of the G20 proposal the application already illustrates the potential of SEAMLESS-IF to assess policies across scales and domains. Focusing on a market level economic policy of trade liberalization we can assess the impacts at EU25 market level, regional level and at the level of different farm types. Furthermore we can assess the impact on economic indicators like agricultural income, but also on biophysical indicators like nitrate leaching and pesticide use. With an FSSIM-EXPAMOD-SEAMCAP chain operational we can repeat the experiment in a more consistent manner with supply response at the macro level being representative of the farm level models.

In this first application we kept the biophysical context fixed. We could however exploit the possibilities offered by SEAMLESS-IF and to explore whether a change in biophysical context (i.e. availability of new technologies) will change the assessment. This can be considered as a kind of sensitivity analysis to assess whether the conclusions of the analysis are robust when the biophysical context changes.

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G20 proposal on market access: http://www.g-20.mre.gov.br/conteudo/proposals_marketaccess.pdf.

3.2 Nitrate Directive

Application of the SEAMLESS-IF model chain to assess agro-environmental policies: Nitrate Directive in the Midi-Pyrenees region

Hatem Belhouchette, Kamel Louhichi, Jacques Wery

What do we mean by application?

An application in the SEAMLESS project is defined as a set of realistic scenarios, based on economic, policy and technological changes. The application is first defined by the scale at which the scenario is assessed (field, region, …). Secondly, several experiments can be developed by specifying, for each scenario, the external driving forces, the biophysical context and the policy parameters.

For this example, the Nitrate Directive is chosen to provide a first example of assessment at the farm and regional levels. The Nitrate Directive is an environmental measure designed to reduce water pollution by nitrate from agricultural sources and to prevent such pollution occurring in the future (91/676/EC).

The model chain CropSyst-FSSIM-Indicators was used (i.e. crop-soil model – farm model – indicators). The impact assessment at field level was done through the biophysical model CropSyst, used as a substitute for APES (Agricultural Production and Externalities Simulator), which is not yet operational for an application. The model-chain was used to compare a baseline scenario driven by the CAP (European Union Common Agricultural Policy) reform, and a policy scenario combining the CAP reform with the application of the Nitrate Directive based on the adoption of alternative crop management (Louihichi et al., 2008). More typical user's problems that SEAMLES-IF is designed to address are developed in Belhouchette et al. (2007). Practical applications include (1) Green intensification at regional scale in animal-based farming systems (Auvergne), (2) Nitrate Directive at regional scale in crop based farming systems (Midi-Pyrenees), (3) Organic farming at regional scale (Midi-Pyrenees), (4) conservation agricultural at regional scale (Poland) and (5) WTO (World Trade Organization) and cotton policies in a LDC country (Least Developed Country; here Sikasso and Koutiala regions in Mali).

Biophysical context and Policy parameters

Biophysical context: current and alternative activities and farm types

The biophysical context is mainly defined by the representative farm types and the activities (current or alternative) cultivated in the region. This farm typology provides, for each sample region (NUTS2 level), a set of typical farms defined by 4 criteria: size, intensity, land use and specialization. In the Midi-Pyrenees region three arable farm types are selected based on Farm Accountancy Data Network (FADN) and Farm Structural Survey (FSS). Information on current activities in the Midi-Pyrenees region is collected. It includes the data on amount, nature, method and timing of management events. Additionally, for each crop a set of economic data has been specified including product prices paid to farmers, variable costs and premiums. To simulate the impact of the Nitrate Directive a set of alternative activities, based on the target yield, is generated (Louhichi et al., 2008).

Policy parameters

Table 3.4 gives a brief definition of the baseline in comparison to the policy scenario, which combines the 2003 CAP reform with the application of the M1 measure of the Nitrate Directive (Belhouchette et al., 2007). The M1 refers to better management of nitrogen minerals and organic fertilization.

Table 3.4: Definition of baseline and policy scenarios

	Baseline scenario [2013]	Nitrate Directive [2013]
2003 CAP reform	- Decoupled payment as is adopted in France - Modulation implementation	
Measures		Cross-compliance restriction (a 3% cut of EU premiums if the Nitrate Directive is not applied)

Results

Farm level

The model results show that few alternative activities are adopted in the farm type 2 cereal/fallow (FT2). This implies that the penalty of 3% is not enough to force this farm type to respect the cross-compliance condition. In fact, only 5 ha (less than 10% of total cereal area) of cereals are cultivated by adopting alternative management. Thus, no significant change is observed for the nitrate leaching when the Nitrate Directive scenario is compared to the baseline (Table 3.5). In contrast, the response of farm types 1 and 3 to the Nitrate Directive scenario is completely different. The cross-compliance restriction was fulfilled and the whole agricultural area was devoted to alternative activities. This implies that the loss of income induced by the adoption of the alternative activities is less than 3% of the premium received in the baseline scenario. Consequently, the nitrate leaching decreased by 40% and 26% respectively for the farm type 1 and 3 (For more detail see Louhichi et al., 2008).

Table 3.5 Economic and environmental impact of the nitrate directive compared to the CAP reform (baseline scenario) at farm scale

Economic and environmental indicators	Nitrate Directive (% change to baseline scenario)		
	FT1 (cereal)	FT2 (cereal/fallow)	FT3 (mixed)
Farm income (1000€)	-1%	-1%	-1%
Premium (1000€)	0%	-4%	0%
Nitrate leaching (kgN-NO3/ha)	-40%	-1%	-26%

Regional level

As expected, the trend obtained at the farm level remains the same at the aggregated level. This implies (1) a partial substitution of current activities by alternative activities, (2) a marginal decrease of farm income and premium due to the penalty and the adoption of alternative activities, and (3) a decline of nitrate leaching attributed to alternative activities which are more efficient in environmental terms.

Concluding remarks

The results presented here for a French region should be considered as preliminary results of the first application of the model chain CropSyst-FSSIM-indicators conducted in interaction with users and stakeholders for the definition of the scenarios. The results show that this model chain can be functional for complex scenarios combining economic and environmental drivers and provides sound results when discussed with local experts. This first application of the model chain indicates that this model should be sufficiently generic to cover the range of grain crops-based farming systems that SEAMLESS-IF aims to address. Further tests will be conducted in other regions and for other types of farming systems (perennial, grasslands and animals).

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Belhouchette, H., Therond, O., Adenaeuer, M., Kuiper, M., Bigot, G., AlkanOlsson, J., Wery, J. et al., 2007. Documentation of baseline and policy options to be assessed with Prototypes 2 and 3, SEAMLESS Report No. 33, SEAMLESS integrated project, EU 6th Framework Programme, contract no. 010036-2, 120 pp. http://www.seamless-ip.org/Reports/Report_33_D6.2.3.3.pdf

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4 Using SEAMLESS-IF

Irina Bezlepkina, Frank Ewert, Martin van Ittersum, Olivier Therond, Rob Knapen

Due to the rapid and always ongoing development of SEAMLESS-IF, the description on how one can use SEAMLESS-IF will need to be updated after the final version is delivered.

The Graphical User Interface (GUI) is structured according to the integrated assessment concept and procedure which is divided into a pre-modelling, modelling and post- modelling phase. The different IA steps relate to each phase as presented in Table 4.1 and are documented in the software within a Project (Van Ittersum et al., 2008). Flexibility exists within this procedure as not all IA steps, particularly in the pre-modelling phase, need to be completed in order to perform an assessment.

Table 4.1: Integrated Assessment phases and steps in SEAMLESS-IF

IA phase	IA step
Pre-modelling	Problem description
	Scenario definition (experiment designer)
	Indicator manager
Modelling	Composition of model chain
	Scaling of model outputs
Post-modelling	Visualization of results
	Exporting, reporting of results

The Problem is described in the pre-modelling phase, where an agricultural system under assessment is specified by the spatial and temporal extent and resolution. Examples are found in Table 4.2 for two cases (G20 and Regional) implemented in SEAMLESS-IF, with possible examples for future applications.

Table 4.2: Spatial scales (extent and resolution) and two developed model chains, and three possible examples for future applications

Application	Spatial scale		Model chain*
	Extent	Resolution	
G20	EU25	Farm type	FSSIM-SEAMCAP
Regional	Region	Farm type	APES-FSSIM
(possible)	EU25	AEnvZ	APES
(possible)	EU25	NUTS2	SEAMCAP
(possible)	Global	Farmtype	GTAP[1]-SEAMCAP-FSSIM

* Individual models are described in Module 5.

Various combinations of the extent and resolution determine the appropriate model chain that is operational and to be used for the specific Project in the modelling phase, which is a central part of SEAMLESS-IF. Once the model (chain) is known, a set of indicators is identified that is computable for a specific model (chain). Some or all these indicators need to be selected for a specific Project from the Library of Indicators, from a list-view or from a Goal Oriented Framework-view to enable their computation at a later stage. Scenario narratives from the pre-modelling phase are translated in the modelling phase by specifying model parameters representing policy options, outlook and contexts by means of adjusting the default values. In SEAMLESS, a policy option refers to one or more policy measures as part of it; outlook describes trends foreseen the context of a problem; and the context specifically defines the biophysical and agro-management system (Belhouchette et al., 2007). Examples of models and parameters which are available in the tool for editing are given in Table 4.3.

Table 4.3: Examples of selected model parameters available in SEAMLESS-IF to design experiments with outlook, policy option and context

Model	Parameter		
	Outlook	Policy option	Context
SEAMCAP	Inflation, Annual yield trend, etc	Tariff rates, Coupling degrees, etc.	
FSSIM	Inflation, Yield trend, etc	Coupling degrees, Farm type resource endowments, etc	Nutrient management, Water management,
APES			Nutrient management, Water management, Tillage management

When the model (chain) run is complete, the results are stored in the system. Indicators that have been selected in the pre-modelling stage can be visualised, also at a later stage once the Project is re-opened. Results can be presented in different formats such as tables, maps and diagrams (line, bar, pie, spider, etc.). Depending on the user role charts can be added and modified (by Integrative Modellers) or reviewed only (for Policy Experts). Since modellers may also be interested in viewing some of the model variables not considered as indicators, to understand the causal relationships that have determined the outcomes of the simulations, an additional option is enabled to store all simulated data in specific (zip-compressed) files in the database.

SEAMLESS-IF is a distributed web service that can be used through a normal web browser. The system allows users to login as an Integrative Modeller (IM) or as a Policy Expert (PE) that activates a set of permissions attached to the specific user role. Through interactions with the GUI of SEAMLESS-IF a user, depending on its role (Super User, Modeller, Viewer or Publisher) has the right to create, update and delete users; create a new project, add one or more publishers to an existing project, create new users, add/delete one or more viewers and modelers to an existing project; browse through existing Projects or create and manage a new Project; view results from the existing model runs, to run additional scenarios within an existing Project or to create new Scenarios within a new Project and more. As mentioned, SEAMLESS-IF is continuously in development and new functionalities can be included.

References and further reading:

Belhouchette, H., Therond, O., Adenaeuer, M., Kuiper, M., Bigot, G., AlkanOlsson, J., Wery, J. et al., 2007. Documentation of baseline and policy options to be assessed with Prototypes 2 and 3, SEAMLESS Report No. 33, SEAMLESS integrated project, EU 6th Framework Programme, contract no. 010036-2, 120 pp. http://www.seamless-ip.org/Reports/Report_33_D6.2.3.3.pdf

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4.1 Pre-modelling

4.1.1 Problem Definition

Jean-Paul Bousset, Marie Taverne, Etienne Josien, Olivier Thérond

This chapter focuses on the definition and the issues of the problem definition process, then describes the content of the process and provides guiding principles and references for scientists.

Definition

In the SEAMLESS-IF impact assessment procedure, problem definition is part of the pre-modelling phase – so called "project definition" in the SEAMLESS-IF, with scenario description and selection of indicators.

In the context of policy analysis, the notion of problem definition, or problem setting, has long been instituted as the most crucial and demanding task facing the analyst (Bardach, 1996). Lessons from public policy research suggest that problems do not exist 'out there', are not objectives entities in their own right, but are personal or social constructs (e.g. Wildavsky, 1979; Dery, 1984; Weiss, 1989; Dunn, 1994). A situation (such as the observing system) becomes a problem only when people perceive the situation as different from what they would like to be.

The way a person perceives a problem, referred to as his or her problem definition, has a major influence on how he or she believes the problem should (or should not) be addressed. Thus, problems are analytic constructs for scientists, while they are political constructs for policy makers. Policy makers express organizational interests, values and motivations, while analysts refer to policy goals, impact indicators, and constraints for the impact assessments as inputs to a political process. In other words, while for policy makers what is recognized or legitimized as the appropriate definition of a given problem is the product of the political process, the analyst engages in 'search, creation and initial examination of opportunities for improvement' (Dery, 1984). So, 'selecting issues for active consideration', which is the essence of agenda setting, is not enough. For example, 'food safety' is a suitable answer to the question: 'Which issues are on the agenda?', but such an answer does not reveal the slightest hint on how this issue is defined. Problem definition must also address questions concerning 'the decision to be made, the ends to be achieved, the means which may be chosen' (Schön, 1994).

Issues

Problem definition affects both how the policy-related issues will be addressed and how successfully SEAMLESS-IF will advocate the tested policies. Therefore, problem definition is not just an academic exercise. In other words, we consider the 'boundary work' between science and politics, or integrative modellers and policy makers, as a part of the process of problem definition and agenda formation. By science, we mean both social and technical science – and thus we like to consider the construction and deconstruction of policy images. By learning to analyze and synthesize problem definitions, scientists can learn to formulate issues in a way that integrates science and public policy perspectives, benefiting science, policy, and society. One very important role that scientists – especially those specializing in modelling or systems analysis – can play is to facilitate the integration of different types of knowledge into the definition of the policy problem. This contribution of scientists is necessary, but also challenging since it means that the scientists need to be able to recognize, understand, and value other forms of social knowledge. Indeed, one reason for placing science within the policy process is so that scientists can learn about social values, appreciate other ways of knowing, and recognize the limits of science in policy.

Second, scientists use methods designed to assess how different elements of a problem are related to one another. Is there a direct causal relationship or an indirect one? Is there no relationship at all? This critical contribution to policy inquiry means that spurious relationships – ones with no causal links – can be sorted out. Often these spurious relationships are popularly supported. It is the critical contribution of science to demonstrate when these beliefs are supported by evidence (reason) and when conventional wisdom is simply wrong. The role of scientists as 'institutionalized critics' naturally occur in deliberative policy analysis.

Process

Problem definition should include two different phases: problem selection and problem framing.

Phase 1—Problem Selection

This phase involves deciding which problems, issues, or questions warrant an impact assessment approach. In many respects, the simplest step to do that is picking a topic, question, or issue on which to focus assessment efforts. It makes little difference if it is driven by policy or science concerns. There are many candidates, and priority-setting processes help identify the most important areas to pursue. Selecting issues for active consideration, which is the essence of agenda setting, must be clearly differentiated from the political process of problem definition. Problem selection is not selecting among issues on the agenda, but rather selecting among decision to be made, ends to be achieved, and means which may be chosen. In other words, problem selection consists of selecting among strategic representation of situations for a given organization (policy maker).

Problem selection is generally the responsibility of decision-makers (both management and funding organizations) who allocate people, money, and time to get work done. In other words, problem selection rests on several factors including strategic direction, the political environment, the budget outlook, and organizational capacity to respond to new work that might require significant new or redirected resources. The assessment and discussion of priorities, however, ought to in some way involve scientists to ensure that diverse perspectives and expertise are imbedded in decisions. In this sense, priority setting would be done at the top of the hierarchical organization, but would be grounded in bottom-up perspectives and insights. In other words, the assessment and discussion of priorities ought to in some way involve scientists to ensure that diverse perspectives and expertise are imbedded in decisions.

Phase 2—Problem Framing

Problem framing emphasizes focusing on problem restricting and structuring. Problem framing requires first that the time span of the problem should be fixed (von Winterfeldt and Edwards, 1986). The geographic extent is also an important aspect that may complicate the picture – consequences on a local level could very well be different from consequences on the EU level.

Problem framing also requires the interpretation of the most important aspects of the issue and how they connect. The factors and causal relationships in this conceptual model will suggest possible interventions (policy options), external driving forces (outlook), and biophysical and agro-management contextual elements of impact assessment to consider and which alternatives do not have to be considered (MacRae and Whittington, 1997; Bardach, 2000). In doing so, problem framing makes possible the definition of different combinations between policy options, outlooks and contexts to be considered, which put together can be viewed as an "experiment plan". Problem definitions that deemphasize or neglect important dimensions of an issue can "limit understanding and narrow analysts' vision," creating "blind spots" in which people will not see potentially valuable alternatives (Stern, 1986, p. 200). The extreme case is when a person "smuggl[es] an implicit solution into the problem definition" (Bardach, 2000, p. 7). Such problem definitions lead one to neglect other options, including no intervention (which is always an option, since resources are limited). Such problem definitions also encourage justifying recommendations using assumptions rather than evidence (Bardach, 2000). At best, this slants analyses or evaluations toward certain options; at worst, it makes them self-fulfilling exercises. Such problem definitions also fail to convince people with other points of view to support one's recommendations.

Some basic principles for problem framing have emerged from the literature and our discussions with scientists and science managers. Since how one defines a problem determines one's understanding of and approach to that problem, being able to redefine or reframe a problem and to explore the "problem space" can help broaden the range of alternatives and solutions examined. Problem framing will reveal if an integrated approach is required or if narrowly defined work is needed to improve understanding of complex issues. Both may be needed; it is not necessarily an either-or choice. Even when a problem (or part of a problem) falls within a particular discipline, integration may be critical at the theory or methodological level. How far one needs to "back up" in the process to improve integration in ongoing efforts must be decided on a case-by-case basis. Learning by doing seems to be critical in processes of integration. Social scientists have often pointed to the importance of "self discovery" as an aid to learning. This all implies the importance of extensive documentation and ongoing feedback and evaluation so we do not forget or repeat ourselves later, and so that lessons can be shared.

Supports

Learning to define problems consciously, by evaluating and synthesizing different perspectives, can help scientists consider policy options in a more balanced way. Doing so will help scientists contribute more effectively to societal decision making on topics of importance to science community and to society. Suggestions on problem definition are provided for scientists considering policy issues.

1) *Pay attention to goals.* Which options appear most favourable depends on one's goals. An important component of any problem definition is therefore what (and whose) goals are emphasized—and what (and whose) goals are not. This includes goals that are stated explicitly, and goals that are implied or assumed. Paying attention to goals, by identifying and evaluating the goals in different people's problem definitions (including one's own), is therefore a key component of developing beneficial policy options and convincing recommendations.

2) *Identify and evaluate significant assumptions.* Assumptions in problem definitions can take numerous forms, including assumptions about goals, causes, predictions, and solutions. Such assumptions will be transferred into the analysis and communication of options, and become so embedded that they are difficult to recognize. Although assumptions cannot be avoided entirely, significant assumptions – that is, "those that may significantly affect the conclusions of the analysis" (Morgan and Henrion, 1990, p. 38) – can lead to many of the difficulties discussed earlier. Consequently, identifying and evaluating significant assumptions in problem definitions, and then modifying them or tracking their influence, is an important step toward balanced consideration of options and persuasive communication (Mitroff and Emshoff, 1979). Assumptions embedded in problem definitions will be incorporated into impact assessments. If these assumptions are invalid, inappropriate, or outdated, the impacts are likely to be inaccurate. Such assumptions may also mask sources of uncertainty, leading to overconfidence in predictions and failure to consider alternate outcomes. Moreover, when

predictions are inaccurate or overconfident, recommendations are likely to fail to achieve the desired results.

3) *Consider different perspectives.* People approach public issues from different perspectives, depending on their knowledge, experience, and values. Scientists can therefore not take for granted that others define problems the same way we do, or even that they view our "problems" as problematic. By considering different perspectives and value systems, we can identify current and potential sources of disagreement about problems and solutions. Incorporating this understanding into how we define problems then produces more societal beneficial, more policy-relevant, and more marketable options. Important perspectives to consider include those of major stakeholders, including the intended audience, and those of people with less evident or more diffuse interests, such as under-represented groups and the general public (Bousset et al., 2005).

For example, analysts suggesting that problem for a given Interest Group (e.g. PE2) could be defined as "area of oil-producing crops – especially oilseed rape and sunflower – are currently growing too slowly in new regions (especially in breeding regions) to improve the biofuel energy balance" (modified from Bardach, 2000, p. 5). Here it is assumed that (1) the goal for PE2 is improving biofuel energy balance, (2) the solution is to develop oil-producing crops, and (3) developing oilseed rape and sunflower in breeding regions will improve biofuel energy balance. Audiences who do not share these assumptions will view the analysis as slanted, irrelevant, or invalid – and may not even perceive the situation as problematic.

Suggesting assessing global performances of cropping systems that contain oil-producing crops in comparison to cropping systems without oil-producing crops and to search for what could occur in term of surfaces at several scales if no specific action is done – with/under various price trends and incites, might be perceived as a more open approach of the problem. "Seemingly inconsequential changes" in framing a choice, such as presenting options in terms of losses rather than gains, can cause "significant shifts of preference" (Tversky and Kahneman, 1981, p. 457). Although results from idealized contexts are not directly transferable to real-world decision-making (e.g., Stewart, 1997), the range of framing effects that have been demonstrated (e.g., Nicholls, 1999) suggests that even subtle aspects of problem definitions can influence which alternative is preferred. Thus, even seemingly minor details in the language used to define a problem can be important (e.g., Stone, 2002).

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4.1.2 Indicator Selection

Jean-Paul Bousset, Marie Taverne, Etienne Josien, Olivier Thérond

This chapter focuses on the definition and the issues of the indicator selection process, then describes the content of the process and provides references for scientists.

Definition

In the SEAMLESS-IF impact assessment procedure, indicator selection is part of the pre-modelling phase with problem definition and scenario description. In the Seam:GUI it is led using the so called "indicator manager" tool.

Selecting indicators consists of making a choice among a set of "some things that provides a clue to a matter of larger significance or makes perceptible a trend or phenomenon that is not immediately detectable." (Hammond et al., 1995, p. 1). In SEAMLESS-IF, selecting indicators consists of making a choice among available information about the likely impacts of a specific policy option; by referring to information on their specific meaning, calculation and by using the so-called "Goal Oriented Framework (GOF) for indicator selection" (Alkan Olsson et al., 2007), in order to test the policy option against a baseline scenario and other policy scenarios (Pérez et al., 2007).

The GOF is based on three generic themes that are the same among the three dimensions of sustainability (environmental, economic and social). Each of these dimensions consists of indicators that refer to two "domains" of assessment which are considered as systemic units, impacts on agriculture and impacts of agriculture on the rest of the world. The first domain hosts indicators that assess impacts of the agricultural sector on itself. The second domain hosts indicators that assess the impacts of agriculture on society as a whole. Within each dimension each theme is thereafter specified in sub-themes (see Figure 4.1).

Figure 4.1: General structure of GOF for indicator selection

	Domain 1 Impacts on the agricultural sector		
	Dimensions of sustainable development		
	Environmental	Economic	Social
Ultimate goal	Protection	Viability	Quality of life
Process for achievement	Maintenance	Performance	Social and human capital
Means	Environmental compartments	Financial and prod. capital	Population

	Domain 2 Impacts on the rest of the world		
	Dimensions of sustainable development		
	Environmental	Economic	Social
Ultimate goal	Protection	Viability	Quality of life
Process for achievement	Maintenance	Performance	Social and human capital
Means	Environmental compartments	Financial and prod. capital	Population

Within each sub-theme, there can be lists of indicators. These lists of indicators are closely related to impact issues, which are used in the EU system to categorise indicators. These sub-themes are a way to ensure the representation of important issues or problems being an issue in relation to agri-environmental policy or external shocks to the agricultural system, such as eutrophication, climate change, farm income, employment rate, gender and behavioural changes of farmers.

Issues

The first challenge in selecting indicators for policy impact assessment is to find assessment criteria (measures) that can meaningfully capture key changes in the assessed system as consequences of the tested policy option, combining what is substantively relevant as a reflection of the desired result with what is practically realistic in terms of available data and models. In other words, the indicator selection will affect how successfully SEAMLESS-IF tools will advocate the tested policies.

Second, the selected indicators must cover in an equal manner all the pillars of Sustainable development, i.e. to cover the environmental, the economic and the social dimensions of policy impacts. Also, preferably the indicators should refer to both domains of assessment: impacts on agriculture and impacts on the rest of the world. It should be noted that these two domains are not symmetric or independent. An impact on the agricultural sector may also have an impact on the rest of the world or vice versa. The impact of the rest of the world on the agricultural sector will probably not be directly tackled within the frame of the SEAMLESS-IF.

Third, indicator selection should insure consistency between the values of the organization – policy maker, the goal of the tested policy option and the ambition to actions, which is the process where goals are translated into strategic objectives. In other words, indicators can be understood as science-policy interfaces for the construction of ‘strategic knowledge’. In choosing strategic indicators we should ask whether this indicator has a high impact on reaching the core goals of the organization. With the strategic indicators we wish to inform policymakers or/and other stakeholders. Based on this information they may decide to take action, by either making or implementing a policy-instrument or to look into the issue further.

In addition, institutional indicators will be selected to assess the plausibility that a suggested policy can be implemented, through the “Procedure for the Institutional Compatibility Assessment (PICA)”. PICA can assist in assessing the plausibility of regulatory instruments to be implemented, i.e. which are the hindering factors and how string are they. This is important as the degree of implementation will definitively influence the impacts of the policy option.

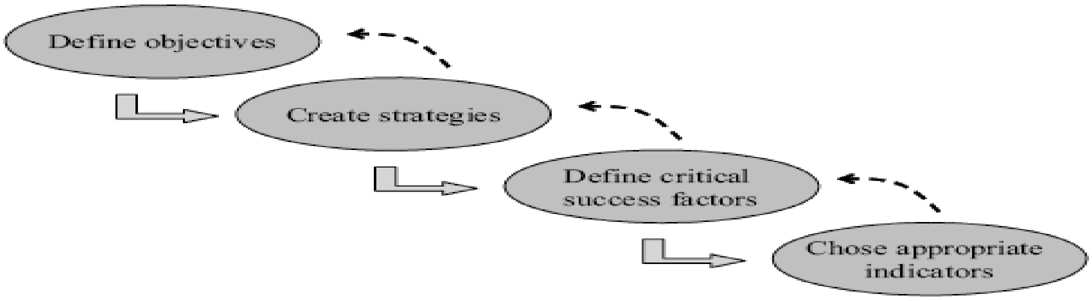
Process

While indicator development follows a top-down structure, the indicator selection should follow a bottom-up perspective (Wireman, 1998; Kaplan and Norton, 2001; Andersen and Fagerhaug, 2002, Engelkemeyer and Voss, 2000). Using the GOF for indicator selection, the first step should be to select the sub-themes relevant for each specific policy issue / objective (Figure 4.2). This approach is in line with the stepwise approach described in the European Commission’s Impact assessment guidelines (SEC (2005) 791) on how the impacts that are of interest to focus in a specific IA could be defined.

The second step should consist of checking that: (1) each theme is covered within a dimension of sustainability; (2) sub-themes are consistent with, for a given policy issue, the geographic situation (e. g. erosion is not an issue in plain regions); and (3) the related indicators are affected or/and reach a “critical” level in the assessed scenarios.

The third step should be to exclude sub-themes which are not key issues for the assessing authority or deemed to be critical for any of the consulted stakeholders. The goal based approach of structuring indicators rests on an approach to sustainability described by Hansen (1996) as “sustainability as an ability to satisfy goals”. Whereas many frameworks provide a (long) list of themes related to problems, which can be translated into goals, this framework has tried to categorize and qualify those “goals”. However, this does not mean that the goals per se are defined; this process must be done by policy makers and politicians.

Figure 4.2: Step-wise process for selecting indicators



The indicator selection should be flexible and it should be done in a negotiation process between different types of actors – e.g. components of the interest group, targets of the assessing authority, with different agendas (Alkan Olsson et al, 2007, section 2.2). Stakeholders from the sector of water management may wish to focus on reduction of nitrate leaching and may propose a management option to reduce nitrogen in soil but with concomitant increased losses of climate warming gases to the air. Another example that can be given is that crop scientists have developed methods to adjust fertilization in line with crop requirements, in order to avoid nitrate leaching without taking account of the energetic cost of mineral fertilizer. Those examples illustrate clearly some trade-off between sub-themes as well as trade-offs between the three generic themes.

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4.1.3 Experiment Design

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This chapter describes the definition of the experiment design process, the content of the process and discusses the issues of each step. Additionally, it provides support and references for scientists.

Definition

In the SEAMLESS-IF impact assessment procedure, experiment design is part of the pre-modelling phase – the so called "project definition" in the Seam:GUI, also including problem definition and indicator selection.

In the context of discrete-event simulation modelling, the design of simulation experiments (DOE) has long been instituted as a crucial and demanding task facing the analyst (Chen et al., 2003). Discrete-event simulation modelling is an effective method for predicting the performance of complex systems. The simulations are used to conduct experimental studies of the modelled system. Simulation runs consist of using mathematical models of a system – in the form of a computer program, in which input factors (independent variables) are combined to produce an output or response (dependent variable). Experiment designs are carefully planned simulation runs, which determine

1. The experimental conditions (independent variables) to be manipulated, i.e. the input variables defining the policy options to be tested in SEAMLES-IF.

2. The measurement (dependent variables) to be recorded, i.e. impact indicators which come from the Indicator Selection process.

3. The extraneous conditions (nuisance variables) that must be controlled, i.e. the agro-environmental and economic context and other outlooks.

Process

Experiment design includes three different phases: define the goals of the experiment; identify and classify independent and dependent variables; choose an experiment design.

Phase 1— Define the goals.

Of course, the selection of what conditions to run depends on the goals of the simulation. Why was the simulation model constructed? What particular issues are being examined during the current cycle of experimentation? These goals generally belong to the upper level in the hierarchy of goals within the organization that is sponsoring the use of the simulation model. It is good to place these goals in perspective, to gain support for the effort that will be required, and to make sure that the short-term objectives are consistent with the overall goals of the organization (see Problem Definition process).

Phase 2— Identify and classify variables.

The second step in the experiment design process is to identify quantities in the simulation that can be set to desired values (independent variables, e.g. input variables defining the policy options to be tested in SEAMLES-IF impact assessments) and the resulting system performance measures that are of interest (dependent variables), which are the selected (policy impact) indicators. Another class of variables to be considered when designing the experiment are variables which are known to affect the behaviour of the system. They are affected by the settings of the independent variables, but they are not considered dependent variables. They are often called "nuisance variables or outlook parameters".

It is necessary to identify all variables of all three types before planning the set of runs. Dependent variables are determined by the objectives of the study. All independent variables should be identified, not just the ones that will be varied in the experiment. Nuisance variables must be monitored so that variation in the experiment results can be understood. In order to be able to reproduce the results later, the (fixed) values of any independent variables that were not adjusted must be recorded, as well as the values of ones that were varied. Independent and nuisance variables whose values are actually changed during the experiment will be called factors. Process diagrams and cause-effect diagrams can be used to identify them (see Barton, 1999).

Phase 3— Choose an experiment design (matrix).

In this activity, one determines the number of distinct model settings to be run and the specific values of the factors for each of these runs. There are many strategies for selecting the number of runs and the factor settings for each run. Four types of experiment matrices are available, including the Hadamard matrix, Rechtschaffner matrix, fractional factorial matrix and the complete (full) factorial matrix.

In Table 4.4, an example of a fractional factorial design is presented. Factorial designs allow the modeller to analyse multi-level parameters influences and their dependencies, which is not possible in Hadamard and Rechtschaffner matrices. Factorial designs are based on a grid, with each factor tested in combination with every level of every other factor. Factorial designs are attractive for three reasons: 1) the number of levels that are required for each factor are one greater than the highest-order power of that variable in the model, and the resulting design permits the estimation of coefficients for all cross-product terms; 2) they are probably the most commonly used class of designs, and 3) the resulting set of run conditions are easy to visualize graphically for as many as nine factors.

Table 4.4 shows how resolution 3-factor fractional factorial designs can be constructed for a large number factor screening experiments (factor L = 6, resolution m = 3) where only main effects exist. The factorial design is based on the first 3 factors, A, B and C. The rest of the main effects (D, E and F) are assigned to the last three columns of AB, AC and BC respectively so their main effects are confounded with corresponding interaction effects. The level settings of main effects confounded with interaction effects at each design point are set to be the same as the level settings of the corresponding interaction effects. Thus, we have a design matrix and all main effects can be estimated.

Table 4.4: Resolution III Fractional Factorial Design

Run	A	B	C	D = AB	E = AC	F = BC
1	-	-	-	+	+	+
2	+	-	-	-	-	+
3	-	+	-	-	+	-
4	+	+	-	+	-	-
5	-	-	+	+	-	-
6	+	-	+	-	+	-
7	-	+	+	-	-	+
8	+	+	+	+	+	+

The disadvantage of full factorial designs is that they require a large number of distinct runs. If a design includes all treatment combinations (with two levels per factor L), it is a full factorial design; if only a fraction of those is included, it is a fractional factorial design. Controlled sequential fractional-factorial designs (CSFD) have the flexibility to stop the experiment early, to increase the model size when further investigation is necessary, and to classify any desired main effect or interaction effect. For detailed description of factorial design and analysis, please refer to Montgomery (2001). Many books (e.g. Wu and Hamada,

2000) and software packages provide recommended designs for various resolutions and various values of L, the number of factors to be screened.

Supports

In SEAMLESS-IF impact assessments, factors can be independent variables to be manipulated, including a policy option to be tested (e.g. A) an agro-environmental context (e.g. B), nuisance variables (e.g. C), and a combination among independent variables and nuisance variables (e.g. C=AB, E=AC, F=BC).

Factors as policy options. What is (are) the policy option(s) that should be assessed? Each Experiment within a project assesses the effects of one or a combination of several policy option(s). One policy option refers to one or a set of policy measures. Each policy option has a set of exogenous policy parameters within a given timeframe or for a given time series. Exogenous policy parameters are variables that together describe one policy option that are outside the SEAMLESS models. For example, the introduction of decoupled payments in the EU is described by the percentage of decoupling for a region, the reference yield for a region and the cut in premiums occurring in the EU. Base year and baseline are two examples/instances of the concept policy option that have policy parameters (namely policies that have already been agreed upon and are currently being phased-in) and occur in the years 2003, 2013 and 2020.

Factors as agro- management contexts. Which are the relevant agro-management contexts to be simulated? The agro-management context of a problem is the object of interest (components of the cropping and farming system), which is delimited by the boundaries to the biophysical and agro-management system. These biophysical and agro-management boundaries determine what is inside and what is outside the investigated system. Each experiment within a problem will be based on ONE agro-management and biophysical context that can be different from those of other ‘experiment(s)’. This agro-management and biophysical context sets the boundaries for the agro-management and biophysical models (FSSIM-AM) and has to be defined before the assessment can be started. Given the current models, relevant properties to define for such a context include the crops to be considered, one or many representative farms (farm types), the production orientation and the crop management. An example of a context is a medium sized low intensity arable farm in the Flevoland region in the Netherlands, which could grow sugar beets, potatoes and spring wheat under conventional management. After one or more Agro-management Contexts have been defined within ONE ‘Problem definition’, the input parameters for the models that evaluate the Policy Options based on this Context (technical coefficient of the investigated farming activities) can be generated. These input parameters corresponding to the different contexts will be generated by some of the models, for example currently FSSIM-AM and APES, even before the specification of the different policy options. These sets of technical coefficients will serve as the base for the assessment of the policy options linked to the experiment.

Factors as outlook parameters. What are trends and trend deviations foreseen to occur in society that might affect the implementation of policy options within a given context, which are not modelled endogenously in SEAMLESS-IF (Outlook)? What do the policy experts and/or integrated modellers expect to happen in the future for the external driving forces? A problem definition can have one or more Outlooks on the future. One reference outlook is always required that describes the prolongation of the current situation into the future, sometimes called ‘business-as-usual’ outlook. Outlooks are usually contrasting, for example a positive versus a negative outlook, a globalization versus a regionalization outlook, a high-employment versus a low employment outlook, etc. Each outlook has several exogenous parameters that capture the different trends occurring in society. These parameters are unchangeable by the models, meaning that the model run does not affect the value of the parameter. Examples of these parameters are atmospheric CO_2-concentration, GDP-growth and unemployment rate. It should be noted that the exogenous parameters vary between models. For example, in the APES-FSSIM model chain, prices are exogenous, whereas in FSSIM-EXPAMOD-SEAMCAP chain these prices are endogenously determined by demand and supply.

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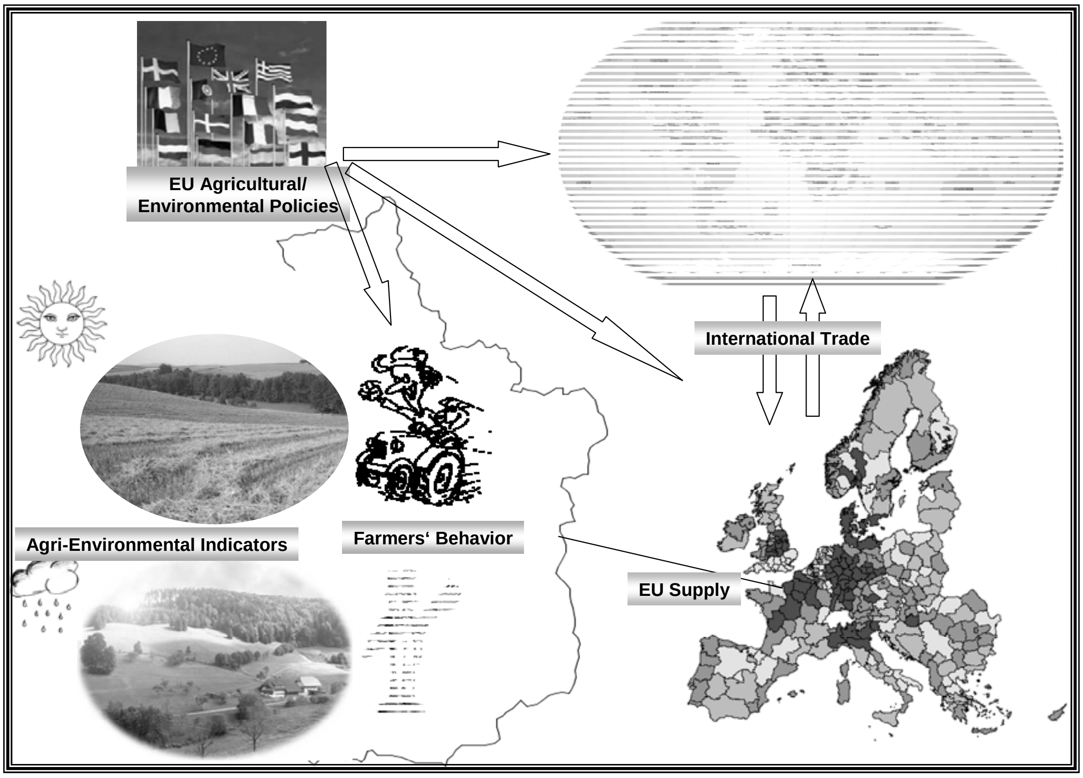
4.2 Modelling

4.2.1 Model chains

How Farmers behavior can impact on EU market prices

Marcel Adenauer

The SEAMLESS Integrated Framework (SEAMLESS-IF) is developed to support assessments of policies affecting sustainability of agricultural systems. This goal is partly addressed by linking models and thereby bridging economic and biophysical spheres as well as smaller with larger scales. The fascinating challenge of SEAMLESS-IF is the concrete implementation of the model links. They will provide the unique opportunity to consistently connect farm level behavior and its differentiated economic and environmental consequences with agricultural markets and market policies.

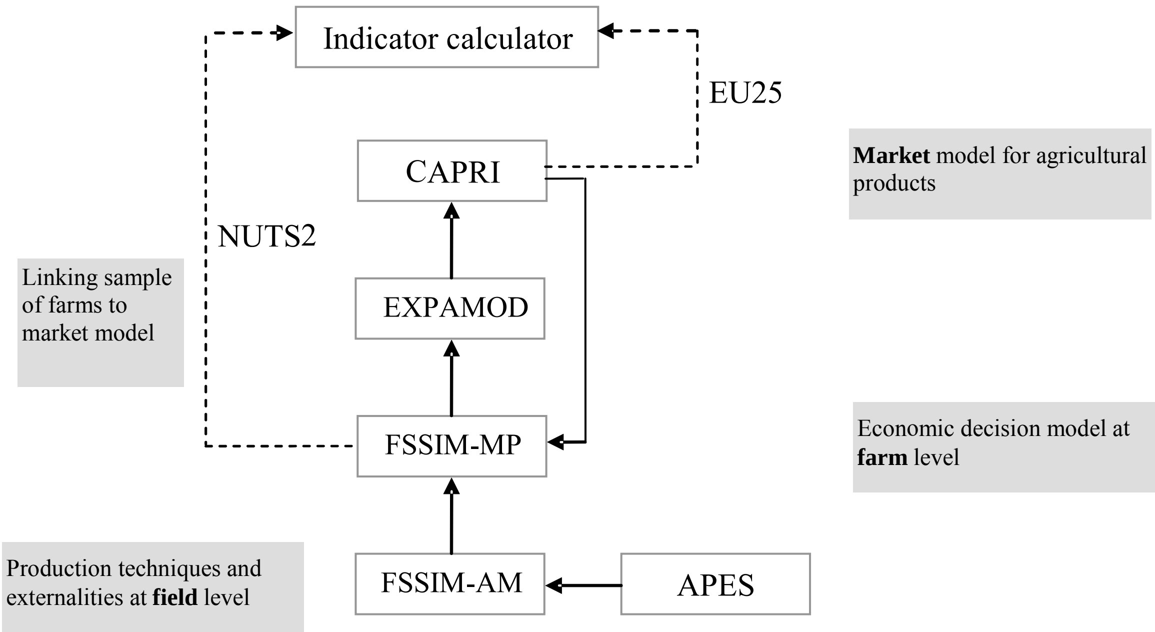


Farms are the basic decision making units in agricultural production, and therefore impact on land use, their environment and market outcomes. The characteristics of farms and the behavior of their operators vary a lot across Europe. In the picture above we find two exemplary farmers from a region in France. The upper one seems to be more progressive and dynamic than the one on the bottom who is a cool-headed old fashioned guy. They also work under different agro-environmental conditions like different soil types, rainfall patterns or landscape. The behaviour of farm types similar to our two farmers (and a few other farmers) are modelled by the FSSIM models (Farm System Simulator) which simulate responses of farmers with respect to land use and production levels to changes in prices or policy support. The biophysical model APES (Agricultural Production and Externalities Simulator) provides the information on environmental impacts of various farming activities. The aggregated response from these farmers may have significant market impacts, and hence in turn influence agricultural commodity prices. SEAMLESS-IF will contain farm models for about

25 European regions, capturing most of the variance of conditions and farm characteristics across Europe. From these 25 regions a further model component (EXPAMOD) extrapolates the supply behaviour to the entire EU25 using a statistical approach. The agricultural sector model CAPRI (Common Agricultural Policy Regional Impact analysis) then adopts this supply behavior and finds a new market equilibrium on EU and international markets for agricultural products. Final farm behavior will then be simulated using the new equilibrium prices to assess their impact on European farms.

The linkage of the models APES, FSSIM, EXPAMOD and CAPRI is called the Backbone Model Chain as it contains the core feedbacks across scales and disciplines providing important indicators by themselves, but also allowing linking other modules and indicators which require consistent solution of these models. A more schematic representation of their linkage is given in Figure 4.3.

Figure 4.3: Linkage between models in SEAMLESS-IF.



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Flichman, G., Donatelli, M., Louhichi, K., Romstad, E., Heckelei, T., Auclair, D., Garvey, E., van Ittersum, M.K., Janssen, S.J.C., Elbersen, B.S., 2006. Quantitative models of SEAMLESS-IF and procedures for up- and downscaling. Report no. 17, SEAMLESS integrated project, EU 6th Framework Programme (www.seamless-ip.org/Reports/Report_17_PD1.3.2.pdf).

4.2.2 Calculations

Patrik Wallman

SEAMLESS-IF consists of four main models coupled in a model chain. The different models in the chain represent different geographical scales, from field to region to country and the EU, but also different scientific disciplines such as biophysical models and economic models.

APES (Agricultural Production and Externalities Simulator) is a tool to integrate analyses of impacts on a wide range of aspects of sustainability and multi-functionality by evaluating agricultural production and system externalities for most types of agricultural production systems. APES uses three kinds of input data: 1) variables and parameters provided directly by the user (physical site, soil parameters and daily weather data), 2) parameters which can be accessed by specific components i.e. biophysical parameters for different crops, and 3) parameters provided via agro-management files (all the actions to be performed on the crop). APES calculates the yield of crops by use of physiologically based process descriptions such as root growth, water uptake, light interception etc.

FSSIM (Farm System Simulator) is a bio-economic farm model that links a mathematical programming model formulation of farmers' resource management decisions, to a data module that includes agronomic and economic information coming respectively from APES and statistical data bases (costs, labour, machine requirements). The data module aims to generate a set of agricultural activities and to quantify the input-output coefficients (both yields and environmental effects) of the farming system. In the data module, firstly a set of suitable production enterprises is generated, secondly these production enterprises are linked to production techniques that describe all the agronomic inputs to the farming system and lastly, for these combinations between production enterprises and production techniques input-output coefficients are derived. The set of agricultural activities and quantified input-output coefficients is then included in the FSSIM model. The FSSIM model tries to solve the mathematical programming model by maximizing a utility function subject to a limited number of explicit constraints.

EXPAMOD (Extrapolation Model) is used for up-scaling the outcomes from FSSIM to the European scale, in the form of price-supply relationships. EXPAMOD estimates the differences in supply responses, and statistically propagates these responses to out of sample farm-region combinations. Changes in relative farm level profits are then used to assign new weights to the farm types covered by the analysis. The supply changes at the micro level and the revised weights for the farm types are then used to adjust supply in the market model SEAMCAP (see below), so that revised prices are obtained. These prices are then fed back in a last step to FSSIM.

SEAMCAP, a version of the CAPRI (Common Agricultural Policy Regional Impact Analysis) model that has been adapted for SEAMLESS-IF, is a comparative static equilibrium model providing information on price-supply relationships, solved by iterating supply (from EXPAMOD) and market modules, and applied to the agricultural sector of the European Union. Simulation results cover areas cropped and herd sizes along with output and inputs coefficients and income indicators for each agricultural activity and each region; prices, supply and demand positions at country level; environmental indicators (gas emissions, N,P,K balances) at regional level; producer and consumer prices, supply and demand positions as well as bilateral trade flows with attached prices, transport costs and tariffs globally for each trade block; the costs of Common Agricultural Policy broken down to individual of policy instruments; a welfare analysis for all countries or country blocks in the system and many other interesting aspects of agriculture.

A fifth model that does not include calculations *per se* is also attached to SEAMLESS-IF, which is PICA (Procedure for Institutional Compatibility Assessment). PICA is a systematic procedure to use information from ex-post case studies and indicator databases for making ex-ante predictions of the institutional feasibility of policies. PICA comprises four distinct steps: 1) Policy options are clustered according to the type of intervention (regulatory, economic, and advisory), the area of intervention (hierarchy/bureaucracy, market, and self-organized network), possibly involved property rights changes, and the attributes of the natural resource addressed. This classification allows identifying the generic structure of a policy option. 2) Each policy cluster is linked to specific sets of crucial institutional aspects (CIA) that may constrain or foster policy implementation. 3) Institutional indicators are used to evaluate the potential of a respective CIA. 4) Combination of the identified CIA and assessment of their relative explanatory power leads to statements about the probable effectiveness of a policy option. The mainly qualitative PICA outputs are arranged in thematic categories of institutional compatibility.

4.3 Post-Modelling

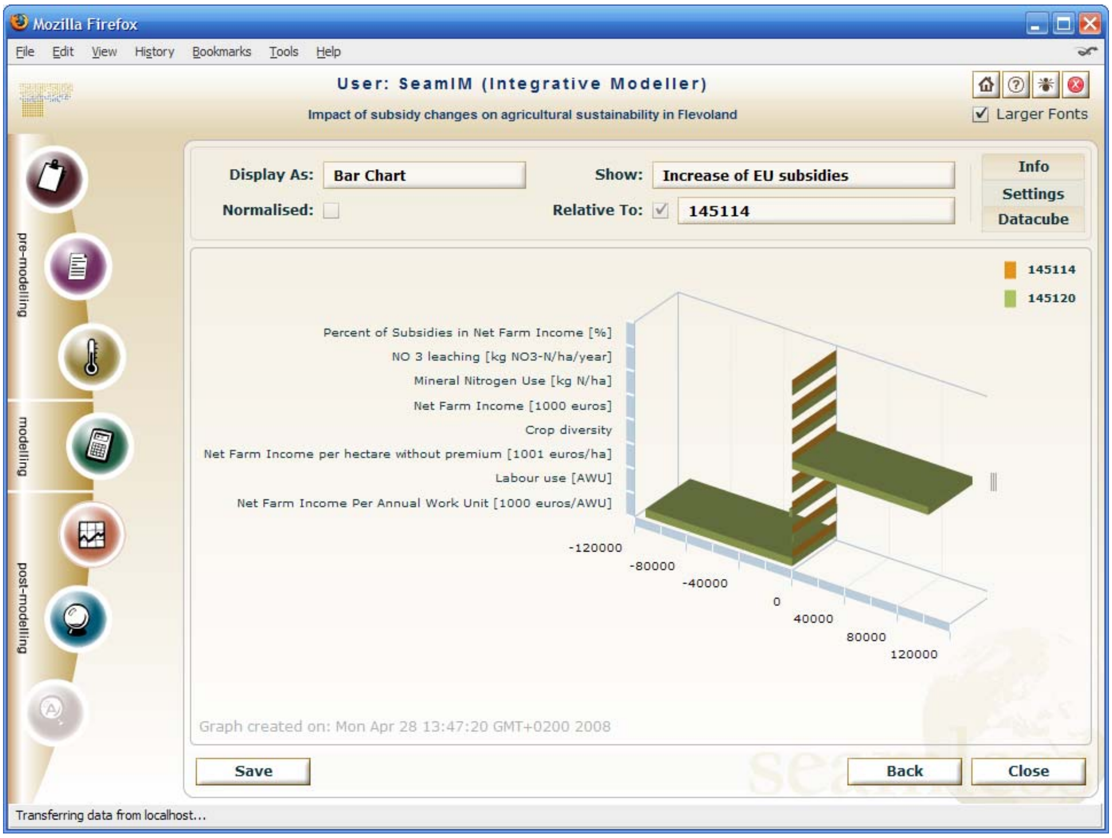
4.3.1 Creating Visualisations with Seam:PRES

Rob Knapen

Seam:PRES is the part of the SEAMLESS-IF software that provides the functionality to create and view visualisations. A visualisation is a table, chart or map that shows the calculation results of the models included in SEAMLESS-IF. Before Seam:PRES can be used a project has to be created, experiments (scenarios) defined and calculated on the server so that the results are readily available in the SEAMLESS database.

At that point Seam:PRES can be used to retrieve the data from the database and use it to create charts. Depending on the user role, charts can be added and modified (by Integrative Modellers) or reviewed only (for Policy Evaluators).

Figure 4.4: Sample screenshot of Seam:PRES

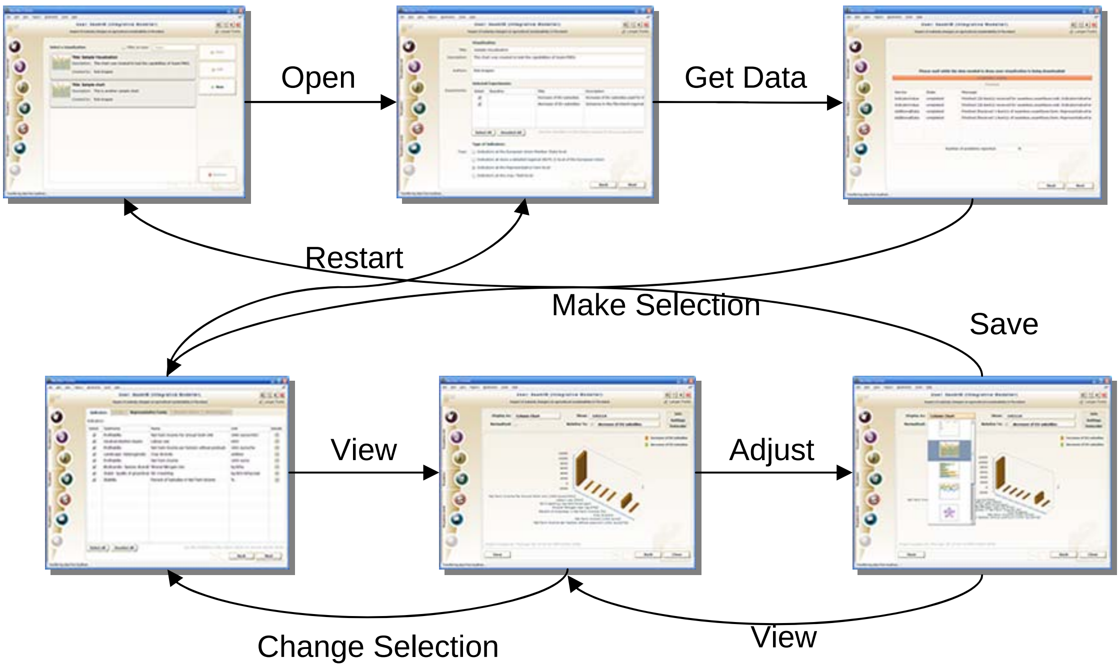


With the current version of the software (April 2008) a limited number of types of charts and tables is supported by Seam:PRES. However this will be extended for future versions, based on requirements and user requests. Included at the moment are: data tables, column charts, bar charts, line charts, pie charts and spider diagrams. There is also a member states map and a NUTS2 regions map, but these are highly experimental. Additionally Seam:PRES can normalise data for a visualisation or calculate relative values based on a selectable reference.

Seam:PRES Workflow

Visualisations created with Seam:PRES are stored in the project. To start an existing one can be opened or a new one created. Next, a first selection has to be made of the experiments and type of indicators to be used for the visualisation. Seam:PRES will then retrieve the data from the SEAMLESS server and store it locally in a three-dimensional data cube.

Figure 4.5: Overview of the Seam:PRES workflow



The content of the data cube can then be further selected from to create the initial visualisation, followed by adjusting the chart type, the selection, the reference point, and so on, until the desired output has been achieved. At which point it can be saved for future use.

4.3.2 Interpretations of results for Sustainable Development

Marijke Kuiper, Hatem Belhouchette, Pytrik Reidsma and Martin van Ittersum

Applications in SEAMLESS-IF

The two main Test Cases in the development of SEAMLESS-IF are (1) a macro-micro-level application to analyse the impact of trade liberalization on the EU, and (2) a regional level application to analyse the impact of the Nitrate Directive in Midi-Pyrenees. These applications should illustrate the potential of SEAMLESS-IF by analyzing effects at different scales (from global to farm level) and across different domains of sustainable development (economic, biophysical and social). The policies enter the system top-down (test-case 1) or bottom-up (test case 2).

Indicator framework

To ensure a balanced selection of indicators for the assessment of sustainable development, the Goal Oriented Framework was developed (see module 7.1 and 4.1.2). In order to arrive at an integrated assessment across domains and scales the results for indicators first need to be understood in isolation, i.e. for each indicator at a time, and then the results for various indicators need to be contrasted and their implication for sustainable development assessed. In Modules 3.1 and 3.2 the Test Cases (practical applications) were described, the next step is to interpret the results of these applications in the wider context.

Macro-level application

The application focusing on trade liberalization illustrates a typical question of EU policymakers dealing with a macro-level policy. This economic policy may have environmental and social impacts which could conflict or support other policies (at EU, national or regional level). The application requires use of all backbone-chain models thus providing an elaborate test of the full system. Furthermore, although the policy being assessed is an economic one, the assessment of environmental and social indicators will provide a test of the capacity of SEAMLESS-IF for integrated assessments.

Results of this assessment are firstly analyzed at global and EU level in economic terms, employing indicators derived from the market level modelling in SEAMCAP. Points of interest are the implications of trade liberalization for EU’s position in the global market and effects on the EU as a whole. In module 3.1 we observe increasing agricultural income reductions and consumer’s welfare with increasing degree of liberalization. The losses in agricultural income and tariff revenues are in all scenarios more than compensated by increasing consumer’s welfare, so that the total welfare in the agricultural sector increases for all scenarios.

Secondly, economic impacts at member state level are considered in more detail. A key point of interest is the distribution of effects over different member states, since this will be relevant for the political feasibility of a WTO agreement. Results indicate that the regional distribution of the agricultural income changes in the standard G20 scenario. It shows that the 6% income reduction in the EU25 is distributed among regions with a spread between -16% and -2.5%, with smallest reductions in the south and in the north.

The third step is to evaluate the potential environmental impacts of a trade agreement at both regional and farm level using indicators derived from FSSIM (Table 4.5).

Table 4.5: G20 – Average impact Midi-Pyrénées

	2001 (base year)	2013 (changes in relation to base year)		
		Baseline	G20	Total
Farm income (1000 €)	79	-7%	-2%	-9%
Nitrate leaching (kg N-NO3/ha)	34	13%	-3%	10%
Soil organic matter (%)	2	-1.6 %	-0.1 %	-1.7 %

Combining these assessments gives an integrated assessment of the effect of trade liberalization on the EU. Trade-offs as well as win-win situations can be identified, which can be in terms of gains and losses at different scales or in different domains.

The structuring of indicators according to the GOF is still in development. It is clear that the model-chain used produces mainly economic indicators. A few environmental indicators can be produced, but the social dimension is difficult to quantify. The GOF can help to make the set of indicators more balanced, whereas the indicator calculator may be used to calculate indicators for the social dimension based on economic and/or environmental indicators. For example, poverty (social: quality of life) can be based on income indicators, while health (social: population) can be based partly on environmental indicators.

Regional application

The assessment of the Nitrate Directive in Midi-Pyrenees illustrates a typical question of regional policymakers, as it is an EU policy to be implemented at regional level. The application uses the APES (or CropSyst as replacement) – FSSIM model chain. Results are evaluated at farm type and at regional level.

Results presented in Module 3.2 include two economic indicators (farm income, premium) and one environmental indicator (nitrate leaching). These indicators are the most important ones to address the problem of nitrate pollution. To assess the impacts of policies on sustainable development at large, more indicators can be selected that can be produced by FSSIM. The GOF can be used for a balanced selection of indicators. As noted before however, the assessment of social indicators is more problematic than economic and environmental indicators. And when assessing specific policy options, it may be clear beforehand that these options will only affect a few indicators. Selected indicators should be relevant for the problem and they should be subject to change due to the selected policy option. For example, it is not likely that the implementation of the Nitrate Directive will affect the education level (social indicator) of farmers; it is more likely that the causal effect is the opposite.

Concluding remarks

SEAMLESS-IF has the potential to analyze effects at different scales and for different dimensions. When performing an assessment of a policy often only a limited set of indicators is selected, which is also observed in the first results of the two test cases. The embedding in SEAMLESS-IF ensures to consider other indicators and scales that allow an integrated assessment of sustainable development. For further assessment of sustainable development, SEAMLESS-IF may be complemented with tools such as multi-criteria analysis (MCA).

4.3.3 Sensitivity and uncertainty analysis

Frank Ewert and Martin van Ittersum

We consider that effective application of policy-relevant impact assessments can only be achieved, if uncertainty analysis effectively responds to information needs of model users and stakeholders of the problem (Gabbert, 2008). Accordingly, a concept is developed and applied to determine uncertainty for two aims (van Ittersum et al., 2008): 1) informing users of the model (or the model chain) about critical model assumptions and parameters and their uncertainties, and 2) providing guidance to the model developers in improving the model or model chain. Uncertainty of parameters and specific model assumptions can be tested within the present design of creating different experiments with different parameters and model assumptions.

The prime interest for (policy) users of SEAMLESS-IF lies in the assessment of new policies or agro-technological developments, i.e. how effective and (cost-)efficient are new policies and technologies in realising specified policy aims. The question to be addressed is whether it is likely that the indicator values of the policy scenarios are better than those in the baseline scenario and if so, how much. We hypothesize that the relative difference between the baseline and the policy scenario will be more important than a perfect assessment of the absolute outcomes of a baseline or policy scenario. We therefore propose to focus the uncertainty analysis on the ranking of scenario outcomes.

The critical interactions between the model components of SEAMLESS-IF backbone models are the following: Starting from CAPRI, the key input obtained from EXPAMOD are the price elasticities (price-supply relationships) for the various NUTS2 regions. Key inputs from FSSIM to EXPAMOD are agricultural supply (and eventually externalities) because of prices (and policies, farm structure and objectives). FSSIM uses agricultural activities which have been quantified in FSSIM-AM, using APES for assessing yields and externalities such as water use, nitrogen emissions and pesticide leaching. Only one feedback mechanism is anticipated, i.e. between CAPRI and FSSIM where prices simulated by CAPRI are an input to FSSIM models. In all other instances, models will not be used in an iterative scheme with the other models in the chain. This suggests that one could treat the uncertainty in for instance APES independently of the uncertainty in the other models.

We propose a four-step procedure for uncertainty analysis in SEAMLESS-IF to be illustrated with Test Case 1 (G20 trade liberalization proposal):

Phase 1: Identification of model users' uncertainty information needs

As a first step, a questionnaire has been distributed to users. The results obtained from phase 1 will give insight to uncertainty preferences of model-users. However, given the complexity of SEAMLESS-IF, different types and sources of uncertainties have to be taken into account. In order to evaluate which particular types and sources have been addressed by model users, uncertainty information needs identified in phase 1 will be sorted according to the scheme suggested by Walker et al. (2003).

Phase 2: Identification of key uncertainties

In common situations of limited resources, for a given "budget" (in terms of money, research time, etc.) maximal "output" (in terms of information about uncertainties in IAMs) should be achieved. Thus, of the uncertainties, which are most relevant to model-users, we have to filter-out those which are in fact of main impact on model output. These are called "key uncertainties". It should be stressed that key uncertainties do not necessarily be quantifiable uncertainties (such as model parameters) only. Uncertainties in model structure or data quality, for example, can also turn out to be of major impact on model output and therefore be denoted as key. For identifying key uncertainties, different approaches have been suggested and applied within recent years (Rypdal and Flugsrud 2001, ApSimon et al. 2002, Gabbert 2006). Depending on the outcomes of phase 1 it will be decided which of the approaches available seems to be most reasonable. This facilitates the choice and application of appropriate methods for uncertainty analysis within SEAMLESS-IF.

Phase 3: Uncertainty analysis in components of SEAMLESS-IF

Key uncertainties will be investigated at component level through classical forms of sensitivity and uncertainty analysis. However, in the final version of SEAMLESS-IF delivered at the end of the project this will not be supported within the framework. Still, sensitivity and uncertainty of individual components should be tested outside the framework by the component developer.

Phase 4: Uncertainty analysis in the model chain of SEAMLESS-IF

In a final step, the accumulation of uncertainties throughout the model chain is investigated. SEAMLESS-IF (final version at the end of the project) will support this analysis through the design of experiments (scenarios). This will allow some evaluation of the uncertainty associated to different parameters (of one or more models) with respect to the final results for a specific model chain.

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5 Individual components

5.1 CAPRI – Common Agricultural Policy Regionalised Impact analysis

Marcel Adenauer

The CAPRI modelling system consists of specific databases, a methodology, its software implementation and the researchers involved in their development, maintenance and applications.

The databases exploit wherever possible *well-documented, official and harmonised data sources*, especially data from EUROSTAT, FAOSTAT, OECD and extractions from the Farm Accounting Data Network (FADN)*. Specific modules ensure that the data used in CAPRI are mutually compatible and complete in time and space. They cover about 50 agricultural primary and processed products for the EU (see Britz et al., 2008 in the Annex), from farm type to global scale including input and output coefficients.

The economic model builds on a *philosophy of model templates* which are structurally identical so that instances for products and regions are generated by populating the template with specific parameter sets. This approach ensures comparability of results across products, activities and regions, allows for low cost system maintenance and enables its integration within a large modelling network such as SEAMLESS. At the same time, the approach opens up the chance for complementary approaches at different levels, which may shed light on different aspects not covered by CAPRI or help to learn about possibility aggregation errors in CAPRI.

The economic model is split into two major modules. The *supply module* consists of independent aggregate non-linear programming models representing activities of all farmers at regional or farm type level captured by the Economic Accounts for Agriculture (EAA). The programming models are a kind of hybrid approach, as they combine a Leontief-technology for variable costs covering a low and high yield variant for the different production activities with a non-linear cost function which captures the effects of labour and capital on farmers' decisions. The non-linear cost function allows for perfect calibration of the models and a smooth simulation response rooted in observed behaviour. The models capture in high detail the premiums paid under CAP, include NPK balances and a module with feeding activities covering nutrient requirements of animals. Main constraints outside the feed block are arable and grassland, set-aside obligations and milk quotas. The complex sugar quota regime is captured by a component maximising expected utility from stochastic revenues. Prices are exogenous in the supply module and provided by the market module. Grass, silage and manure are assumed to be non-tradable and receive internal prices based on their substitution value and opportunity costs.

The market module consists of two sub-modules. The sub-module *for marketable agricultural outputs is a spatial, non-stochastic global multi-commodity* model for about 40 primary and processed agricultural products, covering about 40 countries or country blocks in 27 trading blocks. Bi-lateral trade flows and attached prices are modelled based on the Armington assumptions. The behavioural functions for supply, feed, processing and human consumption apply flexible functional forms where calibration algorithms ensure full compliance with micro-economic theory including curvature. The parameters are synthetic,

* FADN data are used in the context of so-called study contracts with DG-AGRI, which define explicitly the scope for which the data can be used, who has access to the data and ensure the data are destroyed after the lifetime of the contract.

i.e. to a large extent taken from the literature and other modelling systems. Policy instruments cover Product Support Equivalents and Consumer Support Equivalents (PSE/CSE) from the OECD, (bi-lateral) tariffs, the Tariff Rate Quota (TRQ) mechanism and, for the EU, intervention stocks and subsidized exports. This sub-module delivers prices used in the supply module and allows for market analysis at global, EU and national scale, including a welfare analysis. A second sub-module deals with prices for young animals.

As the supply models are solved independently at fixed prices, *the link between the supply and market modules* is based on an iterative procedure. After each iteration, during which the supply module works with fixed prices, the constant terms of the behavioural functions for supply and feed demand are calibrated to the results of the regional aggregate programming models aggregated to Member State level. Solving the market modules then delivers new prices. A weighted average of the prices from past iterations then defines the prices used in the next iteration of the supply module. Equally, in between iterations, CAP premiums are re-calculated to ensure compliance with national ceilings.

Post-model analysis includes the calculation of different income indicators as variable costs, revenues, gross margins, etc., both for individual production activities as for regions, according to the methodology of the EAA. A welfare analysis at Member State level, or globally, at country or country block level, covers agricultural profits, tariff revenues, outlays for domestic supports and the money metric measure to capture welfare effects on consumers. Outlays under the first pillar of the CAP are modelled in very high detail. Environmental indicators cover NPK balances and output of climate relevant gases according the guidelines of the Intergovernmental Panel on Climate Change (IPCC). Model results are presented as *interactive maps* and as thematic *interactive drill-down tables*.

The *technical solution* of CAPRI is centred on the modelling language GAMS which is applied for most of the data base work and CONOPT applied as solver for the different constrained (optimisation) problems. The different modules are steered by a Graphical User Interface currently realised in C, which interacts with FORTRAN code and libraries which are inter-alias dealing with data base management. Typically, these applications generate run-specific parts of the GAMS code. Exploitation tools apply additionally Java applets for interactive maps and XLM/XSLT to generate interactive HTML tables.

SEAMCAP is an adjusted version of the simulation engine of CAPRI in order to integrate it into the SEAMLESS framework that

- allows to use external elasticities provided by EXPAMOD to steer the supply response in the regional supply models
- allows to transfer scenario parameters from a Guided User Interface (GUI) for scenario handling
- prepares a subset of model outputs to make them available to the user of SEAMLESS-IF

References and further reading

A detailed documentation of the CAPRI modelling system can be found in Britz et al. (2008) at http://www.ilr1.uni-bonn.de/agpo/rsrch/capri/Final_Report_Model_Description.pdf.

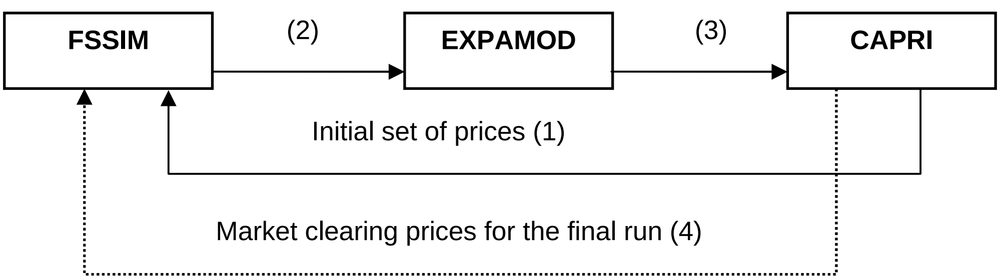
5.2 EXPAMOD – Extrapolation Model

Irina V. Bezlepkina, Ignacio Pérez-Domínguez, Thomas Heckelei, Alfons Oude Lansink, Erick Romstad

Farms are the basic decision units in agriculture and, therefore, influence market outcomes, land use and the environment. Moreover, farmers perceive prices as given, since production in each production unit is small compared to total production in the sector. Farm level optimization models share a similar perspective. As long as the policies investigated are such that market prices remain stable, the error made by taking prices as exogenous is negligible. However, agricultural policies are horizontal and affect all farmers at the same time. Therefore, their aggregated response and their interaction may have profound impacts in agricultural markets, which in turn influence commodity prices. Agricultural sector models such as CAPRI (Common Agricultural Policy Regionalised Impact analysis) are able to capture price changes from policies.

The integrated project SEAMLESS aims at providing a consistent integration between a farm management model specified for a selection of farm types (FSSIM) and an EU wide aggregated agricultural model with an explicit market component (CAPRI). Given the ca. 250 NUTS2 regions and high diversity of farm types within the EU27, FSSIM is only capable of considering a subset of regions and farm types in detail. This is why a complementary procedure for expanding FSSIM results to all other regions is needed. The principle behind the presented methodology (EXPAMOD) is to make the regional supply modules of CAPRI behave like the aggregate of the FSSIM models of the same region (Figure 5.1).

Figure 5.1: Flow of prices (1, 2 and 4) and price supply elasticities (3) between models under a policy scenario



In order to map the supply behaviour of farm management models to the market model, the EXPAMOD methodology comprises the following sequence of steps (see Figure 5.1):

(1) Price shocks are modelled in the existing FSSIM farm type models, with initial prices coming from CAPRI

(2) Estimation of supply responses as response functions of price variations, farm characteristics, regional soil and climate conditions; extrapolation of supply response to other farm types and NUTS2 regions; aggregation of supply response to level of CAPRI regions (administrative units) and CAPRI product categories;

(3) Calibration of regional supply modules in CAPRI to aggregated supply responses;

(4) A final run of FSSIM with market clearing producer prices from CAPRI results in the final consistent specification at the farm level.

Since the approach is still being tested, only some empirical implications of the theoretical approach are emphasized here. In order to arrive at the sensible number of FSSIM models to generate supply-price responses and enable the extrapolation from sample regions to all EU regions, a specific farm typology has been derived within the SEAMLESS project. According to this, 3 to10 most-representative farm types per sample region are selected, so that they adequately represent farm, soil and climate differences among regions. The current simulation design includes the generation of *pseudo-observations* by running the farm management models on different price sets for products (i.e. input data based on a sensitivity analysis of farm model behaviour, prices being changed one-at-a-time). The level of prices for the baseline scenario is kept at the 100% level to the initial prices levels obtained by CAPRI in a similar scenario. Prices of each product are set at 60%, 80%, 120% and 140% of the base level, providing a sufficient number of simulated observations. The choice of agro-environmental variables links closely to the determinants of farm typology (size, intensity, specialization) as well as agro-environmental typology (soil, climate) used in farm spatial allocation procedure. The list of selected variables in modelling the supply response function: economic size unit, machinery, labour, carbon content, root depth, minimum temperature, precipitation, radiation is supported by earlier studies of crop yield variability.

The response function estimated at one scale is not representative for the projection at another scale. Estimation of the response function is based directly on the simulated FSSIM data. Aggregation from farm types within one NUTS2 to the regional level, as needed by CAPRI, is performed by using the shares of land area of each farm type obtained during the farm spatial allocation exercise. The calibration of the response of the CAPRI supply module to the aggregated response of the FSSIM farm management models and the extrapolated regional models is done through regional price-supply elasticities.

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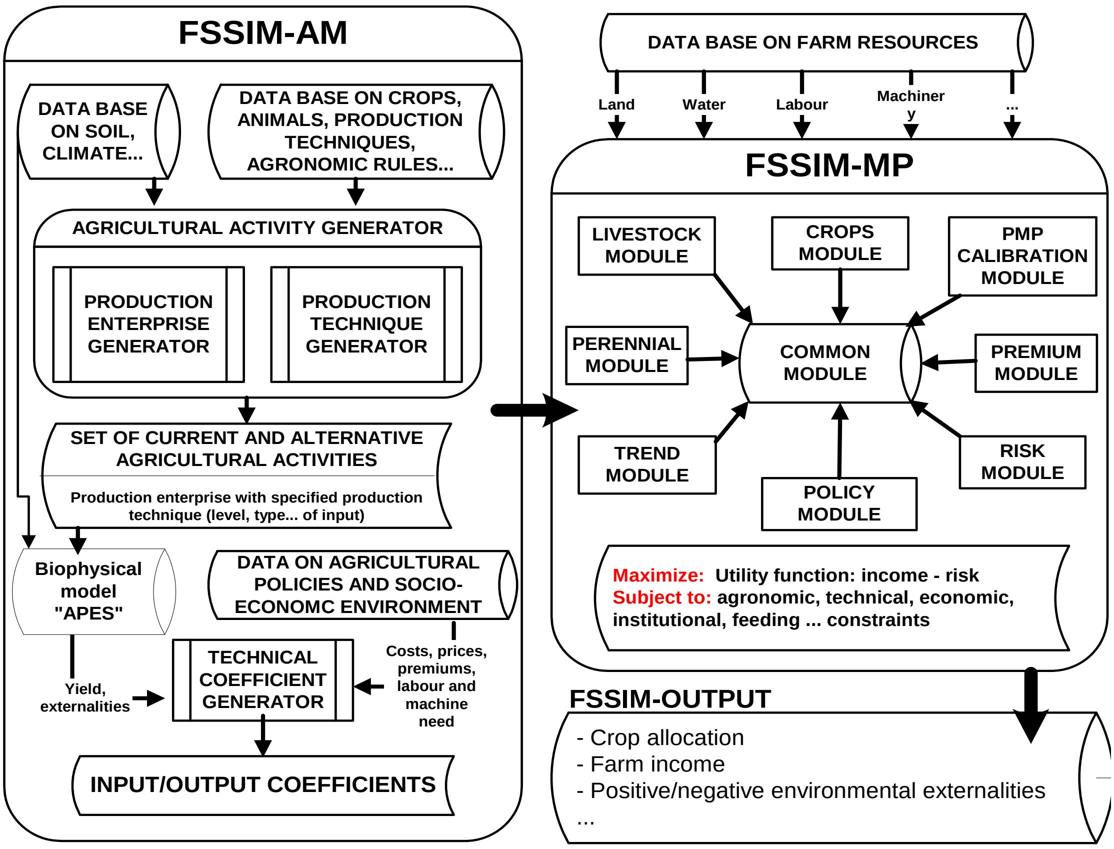
5.3 FSSIM – Farming System Simulator

Kamel Louhichi, Sander Janssen, Argyris Kanellopoulos, Guillermo Flichman, Martin van Ittersum, Huib Hengsdijk, Peter Zander, Maria Blanco, Grete Stokstad

FSSIM is a bio-economic model, developed within the SEAMLESS-IP, to assess at the farm level the impact of agricultural and environmental policies on performance of farms and on sustainable development indicators. It consists of a data module for agricultural management (FSSIM-AM) and a mathematical programming model (FSSIM-MP) (Figure 5.2). FSSIM-AM aims to identify current and alternative activities and to quantify their input and output coefficients (both yields and environmental effects) using the biophysical field model APES (Agricultural Production and Externalities Simulator) and other data sources. FSSIM-MP seeks to describe farmer's behaviour given a set of biophysical, socio-economic and policy constraints, and to predict his/her responses under new technologies, policy and market changes. The principal outputs generated from FSSIM for a specific policy are forecasts on land use, production, input use, farm income and environmental externalities (e.g. nitrogen surplus, nitrate leaching, pesticide use, etc.). These outputs can be used directly or translated into indicators to provide measures of the impact of policies.

Figure 5.2: An overview of FSSIM as a combination of Agricultural Management module (FSSI-AM) and Mathematical Programming module (FSSIM-MP).



The mathematical structure of FSSIM can be formulated as follows:

Maximise: $U = Z - \phi\sigma$ (1)

Subject to: $Ax \le B$; $x \ge 0$ (2)

Where U is the variable to be maximised (i.e. utility), Z is the expected income, x is a (n x 1) vector of agricultural activity levels, A is a (m x n) matrix of technical coefficients, B is a (m x 1) vector of levels of available resources, ϕ is a scalar for the risk aversion coefficient and σ is the standard deviation of income according to states of nature defined under two different sources of variation: yield (due to climatic conditions) and prices.

The expected income (**Z**) is a non-linear profit function. Using matrix notation, this gives:

$$Z = \sum_j p_j q_j + \sum_{j,l} p^a_{j,l} q^a_{j,l} + \sum_{i,t} s_{i,t} \frac{x_i}{\eta_i}(1-\alpha b) - \sum_{i,t} c_{i,t} \frac{x_i}{\eta_i} + \sum_{i,t}\left(d_{i,t} + \frac{\psi_{i,t} x_i}{2}\right)\frac{x_i}{\eta_i} - \varpi L \quad (3)$$

Where: **i** indexes agricultural activities, **j** indexes crop products, **l** indexes quota types (e.g. for sugar beet these are A and B), **t** indexes number of years in a rotation, **p** is a vector of average product prices, **q** is a vector of sold production, $\mathbf{p^a}$ is a vector of additional price that the farmer gets when selling within quota l, $\mathbf{q^a}$ is a vector of sold production within quota l , **s** is a vector of subsidies per crop within agricultural activity *i* (depending on the Common Market Organisations (CMOs)), **c** is a vector of variable cost per crop within agricultural activity *i,* **d** is a vector representing the linear term used to calibrate the model (depending on the calibration approaches), $\mathbf{\Psi}$ is a symmetric, positive (semi-) definite matrix of quadratic term used to calibrate the model (depending on the calibration approaches), η is a vector representing the length of a rotation within each agricultural activity, ϖ is a scalar for the labour cost and **L** is the number of hours rented labour

The general context and the variety of questions that FSSIM must be able to answer justify a number of choices that makes this model unique:

- **Comparative static model:** FSSIM is a mono-periodic model which optimizes an objective function for one period (i.e. one year) over which decisions are taken. This implies that it does not explicitly take account of time. Nevertheless, to incorporate some temporal effects, agricultural activities are based on “crop rotations” and “dressed animal[†]” rather than individual crops and animals.
- **Primal based-approach:** FSSIM follows a primal-based approach, where technology is explicitly represented (Louhichi et al., 1999). It uses engineering production functions generated from agronomic theory and biophysical models (Hengsdijk and Van Ittersum, 2003). These engineering functions constitute the essential linkage between the biophysical and economic models. This discrete mathematical programming approach can (better) capture the technological and policy constraints than a behaviour function in econometric models.
- **A positive model,** where the main objective is to reproduce the observed production situation as precisely as possible by making use of the observed behaviour of economic agents (Janssen and Van Ittersum, 2007).
- **A risk programming model,** taking into account the risk according to the Mean-Standard deviation method in which expected utility is defined under expected income and risk (Hazell and Norton, 1986).

[†] The concept of ‘dressed animal’ represents an adult animal and young stock taking into account the replacement rate.

- **Modular model:** it has a modular setup to be re-usable, adaptable and easily extendable to achieve different modelling goals. Thanks to this modularity, FSSIM provides the capabilities to activate and deactivate modules according to regions and conditions. It allows also the subsequent incorporation of additional modules which might be needed to simulate activities not included in the existing version, such as perennial activities, and the replacement of modules with alternative versions.
- **Generic model**: it was designed sufficiently generic and with a transparent syntaxes in order to be applied to many different farming systems across Europe and elsewhere, and to assess different policies under various conditions.
- **Automatic and integrated components:** it includes several components, which have been linked and integrated. The communication between these different components is based on explicit definitions of spatial scales and software for model integration. It is foreseen that each component can be reused independently for other applications and modeling exercises. New components can also be added in later stages.

FSSIM exists both as stand-alone version and as a version integrated within SEAMLESS-IF. In order to make all FSSIM components easier to manipulate a Graphical User Interface (GUI) was developed. This GUI assists users in setting up scenarios, running the simulations and exploring model outputs in response to changing inputs.

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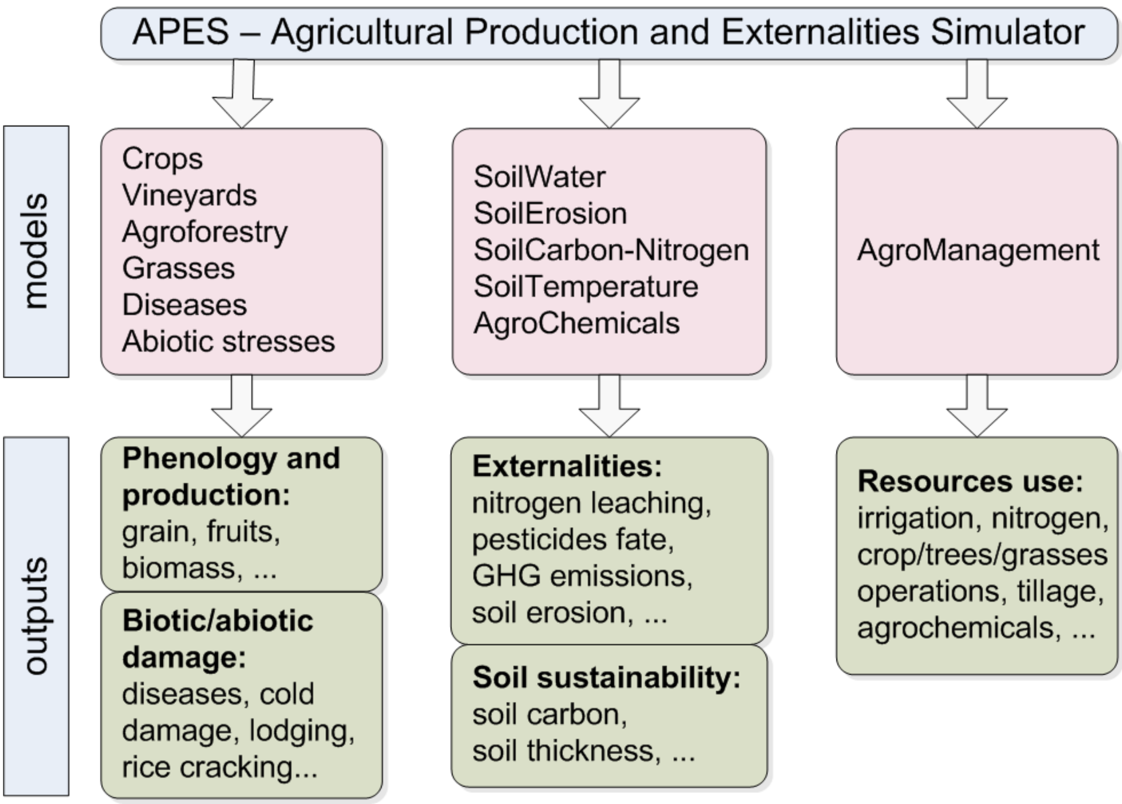
5.4 APES – Agricultural Production and Externalities Simulator

Graham Russell, Marcello Donatelli

The Agricultural Production and Externalities Simulator (APES) is a simulation model system for estimating the biophysical behaviour of agricultural production systems at the field scale in response to the interaction of weather, soil and different options of agro-technical management. Its outputs include not only yield but also externalities such as nitrate loss and erosion as well as values that could be used as indicators of Good Agricultural and Environmental Condition. It provides a transparent, flexible and transparent modelling platform that can be easily extended and adapted to achieve different modelling goals. It is based on a set of components or modules that represent different parts of the system (Figure 5.3). APES allows the subsequent incorporation of additional modules which might be needed to simulate processes not included in the existing version, such as plant diseases, and the replacement of modules with alternative versions. Currently twelve crops plus permanent grass and vineyards are included but the list is being extended by modifying parameters.

Figure 5.3: Models and outputs of the Agricultural Production and Externalities Simulator.



Biophysical processes are simulated in APES using deterministic approaches which are mostly based on mechanistic representations. The criteria for selecting the currently available modelling approaches were based on the need for: 1) accounting for specific processes to simulate soil-land use interactions, 2) input data to run simulations, which may be a constraint at EU scale, 3) simulation of agricultural production activities of interest (e.g. crops, grasses, vineyards, agro-forestry), and 4) simulation of agro-management implementations and their impact on the system. Users of APES can choose a particular modelling solution to meet their particular requirements. A modelling solution is a combination of components and options within components.

To grow a crop in a field, even a model one, requires not only a crop model but also information about soil, weather and management decisions.

APES includes utilities for managing appropriate weather and soil data. The AgroManagement component is designed to represent farmers' decisions realistically, taking into account the state of the crop and the environment. The system permits the consideration of multiple years to take account of rotations and varying weather patterns.

The Graphical User Interface (GUI) allows users to run simulations and explore the outputs of APES in response to changing inputs. The GUI is also made with components and tools which can be re-used in different systems.

References and further reading

There is more information, including help files and video tutorials, on the APES website (http://www.apesimulator.org or through www.seamless-ip.org). You can subscribe to the APES newsletter: news-subscribe@apesimulator.it and to RSS feeds that will update you on progress.

5.5 GTAP – Global Trade Analysis Project

Marijke Kuiper

What is GTAP?

GTAP stands for Global Trade Analysis Project, a global network of researchers and policy makers conducting quantitative analysis of international policy issues. The key product of the network is the GTAP database describing the entire economies of 87 countries or regions[‡] in terms of 57 sectors, as well as all bilateral trade flows between these regions. This database forms the basis for a range computable general equilibrium (CGE) models that start from the same theoretical framework but are adapted to addressing different economic contexts or research questions.

What can a GTAP model do?

Not surprising given its name, the majority of models using the GTAP database focus on assessing trade policies. In the current World Trade Organization (WTO) negotiations on reducing barriers to international trade, about all quantitative analyses of possible agreements use a CGE model based on GTAP data. These assessments can provide indications of changes in, for example, production by sector at national level, trade flows between countries, consumption at national level, tariffs and tax incomes, wages and prices, and welfare impacts of a change in trade policy.

The prominent role of GTAP in the trade policy debate has inspired further developments of the database and models to deal with changes over time (the regular model is static and thus does not provide trajectories of changes over time), international migration (capturing the flow of persons and remittances between nations), energy use (capturing the impact of biofuels in relation to developments in markets for non-renewable fuel) and climate change. For the latter additional databases are developed with more detail on land use (production by agro-ecological zones in each region) and carbon sequestration. The latter developments have led to an increasing role of GTAP-based analyses in the Intergovernmental Panel on Climate Change (IPCC) to assess policies for limiting greenhouse gas emissions.

What is the role of GTAP in SEAMLESS?

Within SEAMLESS GTAP serves as a complement to the EU and global level analyses of SEAMCAP that are limited to the agricultural sector. By combining the two models we obtain detailed modelling of the agricultural sector from SEAMCAP while accounting for feedback loops between agricultural and non-agricultural sectors from GTAP. GTAP thus accounts for changes in the rest of the economy which may affect agriculture, for example by rising wages, increasing the costs of inputs like fertilizer that are produced by the chemical industry, or by changing demand for agricultural goods because of changes in income of consumers.

What GTAP model is used in SEAMLESS?

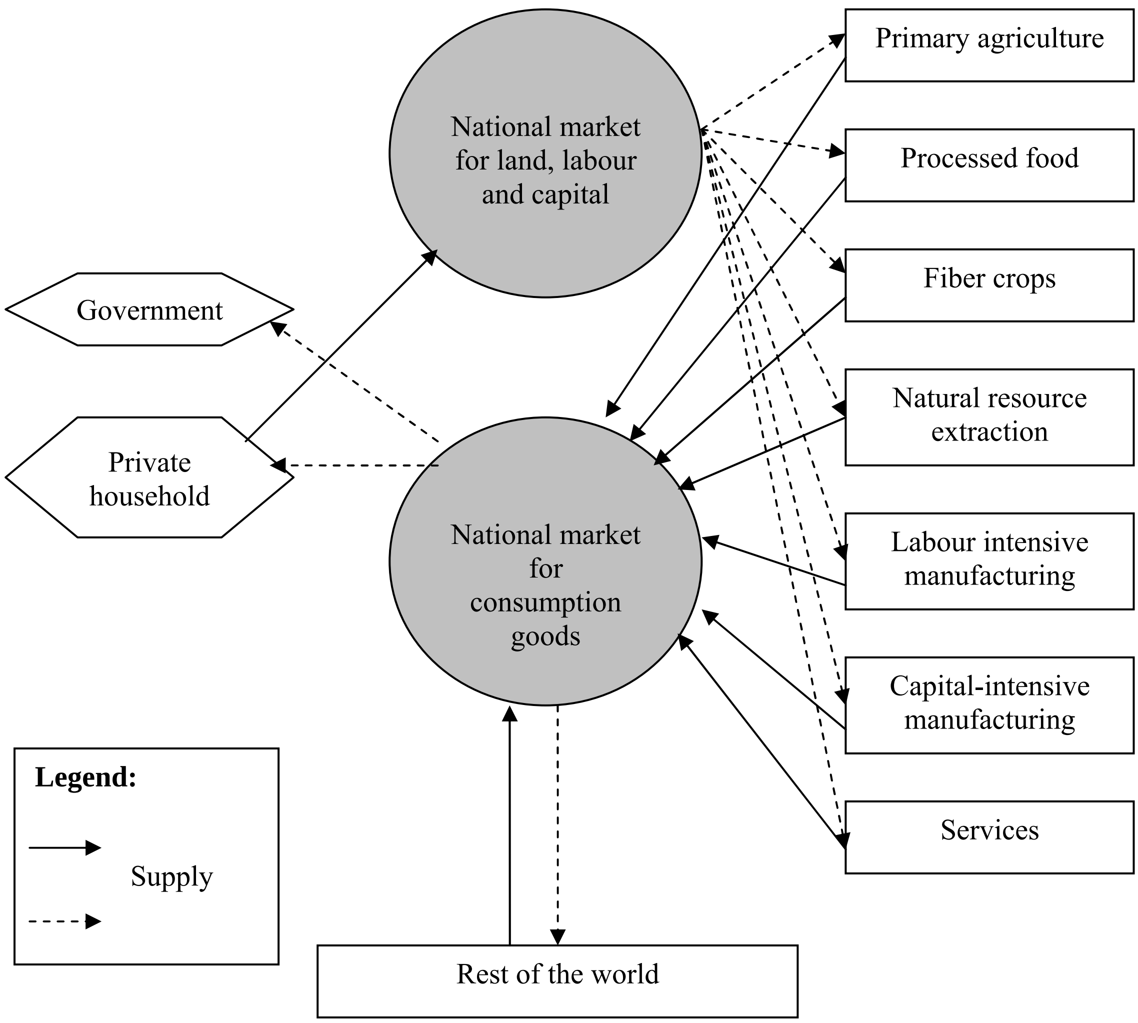
In the context of SEAMLESS, the standard GTAP model as maintained by the GTAP center is used. This model has been adapted in terms of sectors and regions to obtain the best possible fit with SEAMCAP. A region can be an individual country (like all 27 EU member

[‡] The number of regions in the database is increasing with every release as regional aggregates are split in individual countries when the necessary data are contributed to the GTAP network. The next release (version 7) is expected to have 104 countries/regions.

states) or a group of countries (like sub-Sahara Africa). In total, the GTAP model contains 55 regions, which include all 27 EU member states as individual countries.

For every region in the model there is a single representative household demanding consumption goods (including savings) on the behalf of all private households and a government (Figure 5.4). Total demand is determined by income earned by land, labour and capital as well as income from taxes. The demand for goods can be met by national producers or by imports. For each sector there is a single producer, i.e. there is a one producer of agricultural goods, one for labour intensive manufactured goods, one of services etc. Since SEAMCAP models agriculture in detail, all agricultural sectors in GTAP are aggregated to a single agricultural sector.

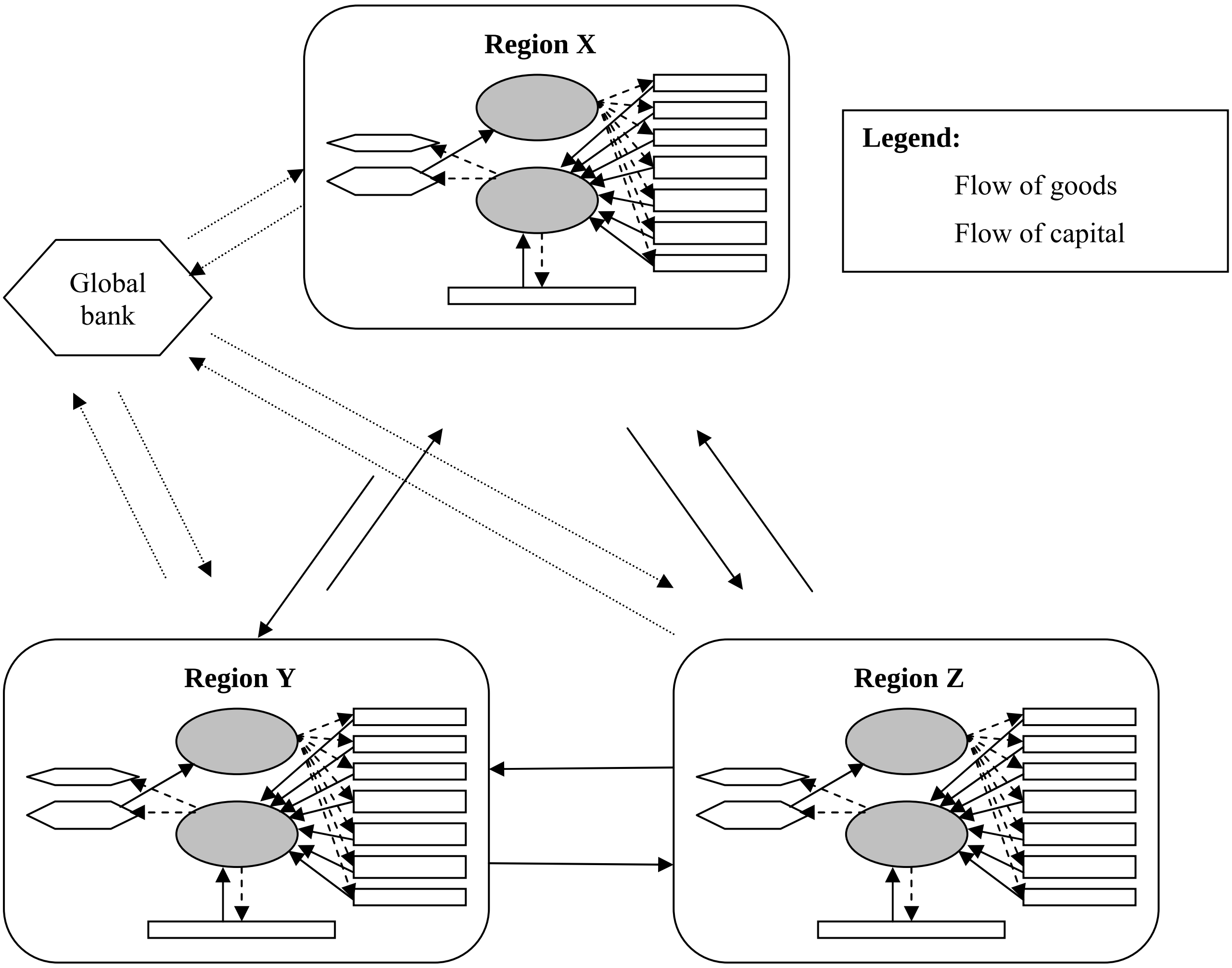
Figure 5.4. Simplified illustration of a regional model within the GTAP model



The model traces trade between all regions in the model and accounts for trade barriers between regions through inclusion of tariffs (Figure 5.5). These tariffs may drive a wedge between prices in regions, i.e. the same product may be more expensive in one region than in another because of tariffs. Whereas international trade is modelled by tracing all bilateral flows international capital flows are governed by a global bank. This bank collects savings and uses these for international investments. Since savings are pooled by the global bank before being sued for investments there is no tracing of bilateral capital flows.

Prices of goods and of land, labour and capital in each region adjust to assure that both national and international demand and supply are equal, hence the term general equilibrium models. Thus when a policy simulation is run, for example lowering tariffs between regions, the model computes by sector for each region production, consumption and trade (both imports and exports) as well as price levels that result in equilibrium at national and international markets.

Figure 5.5: Simplified illustration of links between regional models in the GTAP model



References and further reading

Within SEAMLESS the work on GTAP is done in Task 3.8. There are two deliverables related to GTAP, one describing in general terms role of GTAP (PD 3.8.1) and one describing the details of linking to SEAMCAP (PD3.8.3) (see: www.seamless-ip.org). For more general information on GTAP and its various uses the website www.gtap.org provides an excellent staring point.

5.6 Employment model

Eoghan Garvey

SEAMLESS models European agriculture at a number of levels – from the field to the region, to the continent as a whole. While the focus is mainly on economic and environmental factors, it is important also to look at the changing social and human picture. The employment model is one way in which SEAMLESS does this.

The employment model of SEAMLESS focuses on agricultural labour in regions across Europe. The main question that the model tries to answer is how labour inputs are allocated across the individual agricultural activities. Data on how much family and paid work is done on a farm is fairly commonplace but very little exists on how much labour is generally devoted to each production activity. We do not know very much, for example, about whether a hectare of wheat necessitates more labour in the north or south of Greece, or whether having 10 dairy cows necessitates more labour input in the east or west coast of Ireland. The employment model in SEAMLESS uses Bayesian econometric techniques to try to answer questions like these.

The resulting activity specific data are called input coefficients. Input coefficients can be put to work in a number of interesting fields. Activity specific income indicators may be derived, for example, which should facilitate analyzing broader SEAMLESS results. Labour coefficients can also be used to calculate per capita income in the agricultural sector and to help forecast employment changes. Input coefficients are of most use when integrated into the body of a sectoral model. The version of the CAPRI model to be used in SEAMLESS will contain much of the information on input coefficients yielded by the SEAMLESS employment model.

*Table 5.1: Selection of National Family Labour Input Coefficients for Cereals**

	Austria	Germany	Denmark	Spain
	Family Labour- Hours	Family Labour- Hours	Family Labour- Hours	Family Labour- Hours
Soft Wheat	56.789	36.776	24.117	23.228
	4.02	1.153	0.681	0.785
Barley	69.049	44.724	28.015	23.969
	4.351	1.182	0.552	0.462
Durum Wheat	54.689	0	0	20.37
	14.001	0	0	0.894
Rye	65.005	32.13	25.959	35.893
	8.836	1.448	1.477	3.095

*Coefficients are in hours per annum per hectare. Standard errors underneath.

Included also in the employment model are two useful additions. Work on gender in agriculture is underway, where the focus is to explore the gender balance in family labour, and how this differs across regions and activities.

Table 5.2: Percentage change in the family labour force 1995-2005

	% Δ 1995-2005 (Persons)		% Δ 1995-2005 (AWUs)*	
	Total	Females	Total	Females
Austria	-21.1	-19.6	-13.0	3.4
Belgium	-28.0	-30.9	-20.3	-9.1
Denmark	-32.8	-33.6	-45.3	-46.6
Finland	-38.9	-44.6	-44.4	-48.9
Greece	-3.6	-7.4	-11.4	-14.7
Ireland	-15.2	-20.2	-29.8	-39.7
Italy	-33.4	-30.9	-27.8	-26.4
Luxembourg	-23.2	-26.8	-28.4	-36.1
Netherlands	-24.6	-17.6	-27.9	-19.0
Portugal	-31.9	-31.8	-32.5	-34.1
Spain	-16.8	-12.2	-19.0	-20.3
Sweden	-1.7	4.7	-18.0	-13.9
UK	20.6	36.1	-6.8	9.1

* Annual Working Units

Also, a separate demographic module tracks demographic changes in farming over time at a regional level. This add-on to the employment model is useful on two fronts – for long term employment forecasting and, most especially, because it links agricultural employment to the wider economy.

5.7 SLE – Seamless Landscape Explorer

Visualising changes in agricultural landscapes

Daniel Auclair

Although land managers and policy-makers generally have a good experience of what result can be expected from their decisions, they are often faced with difficulty when trying to communicate the visual impact of a future management option to all stakeholders (local and regional decision-makers, land managers, landscape planners, and various communities involved in outdoor activities). Three-dimensional visualisation of the landscape is often used for communicating with the stakeholders. Static, web-based landscape visualisation tools have made considerable progress in recent years, such as for example Google Earth, covering the entire planet in 3D. Such visualisations are based on aerial (satellite) imagery, at a specific date, but are not dynamic. The challenge in the SEAMLESS project is to view future changes in land use, according to scenarios.

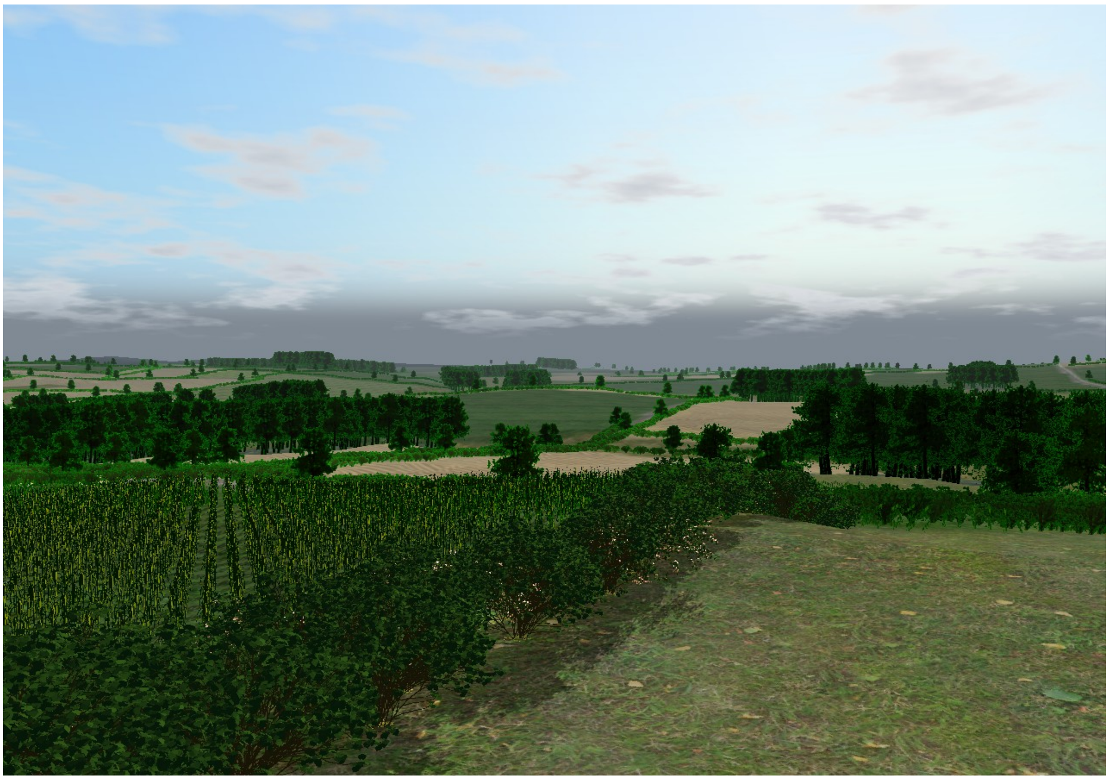
In SEAMLESS, the 3D landscape visualisation component is launched at the end of a scenario simulation to allow for exploration of landscape changes. Pressures causing such changes will come from the FSSIM model, they are then translated into changes in the spatial configuration of the landscape.

To visualise the landscape of a specific region, it is necessary to initially collect input data composed of a high resolution map of land cover (providing land use for each field), terrain data (a Digital Terrain Model), and a satellite or aerial image. The land cover is then modified according to FSSIM results (from different scenarios). For each simulation, representing one "run" or "scenario", SLE ("Seamless Landscape Explorer") processes the input data to build a "virtual scene", which is saved in a "project file". Such files can be used to visualise a scene previously calculated by the land-modeller, for example from a different viewpoint or to produce a film by navigating within the scene. Satellite or aerial imagery or generated textures are draped over the Terrain. The different types of land-use are visualised thanks to a library of detailed textures, and vegetation can be added and visualised according to specific vegetation models. The building process then assembles the 3D landscape model, and displays it in the viewer.

The qualitative outputs can be used in the post-treatment analysis, and/or in the negotiation phases. Such visualisation could have a significant implication for the choice of effective land-use policy, and could be used as a basis for discussion and negotiation within the community.

In Figure 5.6 examples of outputs from the SLE are presented. It shows the French Bretagne region, resulting from two scenarios. The first image represents the current situation and the second a "climate change" scenario with a strong impact on agriculture and forest dynamics.

Figure 5.6: Output from the SLE for the French Bretagne region. The first image represents the current situation and the second a "climate change" scenario with a strong impact on agriculture and forest dynamics



5.8 PICA – Procedure for Institutional Compatibility Assessment

Assessing institutional compatibility of new policies

Insa Theesfeld, Christian Schleyer, Laurence Amblard, Olivier Aznar, Carsten Mann

SEAMLESS investigates the likely economic, environmental, and social impacts of agricultural and environmental policy options. The effectiveness of a policy depends to a large extent on the degree of compatibility between this policy option and the respective institutional context. Appropriate institutions - the formal and informal rules of a society - increase the likelihood that policy objectives are reached.

Because institutions usually relate to a great diversity of situations, the state of the art in institutional economics offers hardly any standardized procedure for institutional analysis that can easily be combined with environmental and agricultural models widely used for policy impact assessment. Within SEAMLESS we have developed the 'Procedure for Institutional Compatibility Assessment (PICA)' as a systematic procedure to use information from ex-post policy evaluation studies, theory-based reasoning, and indicator databanks for making ex-ante predictions of the institutional feasibility of policies.

PICA comprises four distinct steps:

1) Policy options are clustered according to the type of intervention (regulatory, economic, and advisory), the area of intervention (hierarchy/bureaucracy, market, and self-organised network), possibly involved property rights changes, and the attributes of the natural resource addressed. This classification allows identifying the generic structure of a policy option.

2) Each policy cluster is linked to specific sets of crucial institutional aspects (CIA) that may constrain or foster policy implementation.

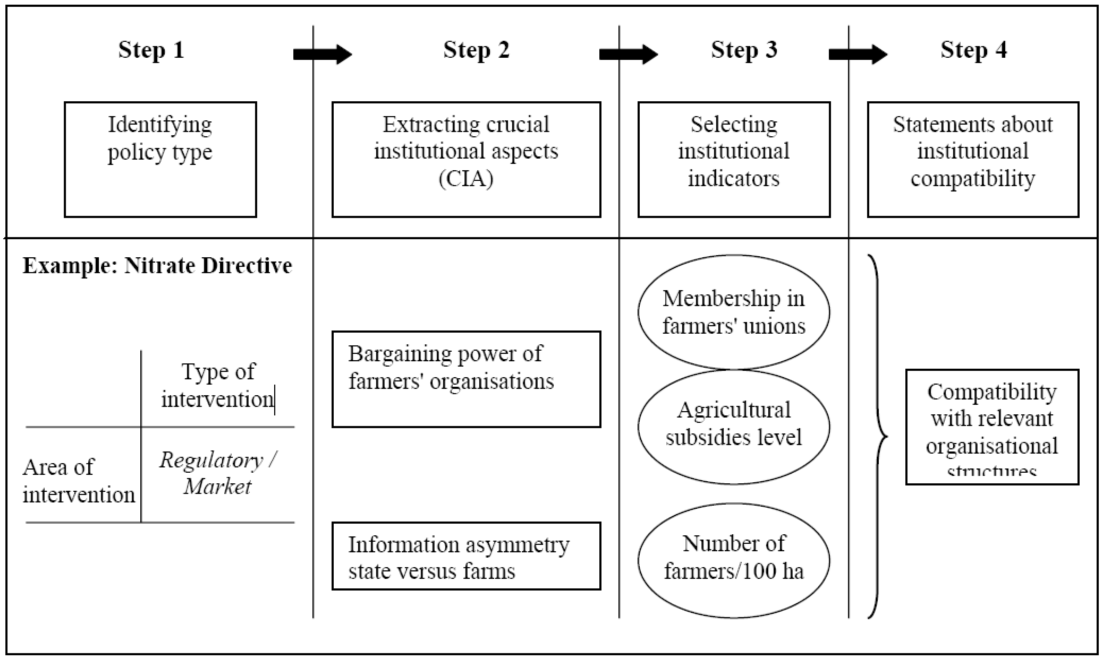
3) Institutional indicators are used to evaluate the potential of a respective CIA.

4) The information provided by the institutional indicators is used for a qualitative assessment of each identified CIA. Subsequently, the CIA and the related assessments are arranged in thematic categories of institutional compatibility leading to qualitative statements about the probable effectiveness of a policy option.

Figure 5.7 illustrates the four steps of PICA by applying the procedure to the policy option 'Nitrate Directive'.

PICA allows for a systematic institutional ex-ante assessment of (agri-environmental) policies. This enables policy makers and decision makers in charge of implementing policies to identify at early stage (potential) institutional incompatibilities between policy options and the various institutional contexts in different countries and regions. In addition, PICA provides hints for a better policy design in terms of effectiveness and cost-efficiency. This may include redesigning or adapting the policy options and the design of complementary policy measures.

Figure 5.7: PICA applied to the policy option 'Nitrate Directive'



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5.9 SEAMFRAME – Software infrastructure

Patrik Wallman

SEAMLESS-IF is based on project requirements and current IT-trends. In this case this means a web based distributed system. This solution brings many advantages for both the users and the developers of the framework. There is no need to install any specific software on the local computer, all services are run on SEAMLESS' own servers. SEAMLESS-IF can be viewed and used on the Internet if the web browser used has Flash Player 9 installed, which almost all modern browsers have.

SEAMLESS-IF contains three different layers, a graphical user interface (GUI), a service layer with a processing environment and a data layer where data is stored in databases.

The GUI is developed in Flex, a framework that helps you develop and deploy cross platform dynamic and interactive rich Internet applications. The communication between the (GUI) and the processing environment in the SeamFrame server is handled by Java Servlets. A servlet is a small Java program that runs within a Web server, receiving and responding to requests from Web clients, in this case GUI of Seamless-IF, usually across HTTP (HyperText Transfer Protocol). The Java Servlet API (Application Programming Interface) allows developers to add dynamic content to a Web server. In Seamless-IF the content generated by the servlets is XML (Extensible Markup Language), which is a general-specification for creating custom markup languages. It is primarily used to facilitate the sharing of data, especially via the Internet.

Seam:Pres is the visualization part of the Seamless-IF GUI. It is used to present the results in a meaningful way. Seam:Pres uses ILOG Elixir, a suite of user interface controls that provides a set of graphical data-display components for Flex applications such as the graphical user interface of Seamless-IF. ILOG Elixir turns raw data into clear, actionable information through highly graphical and interactive data displays for dashboards, data analysis, planning and human resources applications.

The processing environment in SEAMLESS-IF is called SOFA (Seamless OpenMI Framework Architecture). Seamless has chosen to adopt the Open Modeling Interface and Environment (OpenMI) framework, which originally is a product of the EU FP-5 project HarmonIT, to link models, data and tools. The OpenMI standard is a software component interface definition (predefined interfaces, compliancy rules) for the computational core (the engine) of the models. Models or model components that comply with this standard can, without any programming, be configured to exchange data at run-time. The standard supports two-way links where the models depend on calculation results from each other. Linked models may run asynchronously with respect to time steps, and data represented on different spatial levels can be exchanged seamlessly. Models ranging from very simple to very complex (even composites) including everything in between, can in most cases be added to the processing environment using the OpenMI interfaces as a wrapper around the model. In the processing environment components are linked together to form a 'workflow', which can be annotated and stored in a file or in a database. The workflow can include all kinds of components, as long as they are OpenMI compliant. Besides models, this also includes components that get data from databases, converters, visualization tools, and model-chain analysis tools. OpenMI uses a pull-based approach which means that one component in the workflow is somehow triggered to ask another component for input.

The web based implementation of SEAMLESS-IF also means that the users do not have to go into any database, the available data and the results are presented through the GUI and there is no risk of destroying the database. All the data used and saved by SeamFrame is stored in a central SEAMLESS server in a PostgreSQL database. PostgreSQL is an object-relational database management system which communicates with the processing environment via Hibernate, an object-relational mapping library for Java. Hibernate provides a framework for mapping an object-oriented domain model to a traditional relational database. Hibernate also provides data query and retrieval facilities which are used in SEAMLESS -IF.

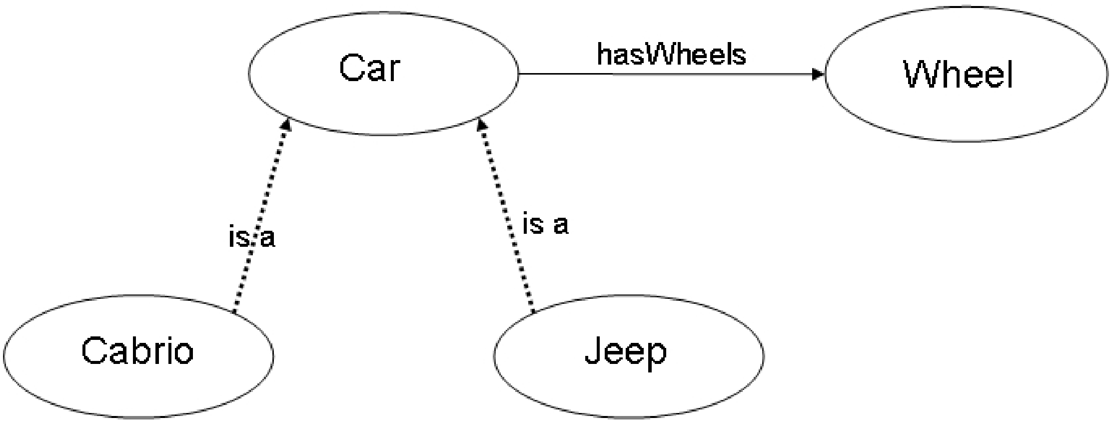
5.10 Ontologies for integration in Integrated Assessment

Sander Janssen, Ioannis N. Athanasiadis

Definition of ontology

The term ontology originates from philosophy, originally coined by classical philosophers Plato and Aristotle (Aristotle, 336-332 BC) in the study of types of being and their relationships (metaphysics). An ontology in computer science is considered as a specification of a conceptualization (Gruber, 1993), where a conceptualization is '*an abstract, simplified view of the world* e.g. systems under study *that we wish to represent for some purpose*' (Gruber, 1993) Such a formalization could be expressed in a machine readable format, i.e. as the Web Ontology Language (McGuinness and van Harmelen, 2004). An ontology consists of a finite list of concepts and the relationships between these concepts (Antoniou and van Harmelen, 2004). Figure 5.8 gives a simple example of an ontology for a car by showing concepts (e.g. Car, Wheel, Cabrio and Jeep) and relationships (e.g. hasWheels and is-a). The car-ontology shows us that a car has wheels and that both cabrio and jeep are cars, that consequently also have wheels.

Figure 5.8: An ontology for a car with kinds of a car (a jeep and a cabrio) and a relationship between concepts car and wheels through the hasWheels relationship.



Ontology and integrated assessment research

Integrated assessment research is characterised by, among others, its interdisciplinarity and its stakeholder interaction. Thus, integration between disciplines and between researchers and stakeholders is often an important objective of integrated assessments. In our experience, in this integration different types of misunderstandings around the meaning of concepts can occur:

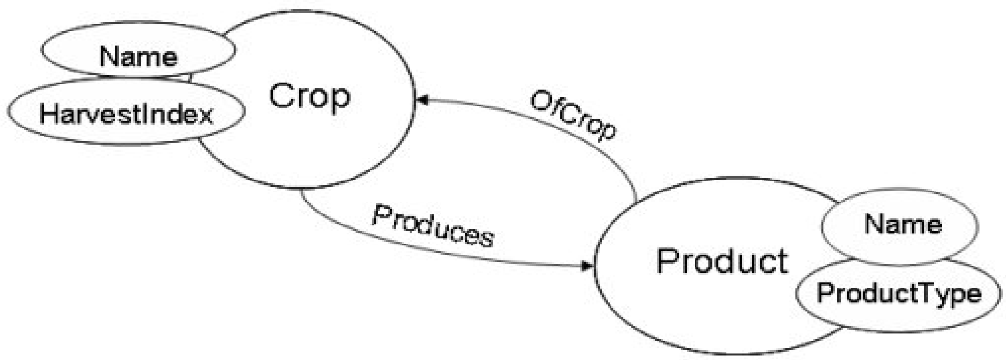
- as the same concepts might be used for different meanings, for example area in a model and area in the database,
- as different concepts might be use, which have the same meaning, for example a internal user and an integrative modeller,
- as concepts might be used with an ambiguous meaning, for example scenario (Schoemaker, 1993),
- as relationships between concepts might be understood in a different way, for example between the different spatial scales and administrative regions.

To avoid these misunderstandings and to achieve a common jargon between researchers common ontologies can be used. A common ontology, i.e. ontology which is shared by all researchers participating in integration, serves as a knowledge-level specification of the joint conceptualization of the participating researchers. Each researcher must adhere to the semantics of the concepts in the common ontology, including restrictions on the concepts and relationships between the concepts.

Example of ontology use from agricultural domain

In the SEAMLESS integrated assessment project different models, data sources and indicators are integrated into one operational tool. This integration requires particularly achieving a common understanding of the terms used in this tool by researchers from different disciplines with a dissimilar experience and education. In Figure 5.9 a very small part of the SEAMLESS ontology is provided as an example. This example shows the relationships between concepts products and crops as used by some of the models in the SEAMLESS project.

Figure 5.9: Concepts crop and product, their mutual relationships (e.g. OfCrop and Produces) and their properties (e.g. Name, Producttype and HarvestIndex)



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6 Data

Erling Andersen and Berien Elbersen

Which data is needed in SEAMLESS?

The diversity of models used in the integrated modelling of SEAMLESS, the inclusion of both quantitative and qualitative indicators and the hierarchical farm system typology result in a very complex demand for data. The data have to provide information on the biophysical, social, economic and institutional aspects of a system. Furthermore, the data need to be organised to support modelling and assessments at different spatial scales.

Data integration

To provide the necessary data the challenge is to bring together existing datasets that have been generated for very different purposes and with very different methods. For example, data on agriculture have been generated with the purpose of monitoring the agricultural sector mainly from an economic point of view. On the other hand, data have been gathered on environmental issues mainly to provide information on the state of the environment and linked to assessment of environmental issues. In addition to this, economic and socio-economic data are usually linked to administrative regions, whereas environmental data often are linked to discrete spatial units. In the knowledge base of SEAMLESS the different data sets are adapted and linked to a common spatial framework enabling linkages between the different data sources.

One example that can illustrate the challenge is the link between data on farming and data on the environment. Statistical data on farming is linked to regions, whereas environmental data is linked to grid cells. In order to link the two data sets it is therefore needed to disaggregate the data on farming, to aggregate the environmental data, and to link them at a common regional entity that is meaningful from the perspective of both data sets. This is a challenging task but crucial to enable farm type modelling in an environmental context.

Main data collected in SEAMLESS

The key data included in the database of SEAMLESS are:

- the farm typology used to structure the statistical data on farm resources
- the agri-environmental typology used as a spatial framework combining biophysical characteristics and administrative borders and enabling the linking of farm information to environmental regions
- additional farm management information collected in a project and linked to farm types of the SEAMLESS farm typology
- global data for the global market model component of SEAMLESS.
- the regional typologies provided as context for assessments in SEAMLESS.

6.1 Typologies

Erling Andersen and Berien Elbersen

Introduction

Typologies are needed for classification, simplification and for making integration with other datasets possible. A typology is the same as a classification of one of more variables into meaningful classes. This implies that the threshold values between two classes have been chosen from a certain perspective (environmental, social, economic, etc.). Typologies can be expressed in spatial and in tabular format. Typologies can be one and more dimensional. Examples of the main typologies included in the SEAMLESS database are discussed below.

Farm typology

In SEAMLESS the data on farming stemming from the EU dataset Farm Accountancy Data Network (FADN) have been aggregated to farm types. This is based on a farm typology elaborated in earlier projects and adapted to SEAMLESS. The typology is based on a combination of three different dimensions, size, combined specialisation and land use and intensity. An example of a SEAMLESS farm type is thus large scale-medium intensity-arable/cereal farm – the most dominant type managing 15% of the utilised agricultural area in EU15 in 2004. One of the main reasons that the single farms included in FADN are aggregated to farm types is the disclosure rules that specify that FADN information can only be displayed if it is representing a minimal of 15 or more sample farms (Andersen et al., 2006). The different discriminating variables and the specific threshold values determining the classes in the 4 dimensions of the typology build on earlier work and include consultations with Member State experts as well as statistical analysis. In SEAMLESS further consultations with experts have been used to improve the typology. The typology is now used as the basis for linking environmental and economic models on both the input and the output side of the model chains to do the integrated impact assessments.

Agri-environmental typology

The Agri-Environmental Zonation (AEnZ) is a framework which is needed to assess the impacts of agricultural policies covering the wide biophysical variation in which agricultural activities take place in Europe (Hazeu et al., 2006). The main objective of building this AEnZ was therefore to stratify Europe on the main biophysical factors that determine the agronomic production capacity in Europe. The agri-environmental zones are based on a combination of biophysical characteristics and aiming to identify regions where the biophysical conditions for farming are relatively homogenous. At the same time the link to the marked level modelling was ensured by the inclusion of the administrative regions (NUTS regions). The combination of agri-environmental zones with the administrative NUTS boundaries resulted in spatial units called SeamZones. To these SeamZones the SEAMLESS farm-type information is linked enabling the combined information to be used for the model chain assessments. The SeamZones have been used as a framework for selection of sample regions. Sample regions are used to collect detailed information on farm management not available in the European level statistical sources. This again enables detailed modelling at crop and farm type level within these regions.

Socio-economic typologies

The SEAMLESS database includes regional typologies based on socio-economic indicators in the EU25 that can serve as contextual information for assessments in SEAMLESS. In the current version of the database, we only included typologies on the share of agriculture in total employment, rurality derived from population density, leading and lagging regions derived from employment growth and livestock density. Further typologies have been developed and are under consideration to be included in the final version of the database such as population density (i.e. rurality), population growth plus rurality, employment growth plus rurality, share agriculture in total employment plus rurality, unemployment rates plus rurality, GDP/capita plus rurality, share of LFAs plus rurality, size of farms in hectare plus rurality, European Size Units per hectare and per farm plus rurality, share of farm holders >65 years plus rurality, share of part time farm holders plus rurality, share of female farm holders plus rurality.

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6.2 SEAMLESS Database

Erling Andersen, Berien Elbersen

Introduction

The final integrated database of SEAMLESS will contain all data used in the project including model input and output data, contextual data and spatial information for assessment and visualization of indicators. The database is implemented and managed in the open source object-relational database management system Postgres with an extension to handle geographical data using PostGIS and Geoserver[§]. It is expected that a Web Feature Service (WFS) will be used in the final version of the database to visualize model results.

In SEAMLESS the database is only planned to be accessed through the Graphical User Interface (GUI) of the SEAMLESS-IF. However, there will also be a stand-alone version of the database, which can be used for applications with specific components outside of SEAMLESS-IF. It is not foreseen to develop new tools for the stand-alone version of the database. Manuals on how to access the database, explore data and export data to other file formats will be based on existing tools such as PGadmin (free) of SQLmanager[**] (available at low cost).

Database structure and content

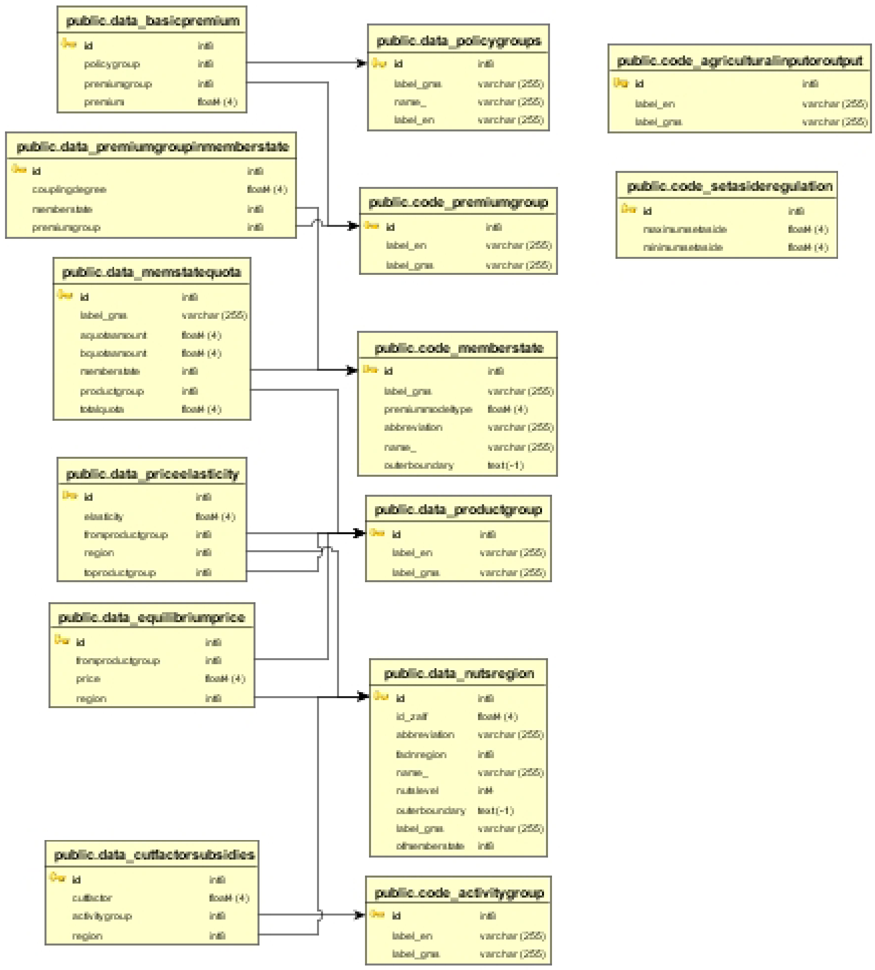
The structure of the SEAMLESS database is based on different components: Schema, tables, fields, data types, primary keys, indexes, relations and constraints. The content of the SEAMLESS database is differentiated in parts of the database such as biophysical data, farm-type data etc. and the linkages between these. These data are collected at different scales within the EU27. An illustration of such a partial database schema is given underneath (Figure 6.1) and shows what type of information is available on subsidies, prices etc. at the regional and Member State level and what relations between the different data are included.

Accessing the database and extracting data

To access the stand-alone database and extract data, knowledge of basic sql language is required. The SEAMLESS database has been used for several applications, but can in principle be used for a wide variety of experiments in the EU27 with the modelling framework of SEAMLESS-IF. Data can be stored in external formats such as text or excel files.

[§] http://postgis.refractions.net/ and http://geoserver.org/
[**] http://www.pgadmin.org/ and http://www.sqlmanager.net/en/products/studio/postgresql

Figure 6.1: A partial database schema



7 Indicators

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Introduction

Ex ante integrated impact assessment of new policies is a prerequisite for them to efficiently support sustainable development (SD). Recently, SEAMLESS Integrated Framework has been developed to assess *ex ante* impacts of agricultural and agri-environmental policies and technologies on agricultural systems across a range of scales, from field–farm to region and the European Union (Van Ittersum et al., 2008). This text briefly presents the set of sustainability indicators developed within the SEAMLESS project.

Indicators are quantitative tools that synthesize or simplify relevant data relative to the state or evolution of certain phenomena. They are tools for communication, evaluation and decision making that can take a quantitative as well as a qualitative form depending on the purpose of the indicators (Gallopin, 1997). The available indicators can therefore always from a users perspective be seen as essential in any model based Impact Assessment.

The SEAMLESS indicators

An indicator list was developed within the SEAMLESS project which is structured and presented through a new indicator framework, i.e. a goal-oriented indicator framework (GOF). This framework covers a broad range of themes linked to the three main dimensions (environmental, economic, social) of sustainability, and generic themes across the three dimensions (Alkan Olsson et al., in review), for two domains; the sustainability of agriculture itself and the impact of agriculture on the rest of the world, i.e. on SD. Three objectives underpinned the development of the SEAMLESS-IF indicator list across scales: i) to provide policy-makers and stakeholders with indicators which they usually use and/or which they would like to use; ii) to ensure scientific soundness of SEAMLESS-IF indicators, i.e. their relevance to represent impacts at stake; iii) to cover the various themes in each dimension of the GOF (see Table 7.1).

Different methods can be used for quantitative assessment (measurement, data census, model output, transformation of model outputs) and qualitative assessment (expert advice, decision makers, participation of populations). Within SEAMLESS-IF indicators are primarily assessed by models (and model chains) and thus their development has been constrained by the nature of the available model outputs. Outputs from three main models integrated in SEAMLESS-IF are used for the indicator calculation: the agricultural sector model SEAMCAP; the farming system model FSSIM; and the cropping system model APES. However, despite the range of scales covered by the SEAMLESS-IF model chains some key indicators can currently not be assessed directly from model outputs. However, despite the high range of scales covered by the SEAMLESS model chains some of key indicators cannot currently be assessed at certain scales using model outputs. To address this problem generic upscaling procedures have been developed and associated to each indicator that needs to be upscaled.

Examples of indicators are shown in Table 7.1. Across scales a total of 80 environmental, 140 economic and only 11 social indicators are or are about to be integrated into SEAMLESS-IF. This new structured set of indicators offered by SEAMLESS-IF enables a multi-scale integrated assessment of SD from the farming systems to the agri-environmental zones and the EU level.

Table 7.1: Example of environmental indicators within the goal-oriented indicator framework (GOF) at different scales (farm, normal font; Nuts 2 region, italic; member state or EU level, bold)

	Domain 1 **Impacts on the agricultural sector**			**Domain 2** **Impacts on the rest of the world**		
	Dimension of sustainable development			Dimension of sustainable development		
Themes	**Environmental**	**Economic**	**Social**	**Environmental**	**Economic**	**Social**
Ultimate goals	Pesticide use	Net farm income Percent of subsidies in farm income *Percent of subsidies in farm income* **Agricultural income**	*Equity* **Equity** **Monetary poverty rate**	Nitrate leaching Pesticide leaching Crop diversity *Percent of area with high leaching* **Nitrate surplus**		*Equity* **Equity**
Processes for achievement	Soil Org.Mat. change *P balance* **N_2O emissions**	Direct payments **Direct payments** Productivity of farm inputs Value of farm production	Labour use *Total labour use* *Potential employment*	Volatization *NH_3 emissions* *P balance* **N_2O emissions**	**First pillar CAP expenditure** **Export subsidy outlays** **Profit of the agr. processing industry** **Terms of trade**	*Fairness*
Means	Soil erosion Water use by irrigation **Energy use by min. fertilizer** **Use of mineral P**	Share of animal production *Share of animal production* **Share of animal production** Total costs	Labour use *Labour use* **Labour use**	Soil erosion Water use by irrigation **Energy use by min. fertilizer** **Use of mineral P**	*Land shadow prices* **Land value**	Labour use *Labour use* **Labour use**

In comparison with many former initiatives the broad spectrum covered and the type of the proposed indicators allows for a deeper analysis of environmental pressures and impacts, economic costs and benefits and socio-demographic dynamics. For example, through the integration of the APES model, indicators assessing emissions like nitrate leaching can be calculated considering key processes, which is not the case for simple indicators describing farmers' practices like nitrogen use (Bockstaller et al., 2008). However, this requires a detailed description of fertilization and pesticides management for a given area. Another example is the assessment of economic indicators at NUTS2 level with two related model chains, which enables capturing complementary impacts of policy options, Social indicators in this list were derived from economic data, on labour and income distribution since no social model is, until now, integrated in SEAMLESS-IF.

Conclusion

The SEAMLESS-IF multi-scale approach with its explicit upscaling procedures, as well as the integration of the indicators into a generic flexible software system linked to a large database mark an important progress with respect to the creation of an efficient set of indicators to assess the sustainability of future agri-environmental policies. However, some methodological issues remain unclear, such as the determination of reference values and the aggregation of indicators into composite indices. For the latter, methods have been explored (Bockstaller et al., in review). Furthermore, there are still themes not covered by the GOF, e.g. impacts on biodiversity, and only few indicators are available representing the social dimension. However, as SEAMLESS-IF is a flexible system further extension of the indicator list is possible through the integration of new models.

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Van Ittersum, M. K. et al. , 2008. Agric. Syst. 96, 150-165.

7.1 Indicator Framework

Christian Bockstaller

Indicators in SEAMLESS-IF, what is specific?

There is a consensus among stakeholders and scientists in the world on the need of indicators to assess the impact on sustainability of human activities and among them agriculture. This is due to the impossibility of measuring or predicting directly sustainability. The aim of the SEAMLESS-IF is to assess the impacts of future policies that means that that the assessment tool will be used in an *ex ante* way which differs from a majority among the huge number of initiative which were aimed for ex post assessment (of an existing situation). The modelling effort is another specificity. It was needed to predict to the evolution of agricultural systems, in term of activities, but is also invested to assess impacts, especially for the environmental impacts. Thus SEAMLESS-IF will not only offer simple indicators based on farmers' management data but also on calculation of emissions, effect on the state of soil, etc.

The Goal oriented Framework (GOF) developed for SEAMLESS-IF

To avoid the trend to develop a simple new indicators list, the group working on indicators in the project has developed an indicator framework in SEAMLESS-IF. The aim of using an indicator framework in selecting indicators for an Impact Assessment is to assist the user in selecting a balanced set of indicators that can help to get a clear picture of how and in what way the assessed future policy may contribute or not to a more sustainable agriculture and society as a whole.

The GOF is structured in

- **Two domains** : 1) *impacts of the agricultural sector on itself,* 2) *impacts of agriculture on the rest of the world*

Within each domain:

- **Three dimensions**: 1) *environmental,* 2) *economic* 3), *social*

Across the 3 dimensions:

- **Three generic themes**: *1) ultimate goals,* 2) *processes for achievement, 3) means*

The idea behind this categorisation is that the development of a policy is motivated by several *ultimate goals* (see Table 7.2). The wording "*ultimate goal*" does not imply that this generic theme is more important than the other two but it refers to its position in a causal chain of action. To achieve these ultimate goals one needs both *means* as well as *processes for achievement*.

To make it easier for lay persons to understand the meaning of the generic theme each generic theme is specified and named according to the common language within that dimension. For these explanations of the generic theme, see Table 7.2.

Table 7.2: Generic Themes of the Goal Oriented indicator Framework (GOF) and their explanation in terms specific to each dimension of sustainable development

Dimensions/Themes	Environmental	Economic	Social
Ultimate goal	Protection of human health and welfare, living beings and habitats	Viability	Quality of life individual, in society
Process for achievement	Maintenance of environmental balances or functions	Performance	Social and human capital
Means	Environmental compartments and non-renewable resources	Financial and productive capital	Population

A flexible list of sub-themes and indicators

For each dimension, the three generic themes are thereafter specified and divided into sub-themes. The definition of sub-themes is a way to ensure that the representation of issues or problems linked to each specific dimension of sustainable development are taken into consideration such as, water quality, eutrophication, climate change, farm income employment rate, gender and behavioural changes of farmers. The number of relevant sub-themes is something that could vary from assessment to assessment but in SEAMLESS we have aimed to develop a generic list of sub-themes covering a vast array of policy problems relevant to the agri-environmental policy area.

Indicators

Each sub-theme contains one or several indicators. Each individual indicator is implemented at a specific scale and with a specific unit.

References and further reading

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Bockstaller C.,Bellon S.,Brouwer F.,Geniaux G.,Girardin P.,Pinto Correira T.,Stapleton L. M., Alkan-Olsson J., 2007. Developing an indicator framework to assess sustainability of farming systems. In M. Donatelli, J. Hatfield, and A. Rizzoli, (Eds.), Int. symposium on methodologies for integrated analysis of farm production systems. Catania, 10-12 September 2007, p. 141-142.

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7.2 Up-scaling

Irina Bezlepkina, Nadine Turpin, Olivier Therond and Christian Bockstaller

In SEAMLESS there is a number of up-scaling issues addressed. Next to the up-scaling procedure which is explained under the Modelling part (EXPAMOD, section 5.2), the up-scaling of model outputs is an important application in the area of indicator calculation. In spite of its complex and important model chain covering a large range of spatial scales, SEAMLESS-IF does not allow to provide all the model outputs needed to calculate all indicators at the full range of spatial scales (for example nitrate leaching is provided by models at field type level but not at a higher level). Consequently, in SEAMLESS-IF the calculation of an indicator at a spatial scale higher than the scale of the model (which provides outputs used to calculate it) requires an up-scaling procedure (e.g., an indicator at regional scale calculated with FSSIM outputs). This type of up-scaling for indicator calculation corresponds to the spatial aggregation of models outputs and is mainly based on the use of:

- Typologies of fields (AEnZ), activities, farms and/or regions. These typologies simplify the diversity to allow handling it with the complex model structure developed in SEAMLESS-IF. These typologies create groups of items that should have homogenous characteristics and behaviour according to investigated policy and/or technological changes.
- Sets of weights for the typology groups (for weighting calculation) which translate the representativeness of the group within the whole population (e.g. number of farms in each farm type, area of an AEnZ in a region, total area of the farms for each farm type). In many case weights used to up-scale model outputs to the higher level may be inferred from the indicators characteristics. Indeed the combination of the assessment criteria unit, the indicators spatial scale and the model that provide outputs allow generally determining the weight to use in the up-scaling procedure. Table 7.3 presents some examples of relationships between the indicator characteristics and the weight used in the up-scaling procedure. The conceptual relation and the final list of the possible and relevant relations between indicator characteristics and weight used to upscale model outputs in SEAMLESS-IF have to be defined jointly by the researchers developing the integrated framework, the indicators and the applications (while testing SEAMLESS-IF).
- An algorithm of aggregation.

A series of algorithms has been developed and further implementation of the algorithms is foreseen in the final version of SEAMLESS-IF. Two indicators (total farm income in a region and nitrate leaching in a region) have been already coded in SEAMLESS-IF and appear on the list of indicators available for the selection in the User Interface. In future advances of this work within SEAMLESS Association an interface can be developed to allow for a so-called Indicator Editor when a user can select the level of aggregation and define which weights (s)he is willing to use. Examples of indicator up-scaling algorithms are found in Table 7.3.

For all the economic indicators that can be assessed at NUTS2 level either from an aggregation of FSSIM outputs or directly from SEAMCAP, a systematic comparison will be held, to improve the complementarities between the two sets of indicators.

Table 7.3: Examples of relations between indicator characteristics and weight used for the up-scaling procedure required to calculate indicators

Indicators characteristics			
Unit of assessment criteria	Scales of assessment problem	Model providing the output that are up-scaled	Weight for up-scaling procedure
Ha	region	FSSIM	Number of represented farms x farm type area
Ha	NVZ	FSSIM	Number of represented farms x area inside the NVZ by farm type
Ha	AEnZ/Water basin	APES	Area inside the water basin by AEnZ by activity
Animal	region	FSSIM	Number of represented farms x number of animal by farm type
AWU	region	FSSIM	Number of represented farms x number of AWU by farm type
Farm	region	FSSIM	Number of represented farms

Two examples of aggregation procedures applied to farm income and nitrate leaching are presented below.

a) Characteristics of the indicator:

- name of the indicator: mean farm income
- unit: €/farm/year
- spatial resolution: modelled farm type
- spatial extent: NUTS2
- FSSIM output: farm income (Z)
- sets of aggregating parameters (name in SEAMLESS database): number of represented farms in FADN data (data_representativefarm.representedfarms) or number of represented farms as an output of the structural model.

Notations for the aggregation:

INC_r : mean farm income in a region r

$rep_{k,r}$: number of represented farms for farm-type k in region r

$Z_{k,r}$: farm income of farm-type k in region r

Aggregation formula: $INC_r = \frac{\sum_k (rep_{k,r}.Z_{k,r})}{\sum_k rep_{k,r}}$

Possible use of the aggregation formula: can be used for any indicator assessed at farm level, expressed per farm (not per worker or per ha), and for which the set of aggregating parameters is the number of representative farms. Such indicators are:

- percent of subsidies in net farm income
- profit (accounting) of the agricultural processing industry
- labour use
- mean percent of debts in net farm income

- direct payments
- first pillar CAP expenditure
- Second pillar CAP expenditure
- other subsidies
- net value of capital stocks (including son indicators as capital in buildings, in animals, etc.)

b) Characteristics of the indicator:

- name of the indicator: nitrate leaching
- unit: %
- spatial resolution: AEnZ
- spatial extents: NUTS2
- APES outputs: nitrogen leaching by activity by AEnZ [POLL(rotation, S, T, P, SYS)] , water drainage per activity.
- FSSIM outputs: area per activity per farm type[$X_{r,s,t,sys}$]
- sets of aggregating parameters: Nk, r : number of farm by region r for a farm type k.

Notations for the aggregation :

Nk, rg : number of farm by region rg for a farm type k

DW : water drainage per activity (m3/ha/year) provided per APES (or CROPSYST)

NN : threshold of nitrate concentration in water: 50 mg NO3/L

NS : threshold of nitrate leaching for a given NN (Kg NO3-N/year)

- NS = 14/62*NN * DW

$X_{r,s,t,sys}$: area per activity per farm type, so-called activity level (ha)

AHLk : total area by farm type with leaching over threshold (ha)

$$- \text{AHLk} = \sum_k X_{r,s,t,sys} \textit{ with } POLL_{r,s,t,sys} > NS$$

UAAk: utilized agricultural area per farm type (ha)

Aggregation formula:

$$\% \, AHNO3_{rg} = 100 * \frac{\sum_k N_{k,rg} . AHL_k}{\sum_k N_{k,rg} . UAA_k}$$

Possible use of the aggregation formula: can be used for any indicator expressed as a percentage of the regional agricultural area, for example percentage of the regional UAA worked by farms with farm income > given threshold. This kind of up-scaling is relevant for indicator addressing impacts at local scale (e.g. watershed), for which the calculation of weighted mean by size of unit is not relevant (see DPD2.1.3, D2.1.2). This is the case for the nitrate leaching, soil erosion, soil organic matter trend.

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