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Different levels of stakeholder participation for Sustainability Impact Assessment Tools - A comparative analysis of four research approaches

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Abstract: In the last decade, a wide range of new modeling approaches has been developed for sustainability impact assessment. They are often based on theoretical concepts on how to cope, process and apply pre-assessments on policy and project instrument-implementation. Experiences show that few models reached immediately a fully operational state ready to provide applied policy advice. Expertise on models and programming skills is often not available. Additionally, the geographical focus plays a crucial role in the success of any assessment approaches. Given the assumption that research should be demand-driven, this paper gives an overview on experiences from several European and international projects with regard to the demand of end users and the supply of research. The determining factors of these framework conditions (e.g. regional conditions towards skills, user demands, project designs, data availability of resources) are analysed, which drive decisions to select components within a "tool box". A decision tree is designed which is based on our experiences which ease an adequate, region and condition-explicit selection of tool-box components tailored for sustainability impact assessments. The paper critically reviews the concepts of the presented tools towards its success factors needed to conclude on adequate participatory stakeholder involvement.
Embedded in the framework of the LIAISE project 'Linking Impact Assessment Instruments and Sustainability Expertise' four approaches will be compared: (1) The “Sustainability Impact Assessment Tool” (SIAT) for Pan-European IA developed in the EU-SENSOR-project, (2) the stakeholder oriented “Framework of Participatory Impact Assessment” (FoPIA) which was also developed in the SENSOR project with the aim to validate results at the regional level, (3) the integrated assessment of agricultural systems and the environment of the SEAMLESS project and (4) the contrasting ‘Scaling up Assessment Tool’ (ScalA).

***Keywords**:* impact assessment, end user, participation, model development, sustainability

1. INTRODUCTION AND PROBLEM

Ex-ante policy impact assessment or appraisal in the area of sustainability can be considered to be a form of Integrated Assessment (IA), the ‘interdisciplinary and participatory process combining, interpreting and communicating knowledge from diverse scientific disciplines to allow a better understanding of complex phenomena’ [Rotmans and Van Asselt, 1996]. In this sense the development and use of IA tools can be framed as a form of integrated assessment modelling (IAM), defined as the participative process of building and using models to carry out IA of policy options [Parker et al., 2002].

The different levels of participation of IA tools have been compared by four approaches of three projects. Among others, these experiences were merged to the LIAISE project (http://www.liaise-noe.eu). The main objective of LIAISE is to build up a broad interdisciplinary community of researchers which develops a mutual understanding for linking-up with external parties involved in Impact Assessment. One focus is to reveal findings of adequate tool design and development with regard to the level of stakeholder involvement, given the framework conditions at project and regional level. Within the LIAISE framework, the two examples SENSOR [www.sensor-ip.org] and Seamless [http://www.seamless-ip.org/] developed models for EU-wide impact assessments. By contrast, the ScalA model was developed in collaboration with the German Agency for International Collaboration (GIZ) in the context of project intervention of developing countries. All here presented models aim at supporting decision making [Bezlepkina et al., 2011; Sieber et al., 2010]. This paper discusses in a comparative approach different ways on how to develop and apply modelling approaches, give insights in actual needs and potential mismatches of the supply by research and demand by policy decision makers.

Major problem of tool development in research is the lack of end users. Often, projects are designed to deliver tools for decision making at policy level. Although the demand-driven nature of tool development is often stated, supply-driven tool development occurs prevalently and the gap between tool design and use still exist. Therefore, the question is, whether one can (1) analyse different types of participation and its consequences and (2) determine model development by analysing the influencing factors of these framework conditions such as regional conditions towards skills, user demands etc. This would assure a higher probability of use or at least might narrow the gap between design and use of IA tools.

2. METHODS AND RESULTS

The LIAISE project is here presented in the way that it subsumes the expertise of the different presented tools, which will be (1) described briefly, (2) characterised in terms of stakeholder participation and processes and (3) synthesised in the decision tree framing the determining factors for tool development (see chapter 3).

2.1 The SENSOR project

The project SENSOR developed two impact assessment approaches: The meta-model SIAT and the framework FOPIA for participative assessment by stakeholder involvement. They both apply scenario-based impact assessment of land use-related sustainable development questions.

2.1.1 SIAT

SIAT is an example for an applied requirement analysis of a model development. SIAT has been designed to simulate land use policies up to the year 2025 at a regional scale across 570 European administrative regions [Helming et al., 2011]. The 83 implemented indicators within SIAT implicitly synthesize the agriculture sector and the related sectors of forestry, tourism, nature conservation, energy and transport [Sieber et al., 2008]. In doing so SIAT provides the functionality for regionalised trade-off analysis of sustainability indicators and the evaluation of sustainability decision spaces [Helming et al., 2011].

SIAT operates using a system of interlinked models in a model chain framework (right side) combining a macroeconomic model, a land use model, and sector models. Each policy simulation is iteratively solved by (1) applying the agricultural sector model CAPRI [Britz et a., 2008] that computes agricultural production, output prices and land prices to be used in the multi-sector (30 sectors) macro econometric model NEMESIS for EU countries [Brécard et al., 2006] until a market supply balance between land supply and land claims over all sectors (in particular agriculture, forestry, tourism, transportation and urban sectors) is achieved; (2) National claims on agricultural land indicated by NEMESIS is disaggregated to appropriate NUTS regions using the land-use change model DYNA-CLUE [Verburg et al., 2006], on which, sector responses to changes in available land are assessed again using the CAPRI model. (3) Successively, all input variables from CAPRI are fed back to NEMESIS (including the land use change-allocation produced by DYNA-CLUE) in order to solve the new equilibrium on endogenous prices. The iterations are repeated until model results converge. (4) Additional needed input variables to compute forest land claim depending on supply-sensitive management practices are calculated by EFISCEN [Schelhaas et al., 2007] and SICK, TIM and B&B are models for urban growth, transport infrastructure and tourism respectively [Helming et al., 2011]. Summarizing all results, a Graphical User Interface (GUI) allows for information retrieval of fact sheets and model results.

SIAT can be posed as an example for a lower stakeholder participation using **non-standardized requirement analysis** in **focus groups** for model development focusing on GUI design. The SIAT developer group was involved in 79 internal and external interactions in group discussions with stakeholders. Unfortunately a fixed composition, stable end-user group could not always be realised due to organisational disposition, which was caused by a lack of permanent members. The SIAT stakeholder participation of policy makers during model application changed depending on focused policy cases, but in this regard no relevant experiences are available. SIAT is still applied at scientific level without experience in operational policy advice.

2.1.2 FOPIA

FOPIA is a complementary methods focusing participative IA. Core of the Framework for Participatory Impact Assessment FoPIA is the stakeholder-based development and assessment of different land use scenarios [König et al., 2012]. The FoPIA provides a general assessment framework, a kind of template that can be adjusted to different regional contexts. It comprises a preparation phase and a regional stakeholder workshop, that follows a structured sequence of assessment steps, namely (i) interactive development of regional land use scenarios, (ii) specification of regional sustainability context, and (iii) and assessment of scenario impacts and analysis of possible trade-offs.

The scenario development (step 1) starts with a characterization of the main case study attributes. Scenario assumptions are defined together with regional stakeholders to achieve a common basis of understanding. The specification of the regional sustainability context (step 2) has the objective of putting the concept of SD into the regional context by using so-called Land Use Functions (LUFs) after Pérez-Soba et al. (2008). LUFs structure the assessment problem and allow for an equal consideration of the economic, social and environmental dimensions of sustainability. Stakeholders assign weights of perceived importance to the different LUFs. Weighing results are used to present different perceptions of LUF priorities as to derive a 'picture' of regionally more or less important LUFs. For the impact assessment (step 3), each LUF is assigned one corresponding indicators in order to have a precise measurement for the scenario impact assessment. After completion of the individual scorings, average impact scores for each scenario on each LUF indicator are calculated and presented back to the group. In order to initiate a discussion, the workshop moderator presents the group average score and highlights contrasting positive and negative impact scores.

FOPIA was developed for **participative IA requirement analysis** for regional land use problems conducted by stakeholders. The stakeholders themselves initiative during the impact assessment process the requirements analysis for the specific problem of the case region, but there was no requirement analysis conducted for the tool development. Not the tool, but the result is the outcome of the participative stakeholder involvement. The objective of the FoPIA method for impact assessment of alternative land use scenarios in developing countries was tested by five cases with different regional contexts and land use problems. The actual impact assessment results, however, are influenced by the participating stakeholders. The stakeholders are key for success of the FOPIA. Therefore, a well-balanced group selection is recommended. Overall, the FoPIA is seen as a complementary assessment tool supplement to quantitative impact assessments.

2.2 SEAMLESS

The SEAMLESS project developed a methodology for policy support in agriculture using a framework (SEAMLESS-IF) that integrates relationships and processes across disciplines and scales and combines quantitative analysis with qualitative judgments and experiences [Ewert et al., 2009]. Major components are the following:

SEAMLESS-IF enables flexible coupling of models and tools. The framework also enables linkage of quantitative models, pan-European databases and qualitative procedures to simulate the impact on society of biophysical, economic and behavioural changes. Technical coupling and reusability of model components are greatly improved through adequate software architecture (SEAMLESS-IF uses OpenMI). The user interface is designed in such a way that it enables different uses of the framework depending on user roles (administrator, project manager, modeller or viewer) and rights (create, modify, read, delete, execute) [Wallman and Knapen, 2009]. The bio-economic farm model FSSIM includes a module for agricultural management (FSSIM-AM) and a mathematical programming model (FSSIM-MP), which forms the core of the bio-economic farm model (FSSIM) (Seamless 2009). Based on mathematical programming approaches, FSSIM-MP captures resources, socio-economic and policy constraints and the farmer's major objectives. The aim of FSSIM-AM is to describe, generate and quantify production techniques of current and alternative production enterprises for which yields and environmental effects can be simulated by APES (or other cropping/livestock system models). The Common Agricultural Policy Regional Impact model [CAPRI, http://www.capri-model.org/] calculates the effects of EU agricultural and trade policy on European agriculture. The CAPRI modelling system consists of specific data bases, a methodology, its software implementation and the researchers involved in their development, and applications. An extensive post-model analysis is provided. Income indicators are calculated consistent with the EAA methodology.

SEAMLESS-IF can be posed as an example for a **non-standardized requirement analysis** using focus groups for the models and sub-modules. Iterative focus groups discussed the design and structure of all involved models of the framework. Compared to SIAT, SEAMLESS-IF is more focused on the technical linking of models rather than focusing on central single modules (e.g. GUI). A continuous composition of a stable end-user group could not always be realised. Due to the need of technical knowledge of software questions, the divergence between skilled programmers in IT and users at policy level is high. SEAMLESS-IF is still applied at scientific level without experience in operational policy advice, but single models (e.g.CAPRI) have long lasting experience in this regard. Policy-makers as end users have been involved in the testing of results to assure the relevance of the integrated framework as well as in formulation of test cases [Bergez et al., 2010].

2.3 ScalA

The Scaling up Assessment Tool (ScalA) conducts ex-ante assessment to compare scaling-up potentials of project interventions (Good Practices implementation) at community level in developing countries [Bringe et al., 2006]. The tool is designed for the purpose of providing decision support to policy makers, as well as practitioners at community level concerned with the planning and monitoring of implementation processes for Good Practices.

Therefore it was necessary to operationalize the findings from a qualitative data analysis in order to develop simple tool to be used for external end users. The operationalization of the complex data material was realized through the following steps: (1) by breaking up the relevant conditions for scaling-up into manageable factors, (2) by introducing a numeric rating system that allows comparing the feasibility among different alternative Good Practices. The results are simple checklists on a Excel-base, which ask end users specific requirements to be fulfilled for Good Practices implementation. A scoring system of the fulfillment of requirements ranks as a result the feasibility to implement different Good Practices.

This tool provides the measure of the scaling-up potential by comparing (a) the characteristics of the GP envisaged for implementation, (b) the features of the implementing organization, including its scaling-up strategy (c) the characteristics of the target community and (d) the adaptation of the GP to the situation in the area envisaged for scaling up with the optimal status of these issues that is likely to be most fostering to scaling up. The deviation of actual conditions from optimal conditions, which are formulated by indicators outlined in the tool, provides the possibility to measure the implementation potential of Good Practices. The higher the deviation from the optimal condition, the less likely is a rapid, cost efficient and successful implementation.

The ScalA can be posed as an example for an **empiric requirement analysis** for model development including a post-testing of the tool feasibility. The development team derived the relevant indicators from empiric studies. The tool was not developed by requirement analyses of end users. But the stakeholder process is key for the decision on adequate Good Practices and the involvement process takes place at the level of the tools application. The results of the tool are requirements to be identified in focus group discussions for successful Good Practice implementation. ScalA was applied to different case studies to test the feasibility of the tool, but there is still no community-based, self-motivated application documented.

3. DISCUSSION

The stakeholder participation can be defined for different levels of IA tools: (1) the participation in the frame of a requirement for tool development, (2) the participation need in the IA process itself (e.g. process oriented decision making), (3) involved stakeholder groups, and (4) the participation tool / method application including the result presentation and analysis (see table 1).

	SENSOR SIAT	SENSOR FOPIA	SEAMLESS	SCALA
Tool flexibility for stakeholder	Meta-Model using an inter-linked model framework for sustainability IA	Participative IA Method for sustainable development	Model framework for agricultural policy IA	Discussion support tool of project interventions at community level
Participation level	Lower to high participation: Non-standardized requirement analysis for the GUI and applications	Non to high participation: Systemized stakeholder participation during impact assessment process	Medium to low participation: Requirement analysis for model, sub-modules & applications	Non to high participation: Systemized stakeholder participation during impact assessment process
Stakeholder involvement	Researcher, Policy Decision Makers (EU Commission)	Researcher, Local policy makers, Representative of NGOs	Researcher, Policy Decision Makers (EU Commission)	Researcher, Representative of NGOs and of rural communities
Restrictions	Limited to change policy definitions for IA for end users	Need for motivation and expert stakeholders	Required knowledge to apply the models	Need for motivation and expert stakeholders

Table 1. Comparing different levels of stakeholder involvement

Summarizing the presented cases in terms of (1) flexibility to conceptually change the tools for stakeholder, SENSOR SIAT is a meta-model with less flexibility to change the model framework by end users, since post-processing of results is involved. SENSOR SIAT is highly flexible with regard to the stakeholder selections and the method on IA as well as the process can be changed on request of end users. SEAMLESS consist of a range of linked models, which are rather flexible to use as single components according to end users requests on the analysis. ScalA comprises simple questions, indicators and scoring systems, which can be used and changed flexible on request of involved end users.

The (2) level of participation of stakeholders differs among differs among observed cases. While SIAT has a lower participation of stable end user involvements during the model development, the participation in result analysis can be high at discussion support level for decision making. FOPIA has a high participation during IA procedures, but a low level during the development period of the method. SEAMLESS Tools were development comparatively by a higher participation level of end user involvement, but a very high expert knowledge to run the models is requested and thus end users are limited to participate actively in the IA applications. ScalA was designed without stakeholder participation, but is tailor-made for strong involvement of end users. While ScalA and FOPIA are process-oriented in decision making, SIAT and SEAMLESS provide in a first instance results do not need necessarily stakeholder participation.

Each case of stakeholder involvement (3) differs in its objectives, level of participation, role within IA and involvement period. The stakeholders were classified into the groups of (1) researchers, (2) local and EU policy makers, (3) representatives of NGOs and (4) of communities.

Each illustrated IA tool (4) has restrictions with regard to most limiting factors. SIAT is analytically rather broad, but less flexible in term of changing policy settings, since post-processed results are used. The success of FOPIA depends on the activeness and expert knowledge of involved stakeholders. SEAMLESS is sophisticated in terms of software components, but the requirements to apply the models and analyse the results are very high. The role of stakeholders in the cases of FOPIA and Scala is central, since the need for expert knowledge and motivation is very high to assure access and reliable results.

These findings can be used for improvement of tools development and its applications. An essential perquisite to bridge the gap between design and use is the strong involvement of motivated stakeholders, which pose at the same time end users of developed impact assessment tools. Among others, one essential measure to improve reliability of IA tools consists of a formalized way of tool development, which evaluated from the beginning of the research project (and tool development) the project, model and contextual environment of the IA. After having defined all relevant levels and having assessed all possible potentials, a prioritisation of the feasible most adequate possibilities to assure at the end a high demand and use of the IA tools will be possible.

Therefore, we summarized all relevant level to be considered in the period of IA tool development. These should be evaluated and streamlined towards an adequate tool design, which is tailor-made for posed research questions and stakeholder demands. The development paths of the IA tool should be outlined before starting the project (see table 2). Depending on mainly the three levels of (1) project analysis, (2) contextual analysis and (3) system analysis the IA tool can be developed and used according to beforehand defined agreements and promises between researcher, users and funding organization. Giving for each category examples (see table 1), the (1) IA tool is highly driven by available budget, objective of the project and funding organisation as well as the magnitude of the consortium due to transaction costs for communication. The contextual analysis drives the IA tool in terms of policy compliance, implementation feasibility of assessed policies, social-cultural factors can be hindering for tool acceptance and the knowledge level and the role of stakeholders in the IA process itself might drive success in terms of tool use. The (3) model/tool system itself affect also the design and use, given the fact that property rights, technical compatibility or simple tool performance hinder easy handling and exclude potential users and therefore limit tool dissemination.

Project Analysis	1. Project environment
	    1. Funding program
	        1. Objectives
	        2. Restrictions by project proposal
	    2. Project design
	        1. Nature of research consortium
	        2. Coordination and structure of teams
	        3. Project & Tool development period
	        4. Tool conceptualizing & testing period
	        5. Budget allocation
	            1. Budget for tool development
	            2. Additional contingency fund structure

Contextual Analysis	2. Policy environment
	    1. Legal policy framework compliance
	    2. Policy implementation feasibility
	    3. Characteristic of policy approach
	        1. Ex-ante analysis
	        2. Ex-post evaluation
	3. Socio-cultural environment
	    1. Cultural, societal acceptability of research
	    2. Self-motivation for active involvement
	4. Economic, environmental environment
	    1. Level of environmental pressure
	    2. Economic efficiency & feasibility
	5. End user environment
	    1. User involvement for tool development
	        1. Knowledge level for IA tools
	        2. Level of demand-driven process
	        3. Decision right assignment for tool design
	    2. End user use
	        1. Role of end user in use of IA tool
	        2. Level of simplicity / complexity for use
	6. Institutional environment
	    1. Institutional support and involvement
	    2. Role of institutions in IA process
	7. Development environment
	    1. Research staff skills
	    2. Hard/software facilities
	    3. internal/external infrastructure

Model System Analysis	8. System environment
	    1. Model environment & accessibility
	        1. Model definition (Stand-alone, web-based etc.)
	        2. Non-modeling approach
	9. Software environment
	        1. System compatibility
	        2. Software Licensing
	        3. Property rights for development & use
	10. Operational model performance
	        1. Computable model results
	        2. Iterative Interaction with end user
	        3. Expert assessment & consultation

Table 2. The decision tree for IA tool development

4. CONCLUSION

The given examples summarized different levels of stakeholder participation with regard to IA. The terminology “participation” should be well defined differing (1) IA tool development involvement or (2) IA process involvement targeting decision making. Requirement analysis are often lacking from the start of the project and IA tool development respectively. Based on our experience, the success for actual IA tool use is high, if both levels of participation have a strong stakeholder participation in requirement analyses.

The pre-definition of a decision tree for the development of IA tools supports the tailor-made IA tool design to guarantee actual use in decision making. Risks for failure can be identified and efficient capacity allocation among pre-defined settings (see table 2) can be undertaken. We ascertain that this careful planning is often lacking and therefore, among other adequate and here not analysed measures, the gap between design and use of IA tools for operational policy and project advice can be narrowed.

The added value of our interdisciplinary research poses a mutual learning between IA tool developers and involved stakeholder groups. By considering the proposed decision tree from the beginning of interdisciplinary projects, envisaged social learning will help to increase tool acceptance and adoption [Lang et al. 2012]. Risks for failure will be minimised, but more evidence-based empiric research is needed.

REFERENCES

Brécard, D., Fougeyrollas, A., Le Mouël, P., Lemiale, L., Zagamé, P., 2006. Macro-economic consequences of European research policy: Prospects of the Nemesis model in the year 2030, Research Policy, 35(7), pages 910-924.

Bringe, F., Crewett, W., Sieber, S., Tscherning, K., Uckert, G., 2006. Sustainable Agriculture as an Approach for pro-poor Growth in Developing Countries, Scaling-up methods for disseminating Good Practices, final report, BMVEL, 227 p., Bonn.

Britz, W., Heckelei, T., Kempen, M., 2008. Description of the CAPRI modelling system, available on http://www.capri-model.org/docs/capri_documentation.pdf.

Ewert, F., van Ittersum, M., K., Bezlepkina, I., Therond, O., Andersen, E., Belhouchette, H., Bockstaller, C., Brouwer, F., Heckelei, T., Janssen, S., Knapen, R., Kuiper, M., Louhichi, K., Alkan Olsson, K., Turpin, N., Wery, J., Wien, J.E., Wolf, J., 2009. Methodology for enhanced flexibility of integrated assessment in agriculture, Environmental Science & Policy, Volume 12, Issue 5, Pages 546-561

König, H.J.; Schuler, J.; Suarma, U.; McNeill, D.; Imbernon, J.; Damayanti, F.; Dalimunthe, S.A.; Uthes, S.; Sartohadi, J.; Helming, K.; Morris, J. Assessing the Impact of Land Use Policy on Urban-Rural Sustainability Using the FoPIA Approach in Yogyakarta, Indonesia. Sustainability 2010, 2, 1991-2009.

Helming, K, Diehl, K., Bach, H., Dilly, O., König, B., Kuhlman, T., Perez-Soba, M., Sieber, S., Tabbush, P., Tscherning, K., Wascher, D., Wiggering, H., 2011. Ex-ante impact assessment of land use change policies – A: analytical framework, Ecology and Society.16 (1): Art. 29, 1-23 Special Issue.

Lang, D.-J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., Thomas, C.-J., 2012. Transdisciplinary research in sustainability science: practice, principles, and challenges, Sustainability Science 2012; 7 (SUPPL. 1):25-43.

Parker, P. et al. 2002. Progress in integrated assessment and modelling. Environmental Modelling and Software, 17, pages 209-217.

Rotmans, J. and Van Asselt, M., 1996, Integrated assessment: growing child on its way to maturity, an editorial essay, Climatic Change 34:327-336.

Schelhaas, M.J., Eggers-Meyer, J., Lindner, M., Nabuurs, G.J., Päivinen, R., Schuck, A., Verkerk, P.J., Werf, D.C.v.d., Zudin, S., 2007. Model documentation for the European Forest Information Scenario model (EFISCEN 3.1.3). Alterra report 1559 and EFI technical report 26, Wageningen and Joensuu.

SEAMLESS, System for Environmental and Agricultural Modelling; Linking European Science and Society, D3.3.11.3: A generic template for FSSIM for all farming systems in the EU, http://www.seamless-ip.org.

Sieber, S., Müller, M., Verweij, P., Haraldsson, H., Fricke, K., Pacini, C., Tscherning, K., Helming, K., Jansson, T., 2008. Transfer into Decision Support: The Sustainability Impact Assessment Tool (SIAT). In: Helming, K., Tabbush, P., Perez-Soba, M., (Eds) 2008. Sustainability Impact Assessment of Land Use Changes. Springer, 107-128, ISBN 978-3-540-78647-4.

Verburg, P.H., Overmars, K.P., Huigen, M.G.A., de Groot, W.T., Veldkamp, A., 2006. Analysis of the effects of land use change on protected areas in the Philippines, Applied Geography, 26, pages 153-173.