EU FP 6 Project
GOCE 037063 with DG Environment

GEO-BENE

Global Earth Observation
-Benefit Estimation: Now, Next and Emerging

STREP
PRIORITY [1.1.6.3]
[Global Change and Ecosystems]

DELIVERABLE D5 (T13)
STATUS REPORT YEAR I

Due date of deliverable: 31 August 2007

Start date of project: 1 July 2006 Duration: 36 Months

Organization name of lead contractor for this deliverable:
International Institute for Applied Systems Analysis (IIASA)

Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Contents

1 Purpose of Deliverable D5

The purpose of the GEO-BENE Deliverable D5 (T13) “Status Report Year I” is to augment the description of work document and serve as a summary of the Reports D1 “ Detailed Project Workplan”, D2 “ GEO-BENE Web Page” and D3 “Benefit Assessment Framework Report”. By that it is envisaged to provide an overview on the work and studies carried out so far within the GEO-BENE framework and make available the actual status of the project.
Additionally, this report provides an overview on the model cluster that is applied in integrative way within the projects framework. The individual models are listed and the influencing parameters are shortly described. A visualization helps in understanding the interaction between the models used in GEO-BENE.

2 Summary Description of the Project’s Objectives and Deliverables in Year I (D1, D2, and D3)

The goal of GEO-BENE is to develop methodologies and analytical tools to assess the economic, social and environmental effects of improved quantitative and qualitative information delivered by the Global Earth Observation System of Systems (GEOSS) for the nine benefit areas of GEO. Global earth observation systems have considerably increased mankind’s capability to understand the physical world which surrounds us. New information technology allows us to shape the future of global society. GEOSS appears as a promising means to measure and to contribute to managing risks arising in the nine benefit areas, altogether avoiding it at times. Our understanding of human preferences through the study of behavioural psychology and economics has also helped us understand ways in which citizens perceive risk and manage it in their lives and provide normative guidance on increasing the effectiveness and efficiency of management. Yet the increasing complexity of modern life is going to require new – and different - ways to share burdens of managing risks ex ante nationally and internationally. GEO information will be crucial in accompanying this process by providing direct and indirect utility in terms of improved understanding of processes and better planning. Likewise the efficiency and effectiveness of ad hoc intervention measures adapting to global risks associated with the nine benefit areas can considerably be enhanced based on more knowledge and on-line supporting data.

Scientists and practitioners around the globe are searching for options to perfect management systems in the nine benefit areas identified by GEO. Both in the EU as well as internationally there is a shortage of analytical tools to quantify reliably and in an integrated manner economic, social and environmental effects of GEOSS. Therefore, the impact of this project on both long- and short-term planning of Earth system policies can be considered substantial. It is thus the prime objective of the proposed research to develop an operational cluster of models to support the international policy processes associated with the nine benefit areas. The application and the development of the models should directly lead to robust policy conclusions pertinent to measures, in particular their implementation schedule, in the affected economic and social sectors vis-à-vis measures taken to improve earth system management based on an improved GEOSS.

The ***overall objective*** is **to develop analytical tools to assess in a geographically explicit fashion the economic, social and environmental benefits of improved information provided in the context of GEOSS in the short and long-term in a transparent and consistent way.** This should support the formulation and implementation of policies and measures associated with the further development of GEOSS in a way that maximizes its benefit to society, including by assisting in the implementation of international commitments, such as the Millennium Development Goals.

In order to achieve the operational goals of the objective the following means have to be considered. A comprehensive and consistent benefit assessment has to be built on a solid scientific concept embracing appropriate **knowledge** and independent observations from **in situ studies/measurements** and **high quality auxiliary spatial data**. System and data integrity is an important requirement, together with the efficient application of data such as **Geographic Information System (GIS)** data related to topography, soil, vegetation, land-use, land cover, forest inventory, region boundaries, other land and landscape information all the way to spatially explicit socio-economic data, which are currently in development. By making extensive use of spatial data we hope to be able to reap the benefits from the huge investment on the part of the GEO partner systems and networks in the collection of consistent spatial explicit data. The subsequent and parallel steps to massive database work is the construction of consistent **baselines** for all spatial units in order to provide a solid basis for assessment of additionality in GEO-benefits in both environmental and financial terms. A **comprehensive inventory of benefit enhancement option** shall be built applying a value of information analysis approach based on the achievements of the **GEO 10 year Implementation Plan**. Each benefit enhancement option based on improved GEOSS will be appraised according to its relative "competitiveness" using a wide variety of tailored models and environmental management criteria that are created in a number of different international agreements. After the application of benefit enhancement algorithms to each geographic unit and sub-benefit area **"benefit landscapes" (direct impacts)** are computed that are visualised by means of GIS. These landscapes will be scrutinized by a user community that will have access to benefit landscape information and tested with real data in a **validation phase**. In addition to direct benefit impact assessment we will also provide integrated assessment **on a sector level and macro-economic/societal level** taking into account indirect effects such as market feedbacks. The assessment of direct GEO benefits and indirect effects on the sector or macro-level will be performed in a specially targeted **scenario package** that will be integrated with a number of existing energy scenario models and integrated assessment models mostly in connection to the work performed in the IPCC and the Millennium Ecosystem Assessment.

The project will conclude with a **Summary for Policy Makers type of report** explaining the scientific concept, technological requirements, simulation results and implications for policy making of the most crucial issues.

The main objective for the first 12 months of the project was to lay the general framework for benefit assessment within GEO-BENE. This assessment framework assures a maximum of consistency in the subsequent work in the individual work packages, especially the analytical approach for benefit assessments across the nine benefit areas of GEOSS. A corollary objective was to develop and test-case a number of different assessment methodologies ranging from systems dynamics modelling, sector specific partial equilibrium modelling all the way to modify and apply methods from modern finance theory.

In the second year focus will be directed on carrying out concrete quantification of **GEO benefits by carrying out detailed quantification studies within each SBA (see table 1)** using the methodologies and assessment tools which were developed and are described by in D1.

These proposed studies are so called **"rifle-studies"** (the "rifle-pathway" is described in detail in the *GEO-BENE Deliverable D3 "Benefit Assessment Framework Report")* which are special selected by GEO-BENE partners. The identified and proposed studies are listed in chapter 2 of this report in more detail.

Benefit Area	**Number of Studies**	**Consortium Partners involved**
Health	4	IIASA, PIK, KTL, others…
Disasters	15	IIASA, KTL, UNIBA, CSIR, others…
Energy	7	IIASA, FELIS, BOKU, others…
Climate	4	IIASA, PIK, others…
Water	4	IVM, EAWAG, CSIR, KTL, others…
Weather	As cross-benefit area	All, others…
Ecosystems	4	IIASA, IVM, PIK, others…
Biodiversity	4	CSIR, IVM, others…
Agriculture	4	IIASA, BOKU, EAWAG, SSCRI, NIES, IFPRI, others…
Cross-sectoral	2	IIASA, IVM, FELIS, others…
Total	48	All consortium partners

Table 1: showing the number of "rifle-studies" by benefit area to be carried out within the GEO-BENE framework and indicates the consortium partner involved.

The Benefit Assessment Framework shall assure internal consistency of benefit analysis projects which are at this stage either finished, ongoing or planned in the individual work packages of the GEO-BENE project as well as provides a framework on compiling information from the existing literature and other sources. The benefit assessment framework has also been designed to feed directly the final GEO-BENE report which will be of a similar form as the Stern Report on the Climate Change Challenge. It has to be noticed that this document outlines only the framework of analysis. It is understood that the heterogeneity of issues and methodological challenges with the analysis of each sub-socio-economic benefit area are much larger to be covered in one framework. Thus, the framework provides guidelines and provides a roadmap for individual analysis and the integration and aggregation steps.

The established GEO-BENE web site: http://www.geo-bene.eu (Deliverable D2) is seen and used as a key tool for the project. The interactive design allows for multi-directional coordination and scientific work on the individual studies and parts of the project.

3 Major Achievements During Year I

3.1 The project's current relation to the state-of-the-art

There is little readily-available literature on the quantitative assessment of either the benefits or the costs related to Earth Observation. This is true both for big, concerted efforts such as satellite missions, but also for in-situ networks such as weather stations or river hydrographs. It is especially true for determining the incremental costs of the information dissemination systems that follow downstream of data acquisition platform. The costs of satellite missions are usually incomplete (for ENVISAT only the full program costs are given, 2.3 billion Euro or entirely missing (e.g. Landsat 5, The Satellite Encyclopedia) or insufficiently itemized to be able to understand their incremental components. In addition, it is difficult to assess the incremental costs of GEOSS since cost estimates regarding the existing ''in situ' data collection systems are often missing. For example, in Europe, investment costs are largely unknown due to the fragmented ownership and funding structure of the European Union, each sponsoring organization only reporting their own contribution to the common budget (Höller and Banko, 2007). Even within a single country, there are often several agencies collecting essentially the same data – for example, in South Africa, rainfall data are collected by the SA Weather Service, the National Department of Agriculture and the Department of Water Affairs and Forestry, not to mention hundreds of private individuals and corporations and other state agencies.

Recent studies have started to look at the benefits of Earth Observation. For example, two studies have been conducted by Pricewaterhouse Coopers (PWC) on contract to the European Space Agency (ESA). The first was to support the development of a business plan for the GALILEO programme (Pricewaterhouse Coopers, 2001). The second was a benefit assessment of the Global Monitoring for Environment and Security (GMES) programme (Pricewaterhouse Coopers, 2006). Whereas the study on GALILEO did not consider benefits in the context of GEOSS, the GMES study explicitly investigates the impact of an existing and functional GMES system versus the non-existence of such a system (termed the 'without GMES scenario'), and notes that GMES is the European contribution to GEOSS. This study is the only current extensive study which tries to assess the benefit of the European part of GEOSS. The PWC study undertakes a strategic as well as a quantitative analysis. The strategic analysis is looks at strategic benefits in order to determine what GMES as a strategic and political investment is trying to achieve. In a second, so-called ‘bottom up’ study, which encompasses a quantitative as well as a quantitative assessment, the macro-economic benefits and economic efficiency savings are assessed, largely through stakeholder consultation.

The PWC study points out that placing a monetary value on all the potential impacts of GMES is difficult, since monetary estimates of the non-market benefits of GEO information often do not exist. In addition, the relationship between the availability of information and the potential welfare impacts is not always clear. Hence, the PWC study decided to make use of expert consultation to estimate what the value of information is expected to be. A large group of experts was asked to prioritize benefit areas and to assess what the most important benefits of GMES were expected to be. The advantage of using expert consultation is that is a relatively fast way to get an indication of the range of expected benefits. The disadvantage is that outcomes strongly depend on the experts consulted and that the attribution of benefits usually remains unknown. It is crucial that expert consultation studies are transparent about the experts consulted and the range of answers provided (Morgan et al. 2001), because otherwise outcomes are likely to be biased and not representative of what the value of GEO information is likely to be. In fact, the PWC study was criticized for not taking all benefit areas equally into account (GMES bureau, personal communication). Furthermore, the study used a statistical value of life defined by Frankhauser (1995). This value is different in developing countries and developed countries: an approach that has been criticized as being morally indefensible (Fearnside, 1998). Also, the PWC study only presents the average estimates, largely ignoring the range of estimates and the uncertainties involved. It does not provide insight into the incremental benefits that various alternate Earth Observation investments could have, nor the relative importance of improved EO information for the wider value chain.

Another benefit assessment of GEOSS based on expert opinion has been carried out by the Environmental Protection Agency (EPA) of the US. The EPA created an interactive US map separated by states that allows the user to view a fact sheet on the benefits of GEOSS for each state. The fact sheet for each state contains information of an expert consultation mainly covering the disaster benefit area, looking at tornadoes, hurricanes, floods, earthquakes and droughts. Moreover, depending on the state areas such as health (e.g. air quality, harmful aquatic blooms) and ecosystems (e.g. reduction of erosion, pollution in watersheds, fish stocks) are also covered. Some of the global issues like tracking global change are also mentioned in some states, though there is a certain inconsistency as these phenomena do not just occur in those states and are not mentioned in all the states fact sheets.

Alongside the expert consultation based studies mentioned, a number of studies illustrate the potential benefit which could be gained from an improved weather forecast system: with respect to mitigating natural hazards (Williamson et al., 2002); increasing crop yield (Adams et al, 1995), food trading (Bradford and Kelejian, 1977) or road safety (Adams et al., 2001). These studies attempt to measure the value of improved weather information in absolute terms. They show that by simulation modeling can provide insight into the relationship between improved weather information and the resultant economic gain. Moreover, other research has attempted to use alternative approach to the usual cost avoidance approach. The contingent valuation approach is undertaken also by incorporating the commercial sector in the study, such as landscape/ business, TV and film, recreation and sports, agriculture, hotel and catering, and institutions such as sports and hospitals.

The theory on the ‘Value of Information’ (VOI) has been developed by economists working in fields as diverse as stock market trading and manufacturing (see for example Nordhaus 1986, etc.) A working paper by Macaulay attempts to apply the ‘Value of information’ theory to show how space-based Earth Observations can improve natural resource management. This study finds that the value of space-derived data depends largely on four factors: 1) how uncertain decision makers are; 2) what is at stake as an outcome of their decisions; 3) how much will it cost to use the information to make decisions; and 4) what is the price of the next best substitute for the information. Macauley (2005) describes three ways in which value of information can be measured. In the first group the value of information is measured by gains in output or productivity. In the second group the value of information in inferred under the hypothesis that it is capitalized into the prices of goods and services (‘hedonic pricing’). The third group tries to estimate the value of improved information based on the ‘willingness-to-pay concept’ (‘contingent valuation). Macauley however does not clarify how welfare impacts can be attributed to the availability of information and to how the incremental costs and benefits of information might be assessed.

3.2 Objectives for year I

The main objective for the first year of GEO-BENE was to lay the general framework for benefit assessment within GEO-BENE. This assessment framework assures a maximum of consistency in the subsequent work in the individual work packages, especially the analytical approach for benefit assessments across the nine benefit areas of GEOSS. A corollary objective was to develop and test-case a number of different assessment methodologies ranging from systems dynamics modelling, sector specific partial equilibrium modelling all the way to modify and apply methods from modern finance theory.

4 Work performed during year I

During this first year of GEO-BENE (July 2006 to end of June 2007, T1-T12) there were 3 deliverables produced (D1, D2, D3) by the consortium and delivered to Brussels according to the Detailed Workplan (D1). The GEO-BENE deliverables are presenting the research work performed until that stage and in parallel they also serve as a layout for the project's next steps.

4.1 GEO-BENE Deliverable (D1)

By the end of *T8 the first (D1) Deliverable "Detailed Project Workplan"* was due. In accordance with EC in Brussels D1 has been delivered together with D3. The purpose of this deliverable is to augment the description of work document as a supplementary document for detailed planning within the consortium. D1 describes concrete projects and tasks within the GEO-BENE consortium putting special emphasis on the second periodic reporting period. While the first year of GEO-BENE concentrated on the development of methodologies, analytical tools and data compilations suitable to analyse GEO benefits, the second year will be dedicated to concrete applications, and finally the third year will be used to concentrate on integration and aggregation. The framework provided by D1 was developed in order to be dynamically up-dated all the way to the end of the project. Up-dating includes the formulation of new projects and task as well as reporting of final results by up-loading complete papers. It is the intention to write papers for each project which are suitable for submission to peer reviewed journals. These papers will be up-loaded on the GEO-BENE website and be made available to a restricted audience until the paper is accepted for publication.

D1 is delivered in a web-based form in order allow for more transparency and timeliness. To date the GEO-BENE website contains already information (incl. draft papers) on the methodologies and analytical tools which were developed in order to assess the **economic, social and environmental effects of improved quantitative and qualitative information delivered by the Global Earth Observation System of Systems (GEOSS)** for the nine benefit areas of GEO.

Material contained in D1 comprises of inter alia:

1. Theoretical models illustrating general assessment strategies and uncertainty assessments for comprehensive benefit accounting of GEO benefits in economic, social and environmental terms at the grid (polygon) and aggregate levels using a systematic approach;
2. Elaboration of direct linkages between biophysical models and socio-economic valuation models bridging to full benefit chain of GEOs;
3. Setting up a number of tools for benefit assessments, based on a range of different quantitative and qualitative methods for benefit assessments, developing and applying value of information modelling approaches
4. Synergetic use of all relevant sources of information, to be used in a multitude of competing assessment models, with geographically explicit land information as a nucleus of the approach;

5. Design of the structure of an integrated information system directed towards ecological and environmental assessment under global change, which would meet requirements of international conventions and policy processes.

In order to achieve the operational goals of the overall objective of GEO-BENE and tackle the critical issues the following means have to be considered:

D1 contains information on template type models which were developed during the first year of the GEO-BENE project. Emphasis was put on the investigation of appropriate scientific methodologies as the foundation for the upcoming year. In the second year focus will be directed on carrying out concrete quantification of GEO benefits by carrying out detailed quantification studies within each SBA (see table 1) using the methodologies and assessment tools which were developed and are described by in D1.

These proposed studies are so called **"rifle-studies"** (the "rifle-pathway" is described in detail in the *GEO-BENE Deliverable D3 "Benefit Assessment Framework Report")* which are special selected by GEO-BENE partners. The identified and proposed studies are listed in chapter 2 of this report in more detail.

Benefit Area	**Number of Studies**	**Consortium Partners involved**
Health	4	IIASA, PIK, KTL, others…
Disasters	15	IIASA, KTL, UNIBA, CSIR, others…
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Climate	4	IIASA, PIK, others…
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Weather	As cross-benefit area	All, others…
Ecosystems	4	IIASA, IVM, PIK, others…
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Table 1: showing the number of "rifle-studies" by benefit area to be carried out within the GEO-BENE framework and indicates the consortium partner involved.

The **aim of the Web-based rifle study** representation is primarily coordination among the GEO-BENE consortium partners and subsequently to identify possibly gaps. Gaps relate to incomplete coverage of SBAs, partial benefit quantification within an assessment study, or incompleteness due to the selection of the scientific tool which can only cover a part of all potential benefits. In a subsequent step these gaps, once identified, will be filled accordingly in the third year of GEO-BENE. For these gap-filling tasks respective rifle-studies will be formulated. Gaps and uncertainties adjoined to the detailed benefit quantification cannot be identified and defined ex-ante. The gap identification and investigation of "missing" benefits will continuously be performed during the course of the GEO-BENE project. The search for new rifle studies will be guided by identifying points of incidence with maximum leverage in terms of GEO benefits.

Taking "flooding" as an example, respective rifle studies will help identifying whether the best benefits can be identified with respect to GEO improved prevention, or e.g. in the establishment of a GEO improved early flooding warning system enabled by better planning with the help of higher resolution digital elevation models, or if the optimal benefit might be reached by a better detection and prioritization of measures in the recovery phase of the disaster cycle. Hence, carrying out the rifle studies is seen as a **screening for the maximum benefit**, going along with a consequent filling of the gaps identified during the screening phase.

Although aggregation and integration are the prime tasks for the third year, some of the defined projects (rifle-studies) are already directed at integration and aggregation. However, the dynamic properties of the sub-systems have to be studied in more details. One typical question with respect to the open questions would be on how to aggregate exogenous and endogenous risks, where the latter are a function of GEOSS.

4.2 GEO-BENE Deliverable (D2)

Deliverable (D2) "Web Page" (T6) is no report by its nature according to the deliverable plan of the GEO-BENE project. The inter-active GEO-BENE Web Page (http://www.geo-bene.eu) has been successfully launched at the GEO-BENE Progress Meeting (4-6 June 2006).

All "rifle studies" (see Deliverable 1) are based on the GEO-BENE web page under the section "GEO-BENE benefit assessment database" which are restricted in use for consortium partners only. This will enable the partners and the coordinator to steadily update, report and check on the current state of the respective study. Finished "rifle studies" will be uploaded as a pdf-file to the web page in order to disseminate the results to the consortium partners and possibly to a wider audience. By these means it is also planned that successively new projects will be identified by a wider user community which can then be added to the web-based data collection.

This web-based planning process will be used over all phases of the GEO-BENE project and will function as a direct communication tool between the partners in order to inform about the different activities and progress status of the individual studies and assessment tasks.

The web-based planning process aimes at a "cross-fertilization" between the single partners and user groups. This is seen as essential when dealing with a highly complex project such as GEO-BENE.

Additionally, web-blogs and discussion fora for the different sub-groups (e.g. GEO-BENE geo data info group) are hosted online in order to enhance the exchange of ideas and strengthen the communication by complementary communication tools such as telephone and video conferences.

4.3 GEO-BENE Deliverable (D3)

The Deliverable (D3) "Benefit Assessment Framework Report" (T8) has been delivered to Brussels as a product of the GEO-BENE Progress Meeting (4-6 June 2006) together with the Deliverables D2 and D3.

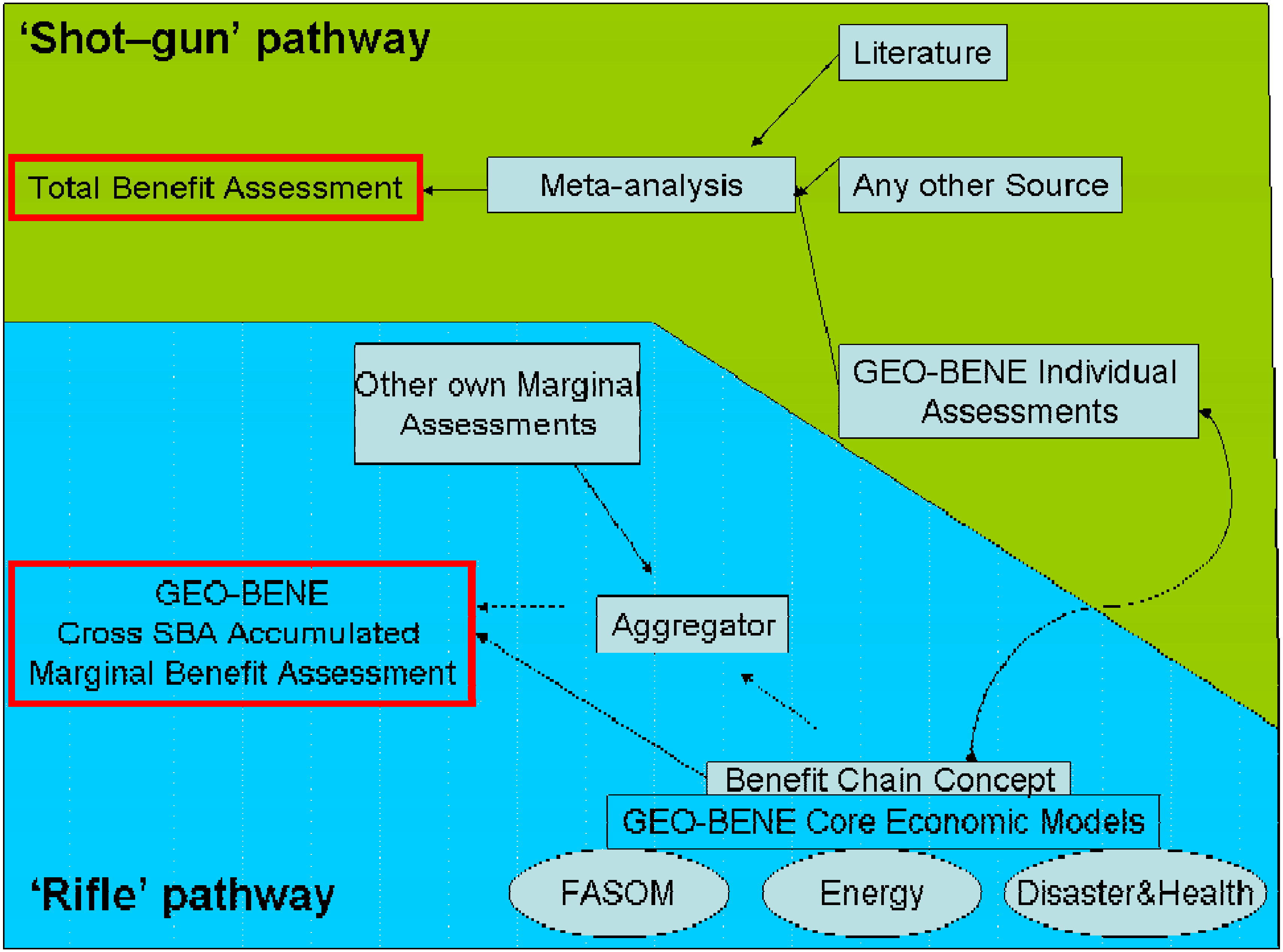
The main goal of this deliverable is to lay out the general framework for benefit assessment within GEO_BENE. The framework shall assure internal consistency of benefit analysis projects which are at this stage either finished, ongoing or planned in the individual work packages of the GEO-BENE project as well as provides a framework on compiling information from the existing literature and other sources. The benefit assessment framework has also been designed to feed directly the final GEO-BENE report which will be of a similar form as the Stern Report on the Climate Change Challenge. It has to be noticed that this document outlines only the framework of analysis. It is understood that the heterogeneity of issues and methodological challenges with the analysis of each sub-socio-economic benefit area are much larger to be covered in one framework. Thus, the framework provides guidelines and provides a roadmap for individual analysis and the integration and aggregation steps.

On the GEO-BENE Progress Meeting GEO-BENE partners agreed to a two tired benefit assessment framework (see Figure 1). Tire 1 called Shot-gun Pathway is based on meta-analysis of already existing assessments published in the peer reviewed and grey literature or from other sources as well as own GEO-BENE assessments. Tire 2 will solely be based on own assessment using GEO-BENE resources aiming at going beyond the assessment of point estimates and ranges of benefits by exploring changes in benefits at the margin and cross margins. Tire 2 type analyses we coined Rifle Pathway.

The final result of Shot-gun pathway type of analysis is the total benefit assessment. In its simplest form the result of total benefit assessment is number and its range in Billions of Euros summing the most credible assessments of GEO benefits net of double accounting (due to multiple reporting in various benefit areas). The aim, however, is that more indicators shall be used such lives saved or changes in biodiversity indices. However, at this stage no final comprehensive list of indicators was developed, although some case studies do compute alternative indicators.

The expected result from Rifle Pathway analysis is a detailed description of the 'in-house' GEO-BENE Marginal Benefit Assessment. Marginal Benefit Assessment refers to exploring the incremental improvement of benefits due to incremental addition of observing capital. It is felt that this additional work will help to mitigate the arbitrariness of baseline setting and provide good information to decision makers based on additional information. This additional information relates to questions of whether in particular SBA marginal returns are expected to be decreasing, i.e. saturation of observing capabilities to solve a particular societal problem, or be of any other shape. The shapes of these marginal benefit schedules will have strong policy implications. The methodology which GEO-BENE has devised will also have substantial potential to be applied for real investment decisions for concrete new missions.

Figure 1: Overview of the two GEO-BENE assessment pathways


'Shot–gun' pathway
Literature
Total Benefit Assessment
Meta-analysis
Any other Source
Other own Marginal Assessments
GEO-BENE Individual Assessments
GEO-BENE
Cross SBA Accumulated
Marginal Benefit Assessment
Aggregator
Benefit Chain Concept
GEO-BENE Core Economic Models
'Rifle' pathway
FASOM
Energy
Disaster&Health

The GEOSS process is going to bring improvements in EO which will consequently affect different benefit areas. These improvements can occur in a number of different ways. The improvement can be achieved though technical improvements in the field of satellite observations as well as in-situ measurements. In the field of satellite observations technical improvements such as an increased spatial resolution, an increased temporal resolution or a higher number of spectral bands can be realized. Improved, better interconnected sensors and a denser sin-situ observation network will bring further improvements. On the other hand better and more sophisticated models (e.g. global CGMs) are being developed and continuously improved. The particular emphasis of GEOSS is to foster international collaboration, international standards defined by the Open Geospatial Consortium (OGC). Furthermore, it is the task of GEOSS to identify current data gaps, to encourage model comparison and to contribute to the long term continuous earth observation. Within the Geo-Bene project these different aspects are examined in more detail.

Recommendations given by the Benefit Chain Concept Break-out group to the Geo-bene partners based on the value chain of the observing system

Recommendation 1

- GEOBENE should adopt a shared conceptual model based on marginal cost-benefit analysis
  - All projects need to at least qualitatively describe the pathway by which the increase in information leads to welfare benefit
  - Some projects [a systematically selected set] should attempt to quantify the entire chain [including the cost side], using a range of methodologies
    - System analysis/modeling/optimization
    - Stakeholder survey/expert opinion
    - Meta-analysis
    - Decision theory, value of information
    - Find out if there are any other key approaches?
  - A conceptual paper [and a set of operational rules for participants] must be prepared

Recommendation 2

- The ‘topology’ of the benefit-effort and the cost-effort curves in the vicinity of the current state are often as useful for policy purposes as actual valuations
  - Will more investment yield *diminishing* net returns or *increasing* returns?
  - This can be done by asking the right ‘expert’ questions, and should be possible even in cases where valuation is impossible

Recommendation 3

- All SBA’s and case studies need to ask the question ‘how will *globalization* of this information lead to greater net benefits?’
  - Local or regional case studies are useful, but they must explicitly address the issue of how they are relevant to GEOSS principles

- How do you upscale them?
- To what extent do they depend on global information?

Recommendation 4

- All studies should undertake some form of sensitivity analysis to help understand in which variables (or which parts of the world) better observations lead to the greatest improvements of welfare [or in accuracy of information for decision-making, as a proxy]
- A ‘technology maturity’ approach may give insights into the investment strategy between SBA’s
  - Where is the learning curve steepest?

The benefit assessment framework has been set up to also deliver the most relevant results and data for the final report of GEO-BENE. The GEO-BENE final report has the aim to be policy relevant and be used for a wider policy community. Currently the benefit assessment framework both for the rifle and on the shot-gun pathway are by design strongly science driven. The communication of the results in relation to the complexities, ambivalences and the many other problems associated with the analysis will require a good strategy and additional thinking. An elaborated communication strategy has not yet been developed and will only be produced in the second half of the project. In order to be directly useful for a wider non-science and non-economic audience a number of simplifications will necessarily have to be performed. As a first step we have outlined the structure of the GEO-BENE report, which is modelled after the Stern Report on Climate Change. It is planned in Part I of the report to present the overall original framework and its simplifications for the report as well as a description of the associated problems with the presentation in a somewhat intellectual disclaimer manner.

Part II and III will present the final results of GEO-BENE first in an integrated manner and then separated by SBA. Special emphasis will be given to the integration externalities such as economies of scope produced by the GEO initiative. Part III follows the framework of the 10 Year implementation Plan. Part IV will focus on the potential policy responses for GEO in a generic manner to provide a strategic view on the issues. To write this part GEO-BENE will organize a series of small workshops – first within the consortium and then with a number of interested stakeholders from the GEO network. Finally Part V will provide the information on the signposts and economic instruments that shall be conduce to convert GEO from a club good to a truly global public good in order to finally materialize on the full potential of global socio-economic benefits.

It is envisaged that the first draft of the final report will be available by the end of 2007 in order to have a basis for additional outside partners and other stakeholders for collaboration and possible joint ownership.

5 Model Cluster Used Within GEO-BENE

The following list of Models should give and overview on the individual models used in an integrated model cluster for GEO-BENE. The model list indicates the objective of each model of the 15 models and is focusing at the key parameters such as input- and output parameters, scope, resolution, and the general modeling process.

Figure 2 below gives a first glance-overview on the models used within the GEO-BENE approach and indicates their interactions.

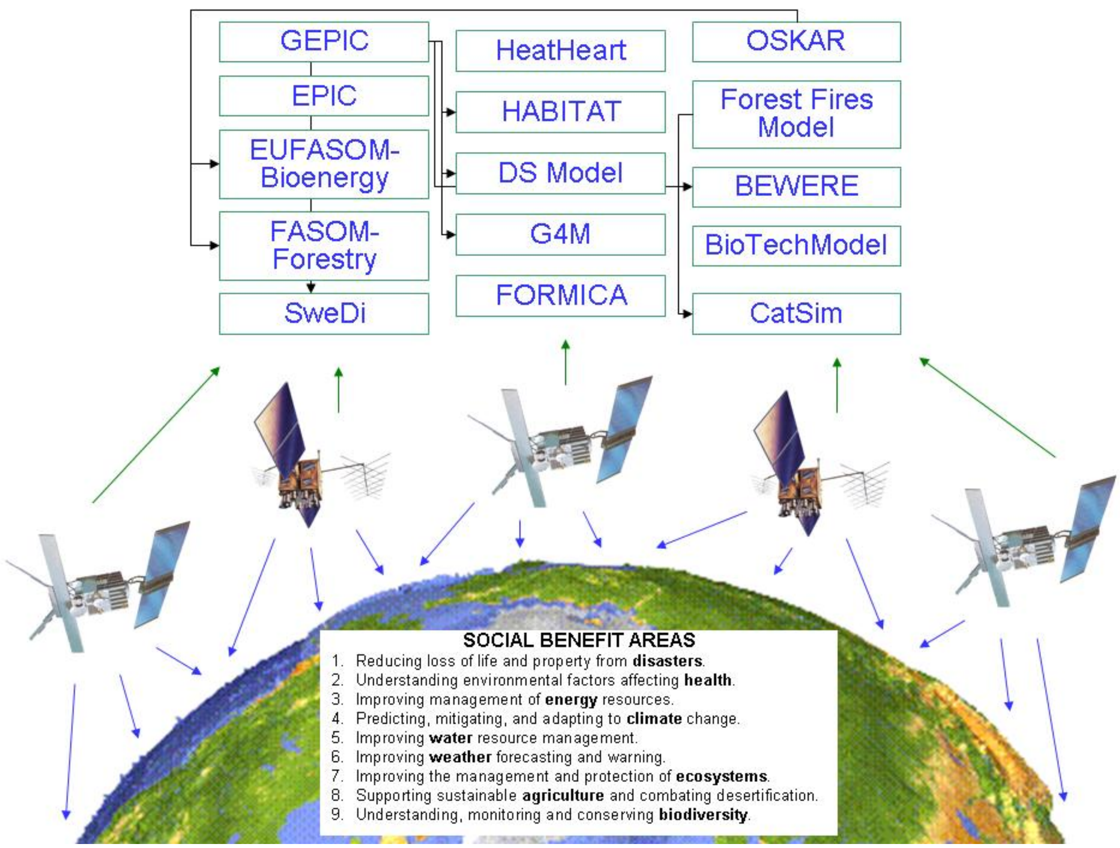


Figure 2: GEO-BENE Model Cluster and Interactions between the individual models

	EPIC (Erwin Schmid, BOKU)	GEPIC (Junguo Liu, EAWAG)	EUFASOM-Bioenergy (Ivie Ramos, UHH)	FASOM-Forestry (Petr Havlik, IIASA)	SWeDi Model (Christine Schleupner, UHH)	HABITAT (Kerstin Janrke, UHH)	DS Model (Petr Havlik, IIASA)
	General focus	General focus				General focus	
scope	simulation of spatially and temporally explicit bio-physical impacts (e.g. crop yields, nutrient fate, carbon sequestration, sediment transport) of observed and alternative land use and management systems at regional and global scale.	Simulation of the spatial and temporal dynamics of the major processes of the soil-crop-atmosphere-management system	Long term assessment of the economic, technical and environmental potentials of energy crops in Europe under different market and environmental conditions and policies.	Evaluation of welfare and market impacts • of alternative policies for carbon sequestration • by forestry and agricultural land use in a long-term prospective.	Location of potential existing wetland distribution and spatial modeling of most suitable potential sites for wetland (re-)creation.	Estimation of habitat requirements for viable populations of European animal species under cost or area minimization objectives	Commercial biomass production (forestry, agriculture, bioenergy) and trade equilibrium in terms of prices, quantities and cultivated areas
resolution	spatial: Homogeneous Response Units (HRU) and Individual Simulation Units (ISU) that delineate representative weather-soil-topography-management systems at regional and global scales. temporal: daily time steps over hundreds of years if necessary.	Spatial: user-defined spatial resolution (flexible) Time: up to hundreds of years	Spatial: nuts 0 (EU-FASOM), Regional Time: 5-year periods, 150 years or even more	Spatial: nuts 0 (EU-FASOM), Continental regions (GLOBAL FASOM) Time: 5 years periods, 150 years or even more	Spatial, geographically explicit: EU-25, 1 ha / 1 km²	Spatial: EU 25; 50 km x 50 km grid cells Time: static, 1 period	Spatial: 11 GGI regions Time: Static model – 1 period

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processes included	• crop growth • hydrology • weather simulation • nutrient cycling (NPKC) • pesticide fate • erosion	• Crop growth • Hydrology • Weather • Climate change • Nutrient cycling • Erosion	• Different uses of a given biomass options are investigated to indicate the optimal way of utilizing the biomass resource and determine the impacts of bioenergy production. • Social welfare, bioenergy and emission offsets maximization	Social welfare maximization by region: consumers maximize their utility and producers maximize their profits -> social welfare (discounted sum of consumer and producer surpluses less the transportation costs resulting from trade with the other regions) restricted by resources, capacity, budget and barriers of trade. Land is transferred in the model between sectors/type of land-use according to its marginal profitability in all alternative forest and agricultural uses included in the model, over the time horizon of the model. Harvesting decisions are endogenous Trade is included endogenously in the model, so that (net) export/import takes place whenever it is profitable	GIS-based model relying on geographical data of: • land cover • soil • DEM • potential natural vegetation • biogeoregions • climate	Cost or area minimization for biodiversity conservation. Ecological constraints reflect representation targets, area requirements for viable populations and habitat type requirements for all considered animal species. Independent (individual species, country-wise, taxon-wise) and joint conservation efforts can be addressed. Opportunity costs can be treated endogenously or exogenously.	Social welfare maximization: consumers maximize their utility and producers maximize their profits restricted by resources. Land is transferred in the model between sectors/type of land-use according to its marginal profitability in all alternative forest and agricultural uses included in the model. Trade is included endogenously in the model.
	Input	Input				Input	

	EPIC (Erwin Schmid, BOKU)	GEPIC (Junguo Liu, EAWAG)	EUFASOM-Bioenergy (Ivie Ramos, UHH)	FASOM-Forestry (Petr Havlik, IIASA)	SWeDi Model (Christine Schleupner, UHH)	HABITAT (Kerstin Janrke, UHH)	DS Model (Petr Havlik, IIASA)
Parameters and initialization	• regional and global weather/climate change data (statistics) • regional and global soil data • regional and global land use data and representative crop rotations • regional and global topography data • regional and global crop management data (e.g. fertilization, irrigation, tillage)	• Historical daily climate data • Monthly statistical climate data • Land use • Soil parameters • Irrigation • Fertilizer application • Elevation • Future climate scenarios • Others	• Resource endowments, initial land use, production and processing technologies • Production data (planting, fertilizing, harvesting, transportation and delivery to the manufacturing plant from the farm gate) • Crop management options (tillage, irrigation, soil type, altitude and slope) and energy use (fuel consumption and mechanization) • Processing data (electricity, heat, biofuels) • Production and processing costs (labour, electricity, fossil fuel, chemicals, etc.) • Input from many models and data bases (EPIC, New Cronos, FAOstat, etc.)	• shape of the economic growth in each region (driving the demand for final forest products) • production costs (labour, electricity, fossil fuel, chemicals, etc.) • foreign exchange rates • future forest growth changes due to climate change • initial land use, production technologies and production structure/capacity for the land-use and forest industries in each region • initial and potential forest structure (land area, growing stock) • input from many models and data bases (OSKAR, EPIC, GTM, New Cronos, FAOstat…and many others)	• land cover: peatland, forests, grassland, agricultural land • wet and peaty soils • elevation • slope • average annual precipitation • mean temperature of coldest month • mean temperature of warmest month	• presence data of animal species for 2016 grid cells covering the European Union • cell areas; spatial arrangement of cells • population densities of species • proxies for minimum viable population sizes • required and optional habitat types • opportunity costs	• Baseline prices and quantities of considered products • Supply and demand elasticities • Ressource requirements (land, water,…) • Production cost • Transformation cost • Transport cost • Conversion coefficients from primary to final products • Initial land use

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	Output	Output				Output	
Variables	• crop yields • hydrology (PET, runoff, percolation) • sediment transport • N-leaching • green house gases • soil carbon sequestrations	• Crop yield • Crop water use • Potential crop yield • Nutrient cycle • Erosion • Hydrological cycle in cropland	• Prices and harvested quantities of energy crops for each period and country • Different land use options (willow, miscanthus, switchgrass, RCG, etc) • Different end product technologies (electricity, heat, biofuels, biomaterials, etc) • GHG emissions • Scenarios for different product, energy and carbon prices	• prices and harvested quantities (for each period and region) for the agricultural products, for timber (wood fibre), for forest products, and for recycled papers • type of land utilization, land transfer between agriculture and forestry, investments in agriculture and forestry primary production, new forest industry production capacities. • transport quantities from/to each region and total use per 5-year period of production inputs (labor, electricity, bio-energy, fossil fuel) for each region • GHG emissions • forest-, agricultural and bio-energy sector are modeled	• spatial explicit location and size of different wetland types → peatland: fens and bogs → wetforests: alluvial and swamp forests → wetgrasslands on non-peaty soil (reeds and sedges) • connectivity between wetland types • quality of the neighborhood of different wetlands	Area requirement • per cell • per country • per habitat type • Yearly opportunity costs per country	• supply and demand quantities • equilibrium prices • volumes traded between the regions • land use change • water consumption
	Current status	Current status	Current status			Current status	

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	delineation of homogeneous response units (HRU) at global scale developing and testing a prototype of the global data-modeling infrastructure for Europe building the global database (weather, soil, topography, crop management) for global EPIC simulations at HRU scale	Modeling of crop yield and crop water productivity for major crops on a global scale Modeling consumptive water use of 17 major crops on a global scale Simulating the role of irrigation in wheat production in China	Projections for the economic, technical and emission offset potentials (present to future) for willow in Sweden included.		Wetland distribution modeling is completed. Suitability Assessment is under construction.	69 animal species and 5 wetland habitat types included Modeling of area and constant cost minimization scenarios for the EU 25	Forestry and crop production including irrigation – near to validation Bioenergy and livestock sectors in progress
	Potential extensions, future plans?	Potential extensions, future plans?	Potential extensions, future plans?			Potential extensions, future plans?	
	linking with Global- FASOM and BEWHERE by providing spatially and temporally explicit bio-physical impact vectors. analyze the bio-physical impacts of alternative agricultural management systems (e.g. tillage systems, precision farming, etc.). simulation of climate change impacts using a statistical approach.	• Study the impacts of climate change on crop production and consumptive water use • Study global nutrient cycle • Produce potential crops yields for BEWHERE	• Incorporate the effect of changing the plant size on the carbon emissions/savings • Include other energy crops • Include other conversion technologies • Can be integrated in higher scope models including multi-sector energy models, and/or earth system models	• calibration (forest) • including of water • bio-energy (including bio-fuels) • data mining for global FASOM • any many more features	• integrate results into EU-FASOM • integrate results into Habitat Model • include Climate Change parameter for bogs • apply spatial model to other biotopes	• Implementation of existing habitat and convertible sites • Interlinkage to EU-FASOM	• Supply curves derived on the basis of biophysical models like G4M and EPIC • Alternative forest, crop, livestock managements • Introduction of environmental parameters like GHG emissions and food security parameters • Improved spatial resolution based on “homogeneous response units”
	Potential contribution to IIASA projects	Potential contribution to IIASA projects				Potential contribution to IIASA projects	

	EPIC (Erwin Schmid, BOKU)	GEPIC (Junguo Liu, EAWAG)	EUFASOM-Bioenergy (Ivie Ramos, UHH)	FASOM-Forestry (Petr Havlik, IIASA)	SWeDi Model (Christine Schleupner, UHH)	HABITAT (Kerstin Janrke, UHH)	DS Model (Petr Havlik, IIASA)
	linkages to • Global FASOM • BEWHERE • improve, extend and validate the 'global database' • promote integrative analysis (i.e. bio-physical and economic analysis)	• Simulate crop yield and water use of major crops on a global scale (as inputs to other models) • Simulate the impacts of climate change on crop yield and crop water requirement • Produce potential crops yields for BEWHERE			•		• Global evaluation of economic potentials for forestry, agricultural and bioenery sectors production and their mutual competition including the environmental and food security impacts • Input to other models (BEWHERE, G4M) in terms of equilibrium production quantities and prices
	General evaluation	General evaluation				General evaluation	

	EPIC (Erwin Schmid, BOKU)	GEPIC (Junguo Liu, EAWAG)	EUFASOM-Bioenergy (Ivie Ramos, UHH)	FASOM-Forestry (Petr Havlik, IIASA)	SWeDi Model (Christine Schleupner, UHH)	HABITAT (Kerstin Janrke, UHH)	DS Model (Petr Havlik, IIASA)
strengths	• spatially and temporally explicit bio-physical impact vectors • simulation of a large set of alternative crop management options. • simulation of bio-physical processes • model flexibility and robustness	• Spatial explicit • Scope: global, national or local • Flexible resolution (but may limited to computing expense) • Powerful functions in food-water-environment-climate study • Widely validated	• Different types of land use and product options are included • Competition for land between agriculture, forestry, biodiversity, livestock and bioenergy are endogenously modeled • Biomass and bioenergy trade included • GHG emissions from various land use options and production/ processing activities are calculated	• incorporation of agriculture and forestry so that the competition for land between agriculture and forestry is endogenously modelled • biomass trade, this might prove important in many countries • track of the GHG emissions from the various land-use and production/consumpt ion activities included in the model. • is designed to work on the forest and/or agricultural sector either independently or simultaneously. (study sector issues either independently or across the two sectors)	• geographical explicit • high spatial resolution for existing wetlands • distinction of different wetland types • easily applicable and transformable to other applications	• Adaptable to different areas, habitats, and taxons • Based on ecological principles; not based on existing nature reserve system • Implicitly integrates many ecological constraints via historic occurrence data • Combination/comparison of cost and area minimization objectives • Linkage to land-use models possible (conservation as a further land-use option)	• Global scope • Comprehensive in terms of the principal land use sectors • Simple structure → tractable results

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weaknesses	• insufficient data to rigorously validate model outputs at global scale • large demands (quantitatively and qualitatively) on input data for EPIC • long modeling experiences	• Mainly focused on the natural, physical, and management factors, but insufficient on the economic aspects • Not possible to directly study the effects of food policies and agricultural research investment on crop production	• see FASOM-Forestry entry	• huge set of data input • perfect foresight • FASOM approach is working on 5-years time steps -> misleading agricultural results • FASOM is not fully operational yet. • FASOM is still not tested much in practice and programming bugs may exist (large EUFASOM versions contain 6 millions variables and more than 600 000 equations).	• uncertainties in source data • source data limit scale for potential convertible sites • underrepresentation of small running waters due to scale reasons	• Not based on existing reserve system • CPU intensive • Validation not done yet	• For the moment: very rough spatial resolution

	G4M (Georg Kindermann, IIASA)	FORMICA (Hannes Boettcher, IIASA)	OSKAR (Oskar Franklin, IIASA)	Forest Fires Model (Nikolay Khabarov, IIASA)	BEWHERE (Sylvain Leduc, IIASA)	BioTechModel (Barbara Hermann, IIASA)	CatSim (Stefan Hochrainer, Reinhard Mechler, IIASA - RAV)
				General focus		General focus	
scope	• Afforestation/Deforestation • Forest Biomass • Harvestable Wood	C budget model of managed forests and adjacent forestry sector	Estimation of biomass, dead wood, harvests and costs for different forestry scenarios (thinning, species, climate change) .	Evaluation of weather observations accuracy impact on • burned forest area • air patrolled area based on application of forest patrolling rules.	Calculation of the optimal location of bio-fuel (methanol) power plants, given the biomass distribution	Calculation of techno-economic characteristics and greenhouse gas emissions (and non-renewable energy) of bio-chemicals production	Calculation of financial vulnerability and macroeconomic risk due to natural disaster events
resolution	Spatial: Global 30’×30’ Time: 1 year	Spatial: not geographically explicit, adjustable, plot level to regional scale Time: 1 year	Spatial: not geographically explicit, adjustable, plot level to regional scale. Time: 1 year (flexible)	Spatial: regional, depending on the area covered by the underlying weather dataset Time: 1-5 years (non-predicting) The model uses internally daily resolution, and aggregates it into yearly descriptive statistics.	Spatial: Biomass and demand input 1km2, power plants: variable Time: as many periods as one wants (depending on the forecast data)	Spatial: not geographically explicit, Time: 2 time steps, current and future technology levels	National scale, NUTS3 Time: Usually 5 and 10 year time periods into the future

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processes included	Decision of afforestation or deforestation based on Net Present Value of forestry and alternative land use, Increment based on NPP	• Biomass, products, soil (YASSO), substitution • Forest growth species specific, derived from yield tables, transformed to relative growth curves • Standing volume from national forest inventories • Age class information from inventories • Forest Management (FM): different thinning regimes, harvest after prescribed schedule; sustainable forestry (annual allowable cut) • Simple economic model to calculate NPV • Calculation on plot level for different strata (age-class, species type, management), regional aggregation by multiplication with area of each stratum	Predicts growth, density, selfthinning and harvests in response to: • species • initial biomass • initial density (trees per ha) • productivity (from NPP model or inventory) • thinnings and changes in density (assigns an optimal thinning sequence for a specified % removal)	• weather observations • air patrolling • fire occurrence • fire spread Daily weather observations are translated into *Nesterov index* on which, in turn, both, the *fire probability* and the *patrol regime* depend. The fire occurs according to this probability and is detected by the patrol. The spread of the fire depends on the time between the occurrence and the detection, and on the average speed of fire only. The losses are proportional to the fire spread.	• available biomass • demand grid points • transportation cost • power plants set up costs • efficiency of power plants • capacity of power plants • fossil fuel price (for competition)	• chemical plants capital costs • two distinct levels of technology: current and future (ca. 2030) • capacity of power plants • fossil fuel price (for competition) • GHG balance for chemicals production	• Economic growth model • Sollow type • Capital stock as stock losses due to damage • Furthermore indirect losses which translate into macroeconomic losses • Econometric parameter estimates from historical time series
				Input		Input	

	G4M (Georg Kindermann, IIASA)	FORMICA (Hannes Boettcher, IIASA)	OSKAR (Oskar Franklin, IIASA)	Forest Fires Model (Nikolay Khabarov, IIASA)	BEWHERE (Sylvain Leduc, IIASA)	BioTechModel (Barbara Hermann, IIASA)	CatSim (Stefan Hochrainer, Reinhard Mechler, IIASA - RAV)
Parameters and initialization	• Net Primary Production • Development of population density • Development of the buildup land • Minimum of agricultural land which is needed for food • production • Agricultural suitability • Price-level of the region • Initial forest biomass • Initial forest area • Discount rate • Protected land area • Current amount of fuel wood production • Corruption of the region • Discount rates • Prices of land, afforestation, carbon and wood	Turnover rate Non-woody litter Fine-woody litter Coarse-woody litter Management mortality Max volume Thinning first year Thinning interval Thinned fraction Harvest age Harvested fraction Fraction to slash Fraction to sawn-wood Fraction to pulp wood Fraction to energy wood Product MRT Recycling rate Energy substitution factor Product substitution factor Costs Revenue Stem volume Soil • soluble • holocellulose • lignin-like • humus1 • humus2 Products sawn-wood • pulp wood • energy wood	Fixed species specific parameters (growth and thinning response) parameterized from yield tables and thinning studies A sub-model estimates initial values for growth rate, density and dead wood from inventory data (done for each cohort)	• daily gridded data - temperature - humidity - precipitation • average fire spread rate • response/extinguishing time • ignition probability (currently based on population density) • fire probability under given weather conditions • number/location of in situ weather stations • satellite/in situ data resolution	• biomass and demand grid points, • amount of biomass, • amount of fuel demand • capacity and efficiency of a methanol plant	• 3 types of biomass input: starch, sugar or lignocellulosics • Fixed output/capacity (100 kt chemical per year) • Exogenous biomass prices • Current or future technology level (static) • production costs (labour, electricity, additives • land-use per type of biomass included • waste management (incineration with or without energy recovery, digestion) •	• Can be distinguished between hazard parameters, resilience and economic parameters • Hazard parameters: return loss periods or loss distribution functions, e.g. extreme value distributions, • Economic parameters: Total capital stock, fixed budget investment of government, growth rates • Resilience parameters: Different financing instruments and mitigation measures the government can set to finance the losses • Portfolio selection of optimal investments possible

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				Output		Output	
Variables	• forest biomass • forest area • deforested area and carbon from these deforestation • afforested areas • harvestable wood • current rotation time • increment optimum rotation time • age-class distribution of forests	carbon stocks • biomass • soil • products other C services (C substituted) revenues costs NPV age-class distribution	• forest biomass • harvestable wood • harvested wood (thinnings and final harvests) • optimal harvest ages • dead wood carbon • costs of planting , thinning and harvests	• burned area • patrolled area (both summary statistics and/or simulated probability distributions)	spatial explicit location and size of methanol power plants	• Price of chemicals • Greenhouse gas balance and non-renewable energy use for chemicals 1) leaving the chemical plant and 2) after waste treatment (incineration with energy recovery) • Scenarios for different oil prices (static, trend to be extrapolated?)	• Return on investment • Discount rates • Depreciation rates • Capital stock rates • Fixed budget • XL pricing (within) • Response variables include probability of financing gap, expected financing gap, Credit buffer drop, • Output uncertainty handled through confidence intervals
				Current status		Current status (August 2007)	Current status

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	G4M (Georg Kindermann, IIASA)	FORMICA (Hannes Boettcher, IIASA)	OSKAR (Oskar Franklin, IIASA)	Forest Fires Model (Nikolay Khabarov, IIASA)	BEWHERE (Sylvain Leduc, IIASA)	BioTechModel (Barbara Hermann, IIASA)	CatSim (Stefan Hochrainer, Reinhard Mechler, IIASA - RAV)
	Model core from DIMA Age/Size dependent increment more or less ready	Parameters and other input currently available for Thuringia, Germany, Europe (not economic part)	Parameterized for all species in Europe. Simulations done for a multitude of scenarios for the EU 25 countries (INSEA). High geographic resolution estimates of productivity for Sweden under way (methanol project)	Weather data (re-modeled) is currently available for Europe (finer resolution is needed), forest patrolling strategy currently implemented is based on Russian rules and for more realistic results needs to be adjusted to local conditions.	Building mill beaver for forest industry (optimal location of the mills with import and export of biomass and forest products)	Modeling of biomass conversion to chemicals is completed.	Based on country case studies the feasibility of general global maps is tested. Under process for Austria.
				Potential extensions, future plans?		Potential extensions, future plans?	Future plans
	• bring it to a stable "user friendly" version • increasing resolution to 30"×30" • include slope • dynamic NPP–Model	Model applications • calculation of plot and regional level mitigation potential of various FM and land-use options (including land-use change) • global technical/biological potential of FM to mitigate Climate Change Technical development • strengthen economic part of the model • include disturbances (like in CBM-CFS, Canada)	• When there is interest: It can be converted from scenario production to real time (ultra fast) productivity response functions (to thinning intensity, species, climate etc.). This could then be integrated with economic optimization models. • A spatially explicit productivity estimation version for Sweden is now being developed.	Introduction of more randomness into the model (response times, fire spread rates); improvement of the fire spread model to account for wind conditions; introduction of heterogeneous forest.	• bio-energy power plants, including side-products • refining the calculation of transport • linking to other models	• link up with BEWHERE model, • extend BEWHERE modeling to link up to EPIC agricultural data • possible to include more 'real' materials, e.g. fibres • pre-treatment technologies will have to be aligned with other models (esp. economics)	• Dependent on the case studies a sectorial approach is developed • Possibility to go on more regional scales,
				Potential contribution to IIASA projects		Potential contribution to IIASA projects	

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	GeoBene • Downscaled forest biomass map • Slope derived from 3”×3” DEM–Map WWF • Potential biomass production • Existing forest biomass stock • Potential forest biomass stock • Find forests with deforestation pressure		WWF (or wherever European forest development and production is of interest): • Already calculated time series of production, dead wood and carbon potential for all European regions and species. (all forest cohorts included in inventories)	Directly related to GEO-BENE. Hopefully it could be also the basis for the global forest fires model.			
				General evaluation		General evaluation	

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strengths	• easy approach • modular • robust	• flexible: adjustable to different scales (stand to regional, probably also global) and crops • optimally used for sector analysis on the regional level • uses data that is often available (inventories)	• predicts biomass AND DENSITY sound modelling of thinning effects (and harvests, costs and dead wood) • based on globally applicable biophysical principles and species characteristics. -easily calibrated and adaptable to different scales and areas • flexible productivity input inventory data or NPP model (e.g.LPJ) • fast	• Clarity (is easy to understand and implement) • Explicitly reflects physical processes • Explicitly connects the increase in quality of observations with benefits • Allows modeling of interaction of satellite and in situ systems • Although involves numerical simulation, is relatively fast to run. (1000 simulations in approx. 30 min)	• very robust model • simple, but powerful • geographical explicit • exogenous prices	• Comparable results for different chemicals • Different types of biomass • Incl. current and future technologies • Any biomass price can be used • CO2 and energy balance including or excluding biomass production and pre-treatment	• Treats probability and flow effects explicitly rather than only looking at stock effects and discrete event scenario analysis • Adaptation is treated as important decision variable for the government financial vulnerability yet and in the future.
weaknesses	• still not finished • validation • slow	• global application is CPU intensive (only possible by region, e.g. US, Europe etc.) • prescribed management only, no optimization • so far no experience on applicability without inventory information • besides C and economy no other impacts of forest management	• no fire and insects • aggregated productivity does not differentiate water and temp effect on different species. • can only be run by oskar	• Relatively rough since it does not account for - different types of trees - fuel load - wind conditions • The rule set is specific to Russia and its adaptation to local conditions may require substantial efforts.	• exogenous prices • no land-use change	• based on Europe (no differentiation between countries) • not yet geographically explicit • standard plant size (though some data on other sizes for sensitivity analysis)	• Economic model has to built very general, however, modulare structure of the model gives the opportunity to test it for specific areas for calibration

	HeatHeart Model (KTL)						
	General focus						
scope	Evaluation of the role of weather forecast on the possible prediction of heart attack rate.				•	•	
resolution	Spatial: city-specific (other modifications possible) Temporal: 1-day, seasonal components - yearly						

	HeatHeart Model (KTL)						
processes included	Daily weather and it's possible effect on the incidence of AMI		•				•
	Input						

	HeatHeart Model (KTL)						
Parameters and initialization	• weather conditions: temperature, pressure, wind speed, precipitation, etc • disease incidence: number of recorded cases of acute myocardial infarction • population-at-risk • seasonal variation (i.e. purely function of time) The parameters of the model are statistically estimated from the above data.	•			•	•	•
	Output						

	HeatHeart Model (KTL)						
Variables	• Predicted AMI incidence. The accuracy of the forecast is assessed using cross-validation techniques. Different models (withi/without seasonal variations and with/without weather information) are compared.	•			•	•	
	Current status						
	Completed for the case of Finland.						
	Potential extensions, future plans?						

	HeatHeart Model (KTL)						
	Other European countries with more noticeable weather extremes and susceptibility to them.		•	•	•	•	•
	Potential contribution to IIASA projects						
	Part of Geo-BENE work package.	•			•		
	General evaluation						

	HeatHeart Model (KTL)						
strengths	• Clear framework, easily applicable to other similar datasets. • Discrimination between the linear trend, the seasonal effect and the daily weather effect.	•		•		•	•
weaknesses	• Finnish data does not provide enough weather extremes to detect usefulness of weather forecasts. • Ecological fallacy: impossible to report the exact measures people take in case of weather extremes.			•		•	•