Indicators in time, space and multiple domains: lessons from applying an integrated assessment tool for agricultural systems

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Executive Summary

In Integrated Assessment and Modelling (IAM) quantitative simulation models are frequently used to compute indicators on several dimensions of sustainability. These quantitative simulation models can be derived from different disciplines and formalisms and can operate on different temporal and spatial scales. In the SEAMLESS project, a set of such models were integrated into an assessment tool for agricultural systems that targets ex-ante assessment of policy and technology changes. Processes at field, farm, regional and EU market level were captured in biophysical and bio-economic models. An example of the integrated use of these models for indicator assessment will be presented.

Based on SEAMLESS several lessons can be drawn with respect to the definition and calculation of indicators. First, the spatial and temporal coverage and integration of existing statistical data sources is crucial to come to a comprehensive assessment and to derive indicators on the different aspects of sustainability. This is not a trivial task as concepts and scales have different meanings in different domains and because of data availability. Second, through typologies and statistical techniques, it is possible to reach a high spatial and temporal resolution of the calculation of indicators. For example, by developing biophysical and farm typologies, diversity in different data sources can be captured and these typologies can be linked through statistical techniques. Hereby many different indicators can be calculated EU-wide for agricultural systems in agri-environmental zones with relatively homogenous conditions for farming. Third, several quantitative models can be used in a standardized and homogenized way to provide consistent indicators across scales if their data requirements and key model outputs have been aligned. Finally, transparency is crucial in relation to the definition, calculation, and delivery of indicators in integrated assessments. On the one hand this requirement is met by developing a software framework that allows the user to explore the calculated indicators. On the other hand we hope to facilitate transparency and to maximise the impact of our efforts by making models and data available under open source conditions.

Introduction

The state of the environment and the progress towards sustainable development can be assessed through the calculation of indicators, where indicators synthesize relevant data and indicate the change or define the status of something (Gallopin, 1997). Agri-environmental indicators specifically focus on the state of the environment as influenced by agricultural practices (OECD, 2008). Indicators are means that can be used to process datasets to provide new insights and simplified statements about complex issues (Andersen et al., 2007). Relying directly on available data, indicators may be used to (a) identify or justify needs for policy intervention, and (b) to assess ex-post the impact of previous and current policies. Indicators are established for achieving both uses, as for example in the IRENA initiative on agri-environmental indicators (EEA, 2005), and in the assessment of the impact of the rural development programs of the European Union (EC, 2006).

Another technique to process data and inform policy making is Integrated Assessment and Modelling (IAM), which is used to assess the impacts of policies, technologies or societal trends on the environmental, economic and social sustainability of a system (Parker et al., 2002). IAM is a methodology that combines quantitative models representing different aspects of sub-systems and scales into an overall framework for Integrated Assessment (Parker et al., 2002). Quantitative models used in an IAM study originate from a different discipline, operate on different spatial and temporal scales, and require diverse (and sometimes, overlapping) data-sources. Model integration within an IAM project requires that all input and output data of each model have to be integrated. Prominent examples of IAM relate to the assessment of climate change impacts (Weyant et al., 1996; Cohen, 1997) or water quality in catchment areas (Turner et al., 2001). Ultimately, these integrated models also calculate indicators across domains, with the important differences that these models calculate ex-ante and that these models often contain a detailed description of processes occurring at lower spatial scales (e.g. crop growth, farm behaviour, nitrate leaching) (Fig. 1).

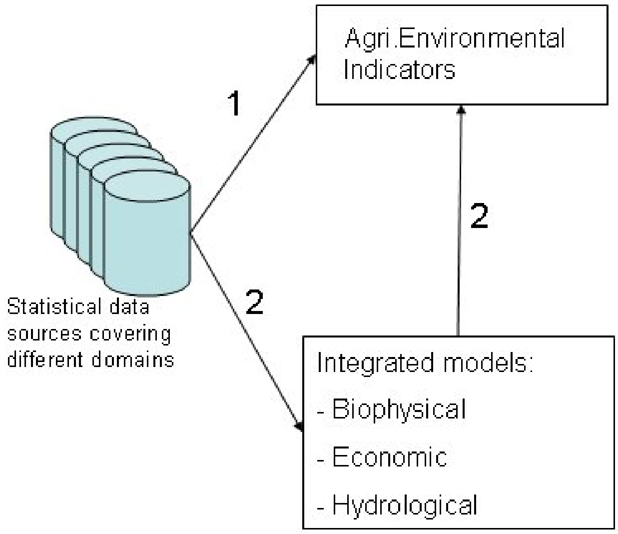

Figure 1. Different paths to the calculation of indicators, either direct, ex-post or as an actual status (1) or indirect ex-ante through Integrated Assessment and Modelling (2)

SEAMLESS (System for Environmental and Agricultural Modelling; Linking European Science and Society) is an IAM research project (Van Ittersum et al., 2008), which aims to provide a computerized framework (SEAMLESS-IF) to assess the impact of policies on the sustainability of agricultural systems in the European Union at multiple scales. This aim is achieved by combining micro and macro level analysis, addressing economic, environmental and social issues, facilitating the re-use of models and providing methods to conceptually and technically link different models (Van Ittersum et al., 2008) (Fig. 2). SEAMLESS provides a framework for policy assessment in agriculture by integrating relationships and processes across disciplines and scales and combining quantitative analysis with qualitative judgments and experiences (Ewert et al., 2009).

In developing an integrated assessment allowing multi-scale and multi-dimensional analysis, a few challenges with respect to agri-environmental indicators emerge. First, a set of calculable and informative indicators has to be defined linked the models available. Second, the diverse data sources needs to be organized and managed to calculate indicators and run models. Third, the values of the indicators calculated by the model need to be presented in an understandable and transparent way. This paper demonstrates the potential of a tool like SEAMLESS for one application, and describes our solutions for the challenges of indicator definition, data management and results presentation with respect to agri-environmental indicators.

The next Section gives some more background information to SEAMLESS and describes a typical application of the SEAMLESS-IF. Section 3 describes our solutions to the challenges of indicator definition, data management and results presentation. The final Section presents a discussion and some conclusions with respect to the Integrated Assessment and Modelling, the challenges and agri-environmental indicators.

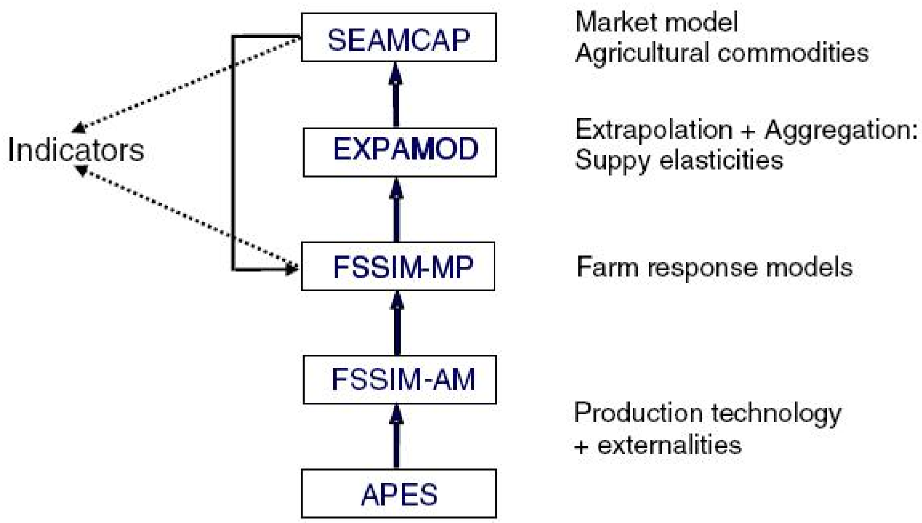

Figure 2 The models in SEAMLESS (after Van Ittersum et al., 2008). APES: Agricultural Production and Externalities Simulator; FSSIM-AM: Farm Systems SIMulator-Agricultural Management; FSSIM-MP: FSSIM-Mathematical Programming; EXPAMOD: EXtraPolation and Aggregation MODel and SEAMCAP: SEAMLESS version of the Common Agricultural Policy Regional Impact Analysis model.

Background

Models and Indicators

The models in SEAMLESS are a cropping systems model APES, a bio-economic farm model FSSIM, an econometric estimation model EXPAMOD, and a partial equilibrium optimization model SEAMCAP. Each of these operate on different spatial and temporal scale and is based on different modelling techniques. The cropping systems model Agricultural Production and Externalities Simulator (APES) operates at the field systems level, and represents one hectare (or a point) (Donatelli *et al.*, 2009). On the basis of agricultural activities, soil and climate data, APES simulates the yield and environmental effects resulting from those activities, and it can calculate biophysical indicators like nitrate leaching, soil erosion, pesticide leaching.

The bio-economic farm model and partial equilibrium optimization model are both optimization models based on mathematical programming techniques. These models are built based on assumptions with respect to the functioning of economic agents, i.e. farms or market parties at continental scale. The Farm System Simulator (FSSIM) is a bio-economic farm model developed to assess the economic and ecological impacts of agricultural and environmental policies and technological innovations (Louhichi *et al.*, 2009). A bio-economic farm model links decisions on management of farm's resources to current and alternative production possibilities describing input-output relationships and associated externalities (Janssen and Van Ittersum, 2007). Indicators calculated by FSSIM are mainly agri-economic, like farm income, subsidies received, production level, farm nitrogen surplus, farm crop diversity.

SEAMCAP is a variant of the Common Agricultural Policy Regionalised Impact (CAPRI) model adapted for inclusion in SEAMLESS-IF (Britz *et al.*, 2009). CAPRI is a spatial economic model that makes use of non-linear mathematical programming tools to maximise regional agricultural income. It explicit considers Common Agricultural Policy instruments in an open-economy and price interactions with other regions of the world are taken into account (Heckelei and Britz, 2001). Indicators are mainly economic like bilateral trade flows, market balances, consumer and producer prices.

Finally, the econometric estimation model EXtraPolation and Aggregation MODel (EXPAMOD) is an econometric meta-model describing price-production responses of farms given specific farm resources and biophysical characteristics (Pérez Domínguez *et al.*, 2009). EXPAMOD accounts for land use changes via production volume. After the calculations done in EXPAMOD, the regional supply modules of the market model SEAMCAP can behave like a representative aggregate of the FSSIM models of the same region. EXPAMOD does not calculate relevant indicators, but facilitates the calculation of indicators by other models.

By linking field-farm-market models in SEAMLESS-IF, the land use changes can be analysed at multiple levels through a selected number of economic, environmental and social indicators, accounting for the impacts of farm responses that could not be analysed by using only the individual models as stand-alone tools. An example of such a question is ‘what are the impacts of implementations of the Nitrate Directive on farm income, on-farm labour, non-point source pollution and resource use in the European Union and in the regions Poitou Charentes (France) and Flevoland (Netherlands)?’ With respect to this question, a bio-economic farm model can provide an estimate of the impacts on farm income in either Poitou Charentes or Flevoland, while a cropping system model can estimate the impacts on non-point source solution and resource use. A market model can estimate the impacts on farm income, trade and markets in the entire European Union. When these models are linked, the impacts can be calculated at all scales and for all indicators in a consistent manner.

Sample Application

In this application SEAMLESS-IF is used to analyze the impacts of a WTO trade liberalization proposal, as formulated in December 2008 on the economic, environmental and social dimensions of sustainability at both farm, regional and market scale (Adenäuer and Kuiper, 2009). For this purpose three scenarios have been defined, featuring different degrees of trade liberalization. It the first scenario we analyse the effects of an abolition of EU’s export subsidies for agricultural commodities. In the remaining two scenarios this subsidy abolition is combined with two proposals for tariff reductions. The effects of the different scenarios on are analyzed on the welfare of the different actors in the agricultural sector of the EU as well as on some environmental and social issues. The total welfare of the agricultural sector increases throughout all scenarios for the EU mainly due consumers gaining from lower prices which compensate the income losses of farmers. Especially agricultural income changes vary across the different regions of the EU, where regions with a higher share in animal production suffer more than those specialized on crop production (Fig. 3). When analyzing the income effects on farm type level, differences occur across types and regions, due to different specialization and production structure as well as biophysical conditions. This is also true for nitrate leaching, which is chosen as an indicator to asses environmental effects. While a reduction of nitrate leaching occurs across all NUTS2 regions of the EU, some farm types show increasing nitrate leaching when switching from less nitrate intensive crops to more intensive ones. Finally an assessment of total labour use in agriculture shows that trade liberalization negatively impacts the labour demand in agriculture which may place additional stress on the viability of rural communities.

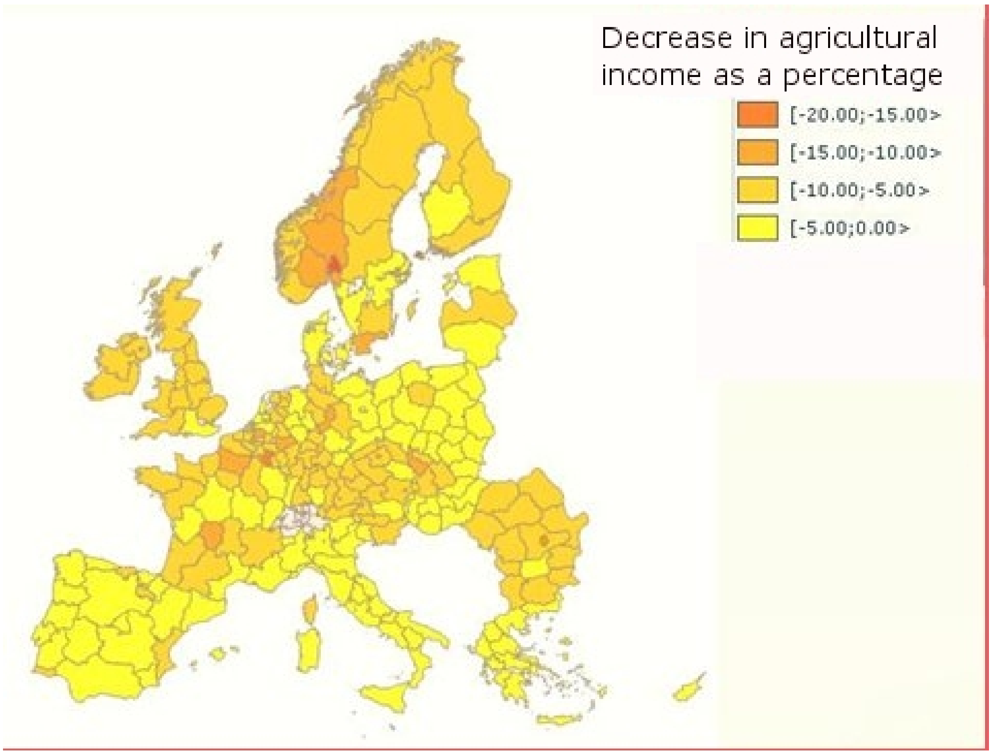

Figure 3 Agricultural income changes at Nuts 2 level in a relative decrease to baseline results (Adenäuer and Kuiper, 2009)

Challenges

Definition of indicators

For SEAMLESS a list of 230 indicators was made, being divided over 75 groups of indicators (see Appendix 1 for an overview of the indicator groups) (Alkan Olsson et al., 2009a). Each group holds a set of indicators at different scales, for example the Nitrogen Use-Indicator Group, has indicators on both farm, regional and country level. Each indicator group is linked to an indicator factsheet describing the indicator, its calculation method, used models and additional metadata. In this way, a separation could be made between the definition and documentation of the indicator in the indicator group and the scale at which this indicator can be calculated. Also mismatches between indicators and desired scales could be identified, and aggregation procedures were made to calculate these indicators at the desired scale. For example, nitrate leaching was originally only available on the field/farm scale, but had to be contrasted with income effects at the regional scale.

Currently the set of SEAMLESS indicators covers mostly the economic and environmental dimensions of sustainability, while it is weak in the social dimension of sustainability (i.e. equity, fairness, income inequality, labour, family work force indicator groups) (Alkan Olsson et al., 2009a). This links back to the models used in SEAMLESS which are either economic, bio-physical or bio-economic. Furthermore, there are a lot of indicator groups focusing on nitrogen, its use and losses, while there is much less attention for phosphorus use or other nutrients, including micro-nutrients. Many agri-environmental indicators could still be improved or better linked to the modelling approaches. This is mainly the case for the indicators which are more difficult to quantify due to their subjectivity or due to lack of data, for example, biodiversity, soil quality and landscape quality.

Based on the processes incorporated in the models, two types of indicators can be distinguished. On the one hand, primary indicators are directly based on a process endogenously modelled in a model, for example, producer and consumer prices for SEAMCAP, farm income and crop diversity for FSSIM and nitrate leaching and soil erosion for APES. On the other hand, derived indicators are not directly modelled by the models but can be deduced from the primary indicators through some simple calculation rules or aggregation steps. For example, based on the nitrate leaching for each crop calculated in APES, FSSIM can calculate an average nitrate leaching for all crops grown in a certain farm type. This distinction between primary indicators and derived indicators is often crucial to understand the changes in indicator values between scenarios.

The models included in SEAMLESS-IF produces many more outputs than the 230 indicators. In some cases these model output can also be valuable in the assessment of the indicators even though they generally are of a more technical value. Therefore a second list of ‘indicators’ was created, called model variables. These app. 280 model variables thus describe relevant model outputs that are not a core indicator in themselves, but help to understand the results of indicators. By making these variables accessible in the database a higher degree of transparency has been reached.

Data management

The indicators and models in SEAMLESS require data from many different sources and at different scales. The use of these dispersed data requires the integration of data sources to ensure consistency in data interpretations, units, spatial and temporal scales, to respect legal regulations of privacy, ownership and copyright, and to enable easy dissemination of data. A structured approach to data management is crucial to enable model and indicator calculations. Data management for SEAMLESS was achieved through an integrated database on Euopean agricultural systems, the extensive use of typologies and a drill down on data to arrive at the smallest geographical unit.

The database contains data on cropping patterns, production, farm structural data, soil and climate conditions, current agricultural management and policy information for European agricultural systems (Janssen et al., 2009). Data on agricultural management are absent at European level, but essential for the database and exploiting the modeling capabilities of SEAMLESS. Data on current agricultural management was therefore collected specifically for the SEAMLESS project. However, these data are only available for 16 regions in Europe due to time and budget constraints. A systematic and institutional arrangement at European level is needed to complete and to regularly maintain this data set. The database has the advantages (i) that several data sources are available on one server; (ii) that difficult questions of data integration and consistency have been solved by specialists familiar with the original data sources and (iii) that the pre-processing of the original data sources is already done. The database will be available for non-commercial use (Janssen et al., 2009).

The datasets on farm structure, cropping patterns, soil and climate have been categorised into farm and regional typologies (Metzger et al., 2005; Andersen et al., 2007; Hazeu et al., 2009) to enable modelling and indicator calculation in homogenous spatial units and to allow for characterization of the variation in the environment, e.g. climate, soil and farms. Typologies are used to combine data, to provide a flexible and manageable data structure, to respect disclosure rules and to facilitate the interpretation of the calculated indicators. Further regional typologies have been developed which characterize regions to provide contextual information for the assessments. Examples of regional typologies are livestock density, share of area in nitrate vulnerable zones and degree of rurality.

Through typologies, the integrated database and statistical allocation procedures a smallest homogenous spatial unit could be defined on which each of the data sources provide at least some data and these can be used as the smallest unit for the calculation of (some) indicators. These smallest units are called agri-environmental zones and have a unique combination of a soil and climate characteristics and their area is used by one or more farm types from the farm typology (Andersen et al., 2007). Consequently, indicators can be calculated for these smallest units and figure 4 shows an example of such an indicator for agri-environmental payments to farmers.. Although this example shows what is theoretically possible, it also demonstrates some practical limitations as country borders are clearly visible in the data and some areas where high payments are expected (i.e. parts of Wales) receive low payments according to the data. This could be caused by differences in data collection methods between countries or coverage and sampling issues of the original data source.

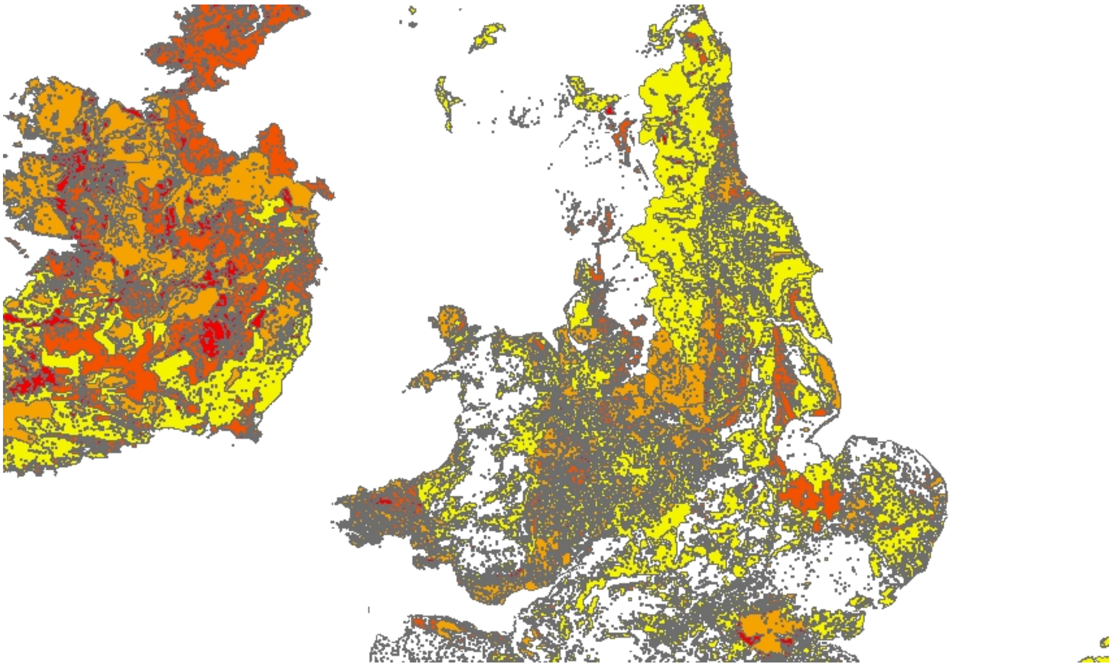

Figure 4. Agri-environmental payments for agri-environmental zones in North England and Ireland (Red is high level of payments, orange is medium, yellow is low and white is no payments).

Presentation of results

The use of indicator values by policy experts or other stakeholders requires that integrated assessment tools like SEAMLESS-IF are well documented and clear. Such transparency and clarity is achieved in three ways for indicators in SEAMLESS-IF.

First, indicators are documented in factsheets providing a standard set of metadata for each indicator. These factsheets contain the calculation methods, sources, relevant model outputs, units, description and references to additional scientific papers or other materials. These factsheets are linked to indicators in the SEAMLESS-IF and are publicly available on the website of the SEAMLESS association: http://www.seamlessassociation.org/index.php?option=com_docman&task=cat_view&gid=55&Itemid=84.

Second, the selection of indicators relevant for an assessment occurs jointly with the policy experts. The selected indicators are linked to the assessment project in SEAMLESS-IF: http://www.seamless-if.org:8080/gromit/wallace/index.html.
SEAMLESS-IF is a web-based tool that is available from any internet enabled computer without any requirement for installation. In SEAMLESS-IF for each assessment, there is a project providing a description of the assessment, selected

indicators, model inputs, and assessment results in terms of indicator values. Thus, the assessment is available for stakeholder scrutiny in the vision of semantic publishing (Shotton et al., 2009), as the stakeholder can create new visualizations (i.e. tables, maps, charts) of indicator values. SEAMLESS-IF has a dedicated part called SEAM:pres for the visualization of indicator values with functionality to compare scenarios, to make different types of visualizations and to compare to baseline scenarios both in relative and absolute terms.

Third, the selection of indicators relevant to an assessment project is based on an indicator framework, called the goal oriented framework (Alkan Olsson et al., 2009b). This goal oriented framework (Fig. 5) aims to relate the environmental, economic and social dimensions of sustainable development can be related to each other in a consistent way. The framework facilitates a balanced selection of indicators across dimensions of sustainability and focused on ultimate goals, process of achievement and means of achievement (Alkan Olsson et al., 2009b). Ultimately, an indicator framework helps to achieve a set of indicators that capture trade-offs vital to an integrated assessment.

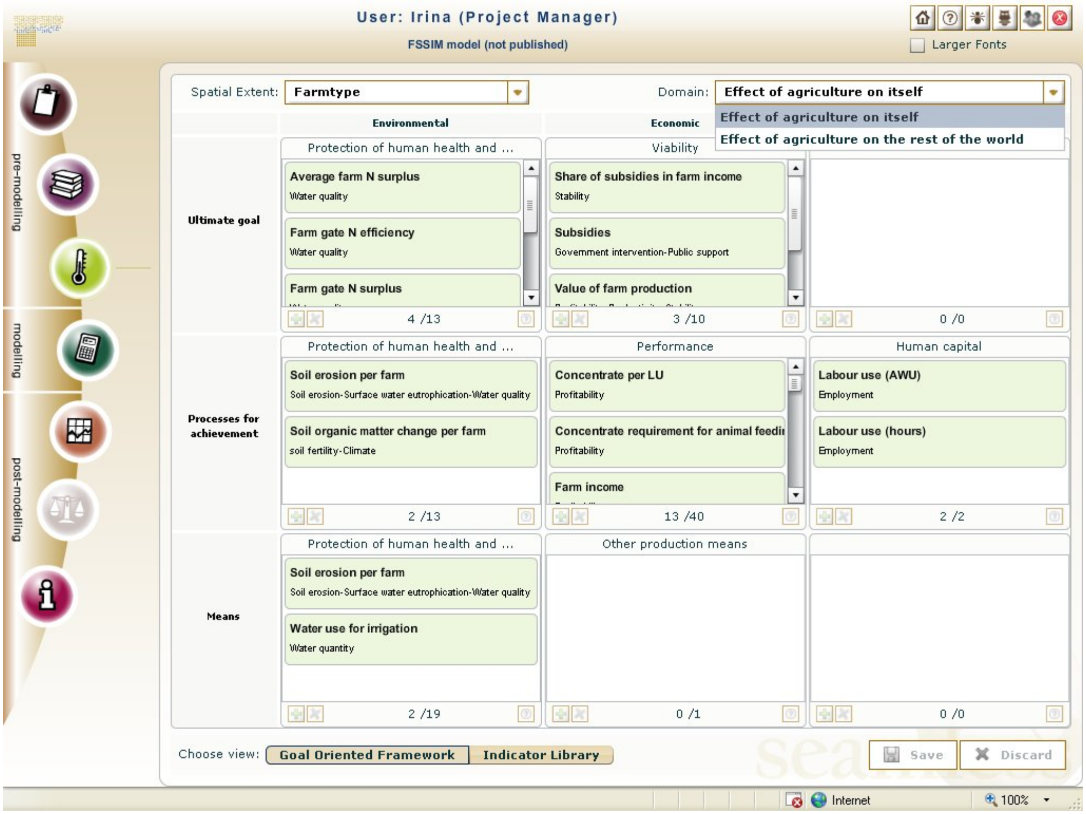

Figure 5. Goal Oriented Framework for indicators implemented in SEAMLESS-IF (Alkan Olsson et al., 2009a)

Discussion and conclusion

The SEAMLESS-IF is an integrated assessment tool focused on the ex-ante assessment of agricultural and environmental policies, and as such has been tested in a limited number of applications. It is now available for integrated assessments through a web-based interface to enable easy access and transparency of results and settings. Agri-environmental indicators can be calculated for future scenarios, but this future situation requires a baseline scenario to compare to. Such a baseline and the differences between baseline and scenarios with policy changes tell the story. The interpretation of the results of integrated models is to date not a straightforward exercise, according to our experience, as often the modellers are required in the interpretation and a good understanding of the nature of the models (i.e. processed incorporated, assumptions made, limitations and strengths) is required. Often these interpretations take the form of stories explaining the values of indicators and the mechanisms according to which the models function. The values of the indicators themselves are of lower importance, as these values are also somehow uncertain. This is a major difference between Integrated Assessment and Modelling and purely indicator based approaches as used by the OECD (OECD, 2008).

There are also many similarities between the development of an integrated assessment tool for indicator calculations and indicator as done by the OECD (OECD, 2008). These similarities relate mainly to type of indicators that can be calculated and to the limitations found in calculating indicators. For example, farm and crop management data are lacking in both approaches, due to these not being centrally collected. Typical farm and crop management can be identified in farm management handbooks, but average data on what farmers are really doing on their fields is often lacking. In case studies such information might be available for a region or part of a region, but not on in standardized way. For the calculation of many agri-environmental indicators, this is a real limitation and shortcoming, requiring many assumptions to fill the gap.

Another similarity is the weakness in biodiversity and landscape related indicators, as identified by the OECD (OECD, 2008). Although individual cases have shown, that it is possible to calculate such indicators (Geertsema, 2002), it is still difficult to calculate such indicators at a large scale. For biodiversity, an promising example is the GLOBIO approach to calculate Mean Species Abundance at a high spatial scale (Alkemade et al., 2009). Such an indicator could be incorporated in an Integrated Assessment and Modelling framework like SEAMLESS-IF.

Data, its availability and a consistent data-integration enable ex-ante assessments on multiple scales and multiple dimensions. We ensured this data-availability and integration through an integrated database incorporating several data sources across domains, and providing typologies that characterize regions in homogenous units, which are geographical relatively small. If such a database and these typologies are supplemented with standardized calculations for indicators as documented by the OECD (OECD, 2008), indicator values can easily be calculated and examined by a larger community in a standardized way.

A vision for the future is the availability of a toolbox with indicator calculations based on shared definitions (as supplied by OECD, EEA), an integrated database covering many sources at both high and low spatial scales (as supplied by statistical agencies) and integrated models for ex-ante assessment of a set of policy changes (as supplied by sciences). With yearly updates of the datasets, both indicator values and future assessments can easily be made across scales and dimensions, which allows scientists and policy makers to focus on the interpretation of the results, improvements of the methods used and designing potential responses to undesirable results.

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Appendix 1: Indicator Groups and their description

Table 1 Indicator groups and their description (Alkan Olsson et al., 2009a)

IndicatorGroup	Description
Nitrogen use	Amount of nitrogen fertilizer used on crops and grassland (expressed in kg N per ha)
Nitrate leaching	Amount of nitrate leached under the root zone of crops and grassland due to fertilization and nitrogen management after harvest (crop residues, catch crops, etc.)
Pesticide consumption	Amount of pesticides used (expressed in g of active ingredients per ha) in a farm to evaluate the pressure on all environmental compartments
Soil organic matter change	Evolution of the soil organic matter content in soil in percentage (soil fertility issue) or absolute value (carbon sequestration)
Soil erosion	Soil losses by water erosion along the slope
Runoff	Surface runoff due to low water infiltration
Water use (quantity)	Amount of water used by irrigation on crops
Volatilization	Volatilization of ammoniac due to nitrogen fertilization or/and livestock (stable, grazing, manure storage and fertilization)
Crop diversity	Land use diversity (and, conversely, dominance) – relevant for biodiversity and for environmental quality, in relation to cropping pattern and concentration/distribution.
% Low fertilised grassland	% Low fertilised grassland per farm type
% Non sprayed area	% Non sprayed by pesticide area per farm tye
% Area with conservation tillage	% Area with conservation tillage (no-till or reduced tillage) per farm type
% Of area with catch crop	% Of area with catch crop per farm type
Pesticide leaching	Amount of pesticides (active ingredients) leached under the root to groundwater
Pesticide runoff	Amount of pesticides (actives ingredients) in the soluble fraction transfered by runoff to surface water
Pesticide volatilization	Amount of pesticides (active ingredients) volatilized
Soil fertility change	% Of farm area with significant increase or decrease of soil organic matter
Nitrate surplus	Surplus of nitrate resulting from the calculation of regional balance (nitrogen input-nitrogen output-NH3 volatilization)
Total CH4 emissions	Amount of CH4 that is emitted due to livestock (entheric fermentation, manure) and rice production, per region, per member state
Total N2O emissions	Amount of N2O that is emitted from the land managements and breeding activities on a yearly basis per region, per member state
Global warming potential	Aggregation of CH4 and N2O emissions weighted by a greenhouse effect impact factor per region, per member state
NH3 emissions	Emissions of NH3
Phosphorus balance	Phosphorus balance per region, per member state
Mineral P, K use	Mineral P, K use per region, per member state
Indirect energy use by mineral fertilizer	Indirect energy use by mineral fertilizer per region, per member state
Gross nitrogen balance	Nitrogen balance (nitrogen import-nitrogen export) at farm level

Table 2 Continued

IndicatorGroup	Description
Energy consumption	Energy consumption due to use of mineral fertilizer, tillage implement, irrigation for crop production, and imported food and animal housing for animal production
Energy efficiency	Energy efficiency for crop crop production, specific animal production (milk, beef, pig) expressed in energy consumption per production unit
Stocking rate	Livestock density expressed in number of livestock unit (LU) per unit of forage or grassland area per farm type
Grassland share	Percentage of grassland (total or permanent) per farm type
Agricultural Income	Value of agricultural output (including premia/subsidies) minus variable costs
Total value of animal production per hectare in a region	Value per hectare of all primary animal agricultural products produced
Total value of crop production per hectare in a region	Value per hectare of all primary crop agricultural products produced
Total agricultural output	Total agricultural output value per region net of subsidies
Total agricultural inputs	Total value of all inputs but labour for producting agricultural primary products
Direct CAP payments	Payments made directly to farmers under the First Pillar of the CAP
Share of animal production	Share of value of animal production in total agricultural production
Total Welfare	Aggregated monetary utility of different sections of society resulting from agricultural production and consumption. Sum of money metric (consumer surplus), agricultural income, processing profits and tariff revenues minus 1st Pillar CAP expenditure
Money metric	Total annual consumer surplus that would result from the application of a given policy expressed in terms of the difference between what a person would be willing to pay and what (s)he actually has to pay to buy a certain amount of a good.
Profits of the Agricultural Processing Industry	Accounting profits of the agricultural processing industry (dairy and oilseeds)
Tariff Revenues	EU budget income from applying Tariffs on imported goods
First Pillar CAP Expenditure	Sum of direct payments to farmers, export subsidy outlays, and intervention stock costs
Terms of Trade	Price indexes of export and import
Export Subsidy Outlays	Compensation payments paid to EU exporters under CAP First Pillar, equal to quantity exported multiplied by difference between EU price and world price.
Second pillar CAP expenditure	Compensation payments for farmers who invest in rural public goods
Intervention Stock Costs	The monetary cost of buying, managing and selling surplus agricultural produce
Shadow price for labour	Marginal welfare change resulting from a unit rise in the net demand for labour.
Shadow price for capital	The present value of the social returns to capital (before income taxes), measured in units of consumption.
Net Farm Income	This indicator aims to assess the total income earned by each farm type

Table 3 Continued

IndicatorGroup	Description
Percent of Subsidies in Net Farm Income	Percent of subsidies in farm income
Subsidies	Total payments made directly at farm level, from first pillar CAP, second pillar, or regional policies
Marginal productivity of subsidies	This group of indicators deals with the relative efficiency, in terms of farm income growth, of public payments, from the policymaker's point of view
Value of farm production	Value of production at farm gate
Profit of the banking system	Total annual accounting profit of the banking system - defined as the availability of financial services and, therefore, of credit.
Total costs	Total costs (intermediate consumptions)
Percent of debts in net farm income	Percent of debts in farm income
Land shadow price	Land shadow price is the amount of money a farm would earn if it had the capacity of cropping one more hectare
Productivity of inputs	Productivity of inputs is the amount of money earned per euro of input bought
Productivity of intermediate consumption	Productivity of intermediate consumption is the amount of money earned per euro of intermediate consumption used
Equity	Difference between the income of the richer farm type and income of the poorer one
Fairness	This indicator compares the income growth rate of the richer and poorer farm types
Income inequality	Income inequality
Net value of capital stocks	The market value of fixed assets and it is obtained by the gross capital stock minus accumulated consumption of fixed capital.
Family work force	Family work force
Accessibility to temporary labour	Accessibility to temporary labour
Land value changes	Shadow value of the land restriction
Ratio of exports to imports at EU level	Quantity of agricultural commodities exported as a proportion of quantity imported
Labour use	Labour force in farming sector
Monetary poverty rate	Percent of population whose income is lower than 60 % of the median income in the population
Potential employment	Potential work force for on-farm activities