FP7 Project nr 226487 Project start date: 01 May 2009
Acronym: EuroGEOSS
Project title: EuroGEOSS, a European approach to GEOSS
Theme: FP7-ENV-2008-1: Environment (including climate change)
Theme title: ENV.2008.4.1.1.1: European Environment Earth Observation system supporting INSPIRE and compatible with GEOSS (Global Earth Observation System of Systems)
Web site: www.eurogeoss.eu

D.6.4: Report on scenarios and baseline definition

Title	D.6.4: Report on scenarios and baseline definition
Creator	
Creation date	20/07/2011
Date of last revision	23/09/2011
Subject	Cost benefit, scenarios, baseline definition
Status	☐Draft ☒Final
Publisher	EuroGEOSS
Type	Text
Description	
Contributor	Kerstin Jantke, Christine Schleupner, Uwe A. Schneider, Erwin Schmid, Felicjan Rydzak, Sabine Fuss, Steffen Fritz, Ian McCallum, Aline Mosnier
Format	Doc
Source	
Rights	☐ Restricted ☒ Public
Identifier	D 6.4
Language	En
Relation	WP6, related to WP2, WP3, WP4
Coverage	Not applicable

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ACRONYMS AND ABBREVIATIONS

Abbreviation	Name
DoW	Description of Work
DOPA	Digital Observatory of Protected Areas
IOC	Initial Operating Capacity
AOC	Advanced Operating Capacity
JRC	Joint Research Centre
SBA	Societal Benefit Area
UNEP	United Nations Environment Programme.
WCMC	World Conservation Monitoring Centre
WP	Work Package

1 INTRODUCTION

The following deliverable D6.4 titled a *Report on scenarios and baseline definition* is an output from the EuroGEOSS Project Work Package 6. Overall, WP6 is tasked with developing methodologies and tools to assess societal benefits of INSPIRE and GEOSS for the 3 thematic areas of the EuroGEOSS project (Forestry, Drought, Biodiversity) as well as the other societal benefit areas of GEOSS. One of the tools undertaken by WP6 involves modelling to assess the potential benefits of GEOSS, and the baseline definition and scenario selection is key to this process. This deliverable builds on D 6.3, a Report of methodologies and tools for benefit assessment.

GEOSS, the Global Earth Observation System of Systems, is envisioned to be a global public infrastructure that generates comprehensive, near-real-time environmental data, information and analyses for a wide range of users. The general assumption regarding GEOSS is that the benefits to society by far outweigh the costs. However, this notion is being increasingly challenged, and it is becoming necessary to provide rational, quantified and persuasive arguments to justify investment of what are often public funds. In particular, the identification of clear benefits is crucial to ensure long term sustained GEOSS operations.

By applying tools (as outlined in D 6.3) we demonstrate the advantage of having improved datasets and improved data interoperability and we illustrate the socio-economic implications for improved policy making. We will feed models with datasets of different quality and illustrate how much better the decision can be on a European (and global) level and what the results would look like if we did not have interoperable systems or were forced to use data of lower quality. The improved value though data interoperability is measured by the expected increase in benefit (economic or other benefits) arising from better information provided though interoperable spatial data. For example, we can apply data-poor and data-rich scenarios (i.e. with and without INSPIRE/GEOSS and an interoperable Spatial data infrastructure). The different scenarios with versus without SDI/GEOSS are shown in the following four examples:

The first example is in the field of wetland conservation related to biodiversity where we show the effects of different resolution datasets on wetland protection in Europe. The data rich scenario is the one with the higher resolution.

The second example describes systems dynamics modelling which attempts to describe the earth system as a whole. Here we design scenarios which represent improvements via GEOSS to the historical baseline.

The third example focuses on the value of information, in particular on the value of reducing uncertainties in global land cover.

The final example focuses on Africa and the Congo basin, with scenarios that include/exclude internal transportation costs to show the value of adding this kind of information, and with/without additional information on land use (protected areas + concessions + permanent forest domain).

The following specific tasks will be outlined in this deliverable:

- Definition of baselines and scenarios with and without interoperable SDI (GEOSS versus non GEOSS scenario) both within Europe and globally.
- Define specific current policy scenarios discussed within the EU (e.g. different targets for bioenergy crops in Europe such as 2020 targets; Convention on Biodiversity target on reducing the loss of biodiversity with focus on Europe and Africa and a specific forest protection policy,
- Examining differences on policy making within regions having different levels of interoperable SDIs e.g. Europe versus Globe, Europe versus a country (e.g. Germany)

The following section identifies four particular methods that will be applied within WP6, for which baselines and scenarios need to be established.

2 METHODS: CASE STUDIES

2.1 Wetland Biodiversity

2.1.1 Wetland distribution data

For optimal wetland conservation planning, the spatial extent and distribution of wetlands and suitable restoration areas denote important input data. This study applies data from the empirical wetland distribution model SWEDI (Schleupner 2010). The spatial wetland distribution model SWEDI is a geographic information system (GIS)-based model that relies on multiple spatial relationships of existing geographical data. It is developed as an extraction tool to denote wetland allocations in Europe and covers 37 European countries at a resolution of 1 km^2. The SWEDI model estimates the spatial distribution of European wetlands by distinguishing between existing functional wetlands and sites suitable for wetland restoration by considering recent land use options. The evaluation of existing wetlands relies on a cross-compilation of existing spatial datasets and extraction of spatial wetland information. The determination of potential wetland restoration sites is more complex. It involves the integration and interpretation of a variety of GIS datasets by assuming that there is a relationship between environmental gradients (Franklin 1995). Knowledge rules for each biogeographical region are defined based on analysis and observed correlation of independent variables such as climate, hydrology, soil, elevation and slope to analyse environment-wetland relationships.

The information is extracted from spatial data, such as CORINE land cover (EEA 2000), European Soil Database (Joint Research Centre 2004), Bioclim (Busby 1991), Worldclim (Hijmans *et al.* 2005), Gtopo30 (USGS 1996), and Potential Natural Vegetation (Bohn and Neuhäusel 2003). In this manner regression parameters that vary across space are estimated with the advantage that they allow for regional differences in relationships (Miller *et al.* 2007). This is especially useful if concerning the broad European scale of the model. In combination with geographical data of potential natural vegetation, land use and land cover only those sites are selected by the model that fall within agricultural areas and forests. Urban and other sealed off areas and their direct vicinity are assumed to be unsuitable for wetland restoration. Furthermore, those sites that contain already existing conservation areas like salt marshes or valuable sparsely vegetated areas are also excluded from potential wetland restoration sites.

As a result SWEDI distinguishes three main wetland types that are further sub-divided into five wetland categories: wet forests (alluvial and swamp), wet grasslands (such as reeds and sedges; only one category), and peatlands (bogs and fens). Open waters (water courses and water bodies) are considered separately. However, a large part of the European wetland species that are included in the land use model also need open water habitat. Spatial data on the extent of water courses and water bodies are derived from CORINE land cover (EEA 2000) and the Global Lakes and Wetlands Database (GLWD) (Lehner and Döll 2004). Figure 1 shows an extract of wetland areas from SWEDI for south-eastern Germany. The detailed map of the European wetland distribution and its potentials are described and illustrated in Schleupner (2009).

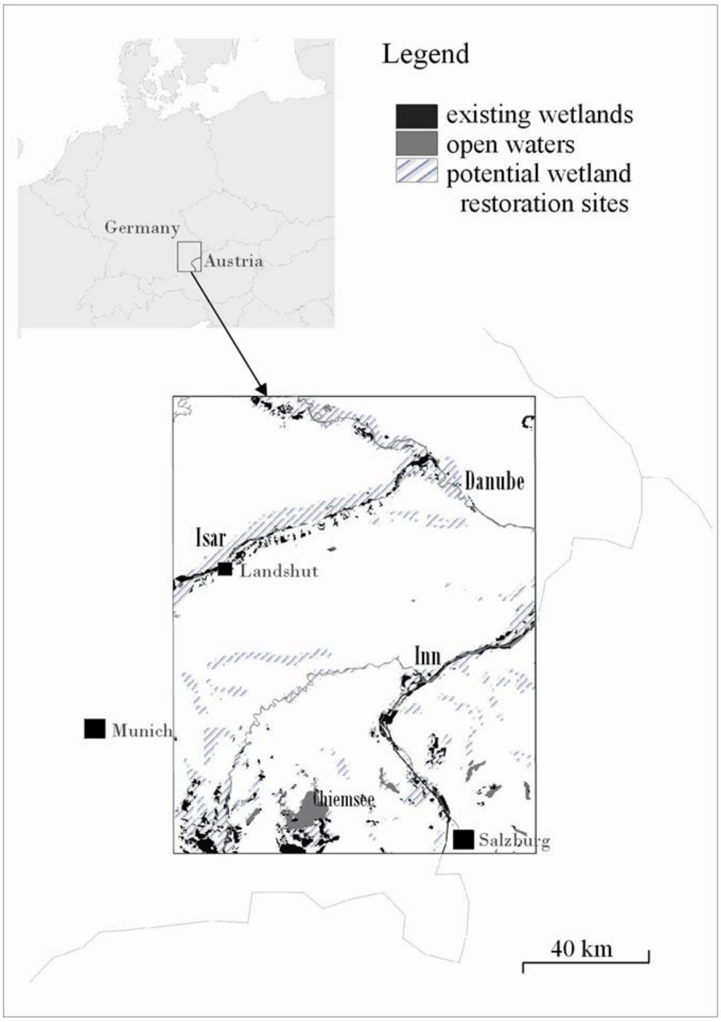

Figure 1. Extract of wetland areas from SWEDI for south-eastern Germany.

The spatial planning units in the land use optimization model correspond to the resolution of the species occurrence data. We integrate the fine scale wetland data in terms of total areas of each wetland habitat type per planning unit.

2.1.2 Land rent data

GEOSS data on land rents are estimated at Homogenous Response Unit (HRU) resolution covering the entire European continent. A HRU is a discrete characterization of land quality with pre-defined ranges on relatively stable attributes. Here, we use discrete classifications of altitude, slope and soil texture established through previous research (Skalsky *et al.*, 2008, based on previous works by Schmid *et al.*, 2006; Balkovič *et al.*, 2006; Stolbovoy *et al.*, 2007). HRUs are delineated on the assumption that within defined ranges of attributes, biophysical processes (e.g. plant growth, nutrient movement) respond similar to any set of exogenous impacts (e.g. rainfall, land management). Available data at HRU level include i) their spatial extent and ii) biomass yields and environmental impacts for major food and non-food cropping systems. The latter data are results from simulations with the Environmental Policy Integrated Climate model (EPIC, Izaurralde *et al*., 2006; Williams, 1995). In addition, we use country specific land rents from the Global Trade Analysis Project model (GTAP, Lee *et al.* 2009). Based on these data, we approximate detailed GEOSS land rent data that are unique for each country and HRU (see Table 1).

We use the following notation: u = {1,…,U) is the set of HRU; c = {1,…,C} is the set of countries. $s_{u,c}$ represents the share of a given HRU u within country c. $mr_{u,c}$ denotes the marginal revenue of land for HRU u in country c. v_c is a value parameter representing the difference between the weighted commodity price and all production costs except for the costs of land in country c. $i_{u,c}$ depicts the weighted average yield per hectare for HRU u and country c. mc_c represents the marginal costs of land in country c and $mc_{u,c}$ the marginal costs per HRU u in country c.

$$\sum_u s_{u,c} \cdot mr_{u,c} = \sum_u s_{u,c} \cdot i_{u,c} \cdot v_c = mc_c \qquad [1]$$

$$v_c = \frac{mc_c}{\sum_u s_{u,c} \cdot i_{u,c}} \quad [2]$$

$$mc_{u,c} = i_{u,c} \cdot v_c \quad [3]$$

Based on classic economic theory for competitive markets, equation [1] forces an identity between marginal revenues and marginal costs of land. While the marginal cost of land is given by its rental rate, the marginal revenue per hectare of land equals yield multiplied by a value parameter. The computation of the value parameter is shown in equation [2]. It depicts the difference between the weighted price of an agricultural or forestry commodity and its production costs. We assume that this value does not differ within a country. Finally, in equation [3] we compute HRU specific land rents by multiplying HRU specific yields by the value parameter.

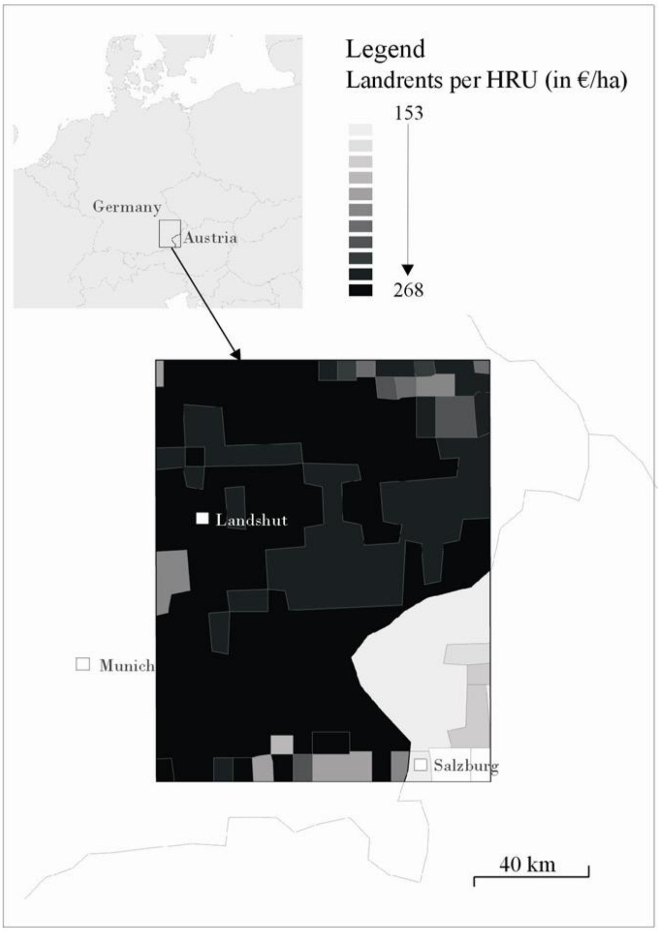

Figure 2. an extract of HRU specific land rents for south-eastern Germany.

Figure 2 shows an extract of HRU specific land rents for south-eastern Germany. See Schleupner (2009) for the land rents for all European countries. In the land use optimization model, HRU specific land rents in Euro per hectare are projected to all planning units. Since the model does not distinguish different HRUs within a planning unit, the land rents in each planning unit are area weighted averages over all contained HRUs.

Table 1. Input data sources for EPIC simulations in the EU at homogeneous response unit (HRU) level.

Category	Datasource	Description
climate	MARS	Monitoring of agriculture with remote sensing (50 km)
	EAST ANGLIA	Tyndall Centre for Climate Change Research (0.5°)
	EMEP	Monitoring and evaluation of the long-range transmission of air-pollutants in EUROPE (50 km)
soil	ESDB v.2	The European soil database v. 2. (10km/1km)
topography	GTOPO30	Global digital elevation model (30 arc seconds)
land cover	CORINE/PELCOM	Combined CORINE & PELCOM (1 km)
agricultural statistics	NEW CRONOS	New Cronos Regional Statistics (NUTS1, NUTS2)
	LUCAS	Land use and land cover area frame statistical survey project data
admin. regions	AGISCO	Geographic information system of European commission data
reference grids	SWU	JRC Soil and waste unit reference grid (10km).

2.1.3 Model scenarios

To estimate the benefits to wetland biodiversity conservation from better resolved GEO data, we examine four data scenarios (Table 2). We compare high-resolution data on wetland habitat areas and land rents to frequently used low-resolution data. These four scenarios simulate running the model with data derived from the EuroGEOSS broker (i.e. Scenarios 1a,b) and scenarios simulating running the model with non-GEOSS data (i.e. Scenarios 2 a,b). Here we assume that for the GEOSS scenario, all data is retrievable from the EuroGEOSS broker.

Table 2. Summary of data sources used in scenarios.

Scenario	**Data sources for**	
	Land rental prices (a)	**Wetland distribution (b)**
1. Geoss	HRU/EPIC**Erreur ! Source du renvoi introuvable.**	SWEDI
2. Non-Geoss	EUROSTAT	EUROSTAT/FAOSTAT

2.2 Systems Dynamics Modelling

The FeliX model is a System Dynamics type model. System Dynamics models attempt to capture as many aspects as necessary of interactions within a closed system. Most variables are therefore “endogenous” (i.e. contained within the system represented by a System Dynamics model). In order to describe the system structure, System Dynamics focuses on the flow of feedback that occurs throughout the parts of a system (feedback loops) – a change in one variable affects other variables over time, which in turn affects the original variable, and so on. The dynamic behavior then occurs when flows accumulate in stocks (e.g. atmospheric carbon). Special dynamic notions are also given by delays and nonlinear relations between the system elements. All these elements produce changes in the way the system has performed in the past and might evolve in the future.

The FeliX model, following the System Dynamics approach, attempts a full systems perspective, where the underlying social, economic, and environmental components of the Earth System are interconnected to allow for complex dynamic behavior characterizing the Anthropocene. A change in one area often results in changes in other areas – for instance depletion of natural resources being a source of energy may impact population growth but also put pressure on the agriculture sector in order to produce more energy crops as a substitute for such natural resources as oil or gas. Being a dynamic model, FeliX captures important stock changes (e.g. depletion of natural resources, accrual of carbon dioxide in the atmosphere) or impacts of certain policies (e.g. afforestation, emission reduction) over time. The FeliX model was built in order to achieve congruence with the nine SBAs of GEO. The model structure of FeliX is illustrated in Figure 3. A detailed description of the FeliX model is provided in Rydzak et al. (2009).

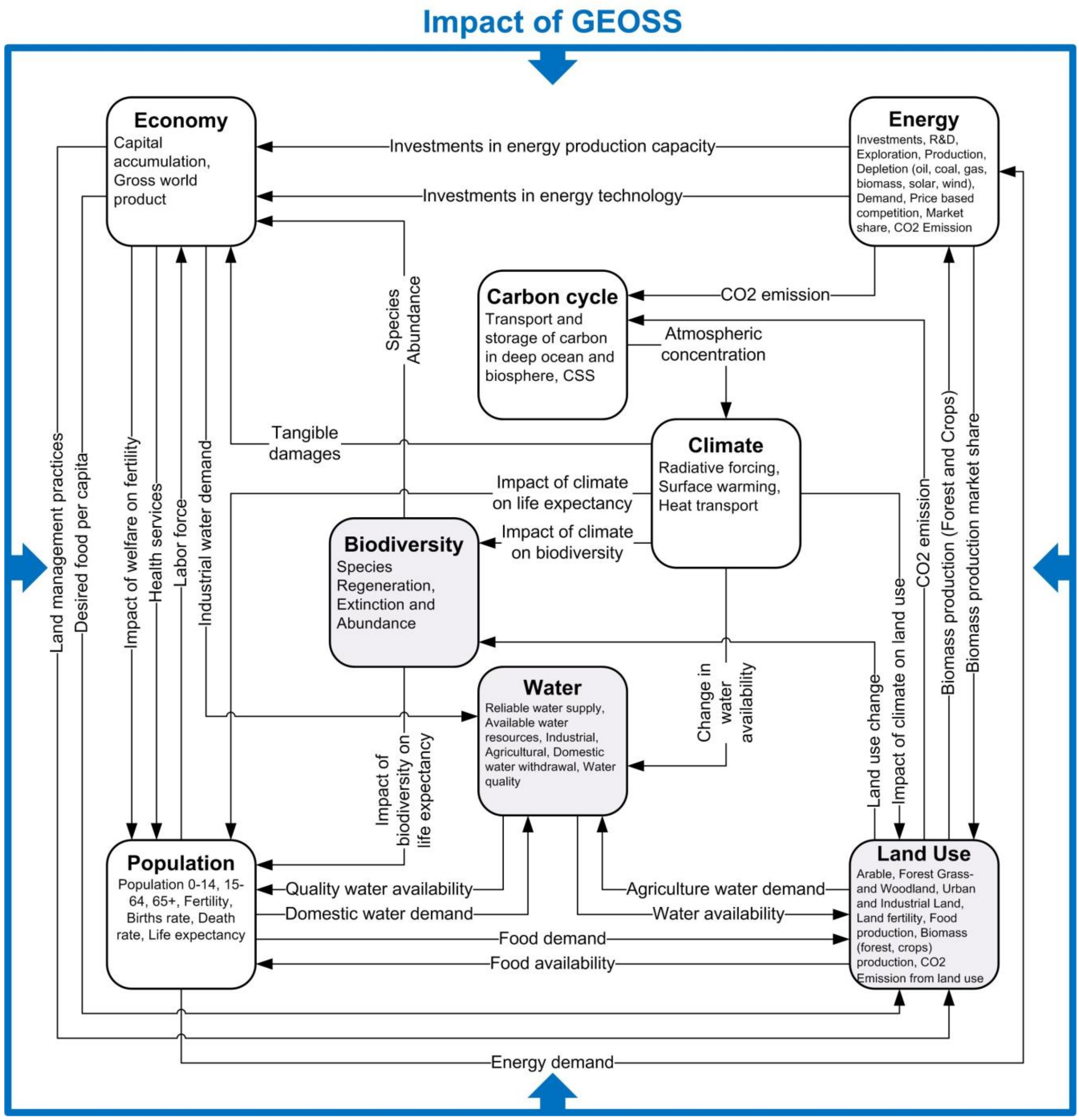

Figure 3: Overview of the FeliX model structure

Major updates to the FeliX model centred around the introduction of the Biodiversity model sector (previously non-existent in FeliX) and making significant changes to the previous Water sector model. Furthermore, changes were also introduced in the Land, Energy and Population model sectors. All changes led to better fit of the model simulation to the historical data.

In addition to modifications to the FeliX model, new scenarios were developed for the EuroGEOSS Project. In order to mimic extreme events occurring in the future (i.e. drought, fire, etc.), system shocks or events can be simulated on a sub-annual scale. These can be introduced as random events, recurring, etc., lasting weeks to months, with varying levels of damage. The EuroGEOSS Scenarios are designed to demonstrate the effect that EuroGEOSS activities could have on mitigating various environmental impacts. They demonstrate the interoperable nature of EuroGEOSS, via linkages among the three benefit areas, in addition to the other SBAs, and are described in the following section.

2.2.1 Baseline Description

Once the model structure was finalized and the model was calibrated to historical data constituting an acceptable representation of the Earth system, the baseline scenario was constructed by extending the model time scale up to 2050. Additional policy assumptions were introduced to the model mimicking consistency with the Millennium development goals. These policies encompass investments in alternative sources of energy including biomass, solar and wind, as well as intensive investments in Carbon Capture and Sequestration. The inclusion of additional policies for the baseline definition is in the spirit of the 2nd Earth Summit in Johannesburg were the GEO idea was born. Thus, our baseline is more in line with a sustainability scenario rather than a forecast of highest likelihood.

2.2.2 Scenarios

Drought Scenarios

Over recent decades, drought has been recognized as an important natural hazard throughout Europe. Current climate change scenarios predict a likely increase in drought frequency and impact in the near future. In addition, anthropogenic impacts such as changes in land use and land cover and water (surface and groundwater) (over)exploitation can aggravate the climatic threat. This situation has raised the awareness of the potential vulnerability of Europe to the drought hazard (both in short and longer terms) and of the need for appropriate monitoring tools and mitigation strategies, as well as adaptation strategies and related decision support tools.

The following scenarios mimic the impact of the GEOSS effort to provide better data and enhanced interoperability across disciplines and systems related to drought.

Scenario: Interoperability Scenario (D1)	**Description:**
Interoperability via EuroGEOSS allows for direct comparison and validation of various drought indicators and indices, translating into improved monitoring and detection of drought events.	Improved monitoring and detection of drought events helps populations deal with such situations. As a result, the impact of GEOSS is modeled to increase the population life expectancy. This in turn reduces death rates of three population cohorts in the model (i.e. Population 0 to 14, Population 15 to 64, Population 65 Plus). The other changes observed as a result of this scenario come from the dynamics of the population.
Scenario: Monitoring Scenario (D2)	**Description:**
EuroGEOSS drought monitoring can assist in placement of irrigation systems and prioritization in the long term. i.e. enhance efficiency of mitigation measures.	Placement of irrigation systems has twofold effects. On the one hand it leads to increased demand for water in order to irrigate appointed areas. On the other hand, such systems might increase productivity of that land. Introduced like that to the model, increased agriculture water demand as a result of the scenario leads to increased total water demand and also greater competition for water resources with domestic and industrial demand. However, together with increased productivity of those areas there are noticeable results in food productivity and increased life expectancy (so long as a reliable water supply is available).
Scenario: Climate Scenario (D3)	**Description:**
EuroGEOSS allows for better monitoring of negative impacts of climate change – specifically drought causing impacts – hence it could reduce these impacts.	Monitoring of negative impacts of climate change and reducing these impacts might lead to improved results in the area of land use. Modeled like that the impact of GEOSS might be visible in increased agriculture land and forest land productivity without increasing of any other required resources (e.g. land areas or water). Greater productivity from agriculture/forest land increases product availability for population in the form of food but

	also energy (i.e. biomass).

Biodiversity Scenarios

Biodiversity is by nature multi-dimensional and can be measured among ecosystems, species and genes. A sound monitoring of biodiversity evolution should integrate a large series of datasets varying in their content, format, and accessibility. The integration of such datasets into analysis models for producing scientific and operational answers to fundamental questions on biodiversity is unfortunately not well-developed.

The following scenarios mimic the impact of the GEOSS effort to provide better data and enhanced interoperability across disciplines and systems related to biodiversity.

Scenario: Interoperability Scenario (B1)	**Description:**
EuroGEOSS will deliver an interoperable environmental information service for enabling improved assessment of areas of high ecological value.	Improved assessment of areas of high ecological value may lead to indicating those areas as protected. The scenario enables the user to indicate what percent of the forest land might become protected (in relation to current trend). The following increase in protected forest land leads to a decrease in available agriculture land. The decrease of agriculture land availability is compensated by its increased productivity - increase of forest land leads to reduction of CO2 emission from land use change and thus limits negative impact of emission and following climate change on agriculture land productivity.
Scenario: Species Abundance Scenario (B2)	**Description:**
EuroGEOSS, via DOPA, through monitoring and better informed modeling, will allow for increases in species abundance.	Monitoring delivered through GEOSS is modeled to reduce the impact of agricultural land use practices as well as forest management practices on biodiversity. This in turn has an effect on population health and also economy.

Forest Scenarios

Information on forest resources is essential for policy makers from local to global organizations. Forest resources are linked to local problems of resources availability for local production of timber and energy, and to global problems of deforestation, carbon sequestration and climate change. However, information on forest resources is often scattered, incomplete and unreliable. Most of these deficiencies are due to the lack of interconnection between the systems established at the local, regional and global levels. Additionally, forestry terminology creates a lack of transparency in forestry figures, as different definitions of forests and forest attributes are used around the world.

The following scenarios mimic the impact of the GEOSS effort to provide better data and enhanced interoperability across disciplines and systems related to forests.

Scenario: Fire Early Warning Scenario (F1)	**Description:**
EuroGEOSS interoperability allows for early warning/detection of forest fires brought on by climate change/drought related increases in fire frequency, affecting forests, savannas, etc.	Early warnings about fires enable more efficient response and sometimes even prevention of the event. This might lead to decreased damage. The impact of GEOSS in this scenario is captured in the area of improved forest management practices that in turn increase the forest land yield.
Scenario: Reducing Deforestation Scenario (F2)	**Description:**
EuroGEOSS interoperability related activities could aid in reducing deforestation/ habitat loss via better forest monitoring.	Forrest monitoring in this scenario is modeled to have a direct impact on reducing deforestation. Saving forest land from being transformed into agricuture, industrial or other land has a positive impact by increasing of biodiversity and reduced emissions from land use change.

Events Scenarios (related to drought)

Scenario: Change in Reliable Water Supply Scenario (E1)	**Description:**
Current level of Reliable Water Supply is 4500 billion cubic meters per year. By year 2100 this level can change (increase or decrease) due to many reasons. Decide what percentage of current Reliable Water Supply level will be available in 2100. Please note: 100 means no change will happen - 100% of current Reliable Water Supply will also be available in 2100; value lower than 100 would mean decrease in Reliable Water Supply over time; value greater than 100 would mean increase in Reliable Water Supply over time.	Scenario to simulate increase or decrease in future availability of water supply.
Scenario: Extreme Drought Scenario (E2)	**Description:**
The model allows simulating extreme drought events in Agriculture. These are additional shortages of water supply. Decide on severity of such event(s) (scale between 0 - no event, to 0.5 - extreme event), duration (at least a year), and time interval between events (in years).	Scenario to simulate repeating, severe drought events.

2.3 Value of Information (Value of reducing uncertainties in global land cover)

Urgent questions exist, such as how much land is available for the expansion of agriculture to combat food insecurity, how much land is available for afforestation projects, and what is the most cost-effective mitigation option (e.g. REDD policies versus Carbon Capture and Storage)? Such questions can only be answered if reliable maps of land cover exist. EuroGEOSS is attempting to improve access to these types of geo-spatial products (i.e. land cover) via improved SDI.

For the purpose of this report, a scenario is devised in which there are two mitigation options, i.e. 1) Reduced Emissions from Deforestation and Forest Degradation (REDD) versus the implementation of a new technology 2) e.g Carbon Capture and Storage (CCS) in the industry/energy sector. Each mitigation option has a different cost. However, the REDD mitigation option has increasing costs due to competition as the remaining land available for cropland becomes more expensive. The uncertainty in these costs is also a function of which cropland extent layer is used as an input to the land use model.

A portfolio optimisation model is implemented in order to find the optimal mix of mitigation options using different estimates of cropland from two land cover datasets as inputs to the model (Fritz et al., 2012). We therefore created 2 different land cover layers, one using the GLC-2000 cropland minimum (the cropland class is covered 50% by cropland and 50% by a non-cropland class) and the other using the MODIS cropland maximum (where the cropland class is covered 100% by cropland).

The focus of our analysis is on the choice between these two options, where the land use mitigation option exhibits increasing marginal costs, which differ between two scenarios depending upon which land cover data set is used, i.e. GLC-2000 or MODIS.

1. Scenario 1 is the GLC-2000 scenario in which quite a substantial additional land resource is available for agriculture and cropland expansion. It can also be termed the ‘available land scenario’.
2. Scenario 2 is the MODIS scenario where most of the land is already in use and much less additional land is available for agriculture and cropland expansion. It can also be termed the

'limited available land scenario'. The other mitigation cost is assumed to be available at a constant cost at the beginning and is completely independent of the first option.[1]

The two alternative scenarios were differentiated by the underlying land cover maps; we used the GLC-2000 cropland minimum (the cropland class is covered 50% by cropland and 50% by a non-cropland class) and the MODIS cropland maximum (the cropland class is covered 100% by cropland). We calculated the ratio between the MODIS cropland maximum and the GLC-2000 cropland minimum area at the national level taking the GLC-2000 cropland minimum as the reference. To mimic the MODIS maximum cropland scenario, we multiplied the cropland reference area by this ratio and divided the crop yield level by the same ratio, assuming that total production of the reference year is known and valid for both scenarios. In those countries, where the MODIS maximum cropland extent exceeded the GLC-2000 minimum crop land area, the additional cropland was assigned to the land category previously labelled "Other Natural Land". This resulted in reducing the possibility of agricultural production expansion beyond forests. We consider the difference of cropland area chosen between the two land cover scenarios as relatively conservative as we could also have modelled the difference between the MODIS cropland minimum and the GLC-2000 cropland maximum. Such scenarios would have resulted in larger differences in cropland extent and would have consequently been more extreme.

We then test the sensitivity of the optimal mitigation strategy and the associated VOI to the cost of this "safe" alternative and the responsiveness to different levels of risk aversion, where we refer to a weight (ω) close to zero as being risk-neutral and then increase it to 0.002 in intervals of 0.0002.

For the latter, we fix the cost of the constant cost mitigation option at \$20 per tCO_2. As the maximum potential from REDD between 2020 and 2030 is about 20 $GtCO_2$ with a price varying between \$0 and \$50 per tCO_2, the total amount to be mitigated by the combination of the constant cost and REDD options is set equal to 20 $GtCO_2$.

In Figure 4, the VOI, assuming the constant cost option to cost \$20/tCO_2, is above the VOI assuming only a \$10 cost. This is because the decision-maker regards the REDD option to be less competitive if the alternative is so cheap. The VOI is then highest for the blue line corresponding to \$30/tCO_2 around 50% probability that the land cover with more available land is correct. Beyond that, the alternative mitigation option gets less and less attractive compared to the REDD option

[1] If two options in the land use sector were analyzed, these could be competing or complementary, so that costs would either decrease or increase as more of one option was chosen. This is not the topic of this particular study, but will be of interest in future research that will also consider bio-fuel policies.

and the value of knowing with more certainty that this cover is correct decreases, i.e. the pink line is underneath the blue one, followed by the dark blue and brown ones (at zero). Also, the maximum of the expected VOI curves is to the left of the 50% probability of having more land in the latter case (i.e. the constant cost option is relatively more expensive) and to the right of 50% in the case where the constant cost option is cheap. This means that the marginal value of information decreases as the alternative option becomes more expensive, and vice versa, and the probability threshold beyond which additional information is valued at a decreasing rate gets lower and lower, too. In other words, the required probability of the map with more land available being correct in order to commit more to the REDD mitigation option is not so high anymore.

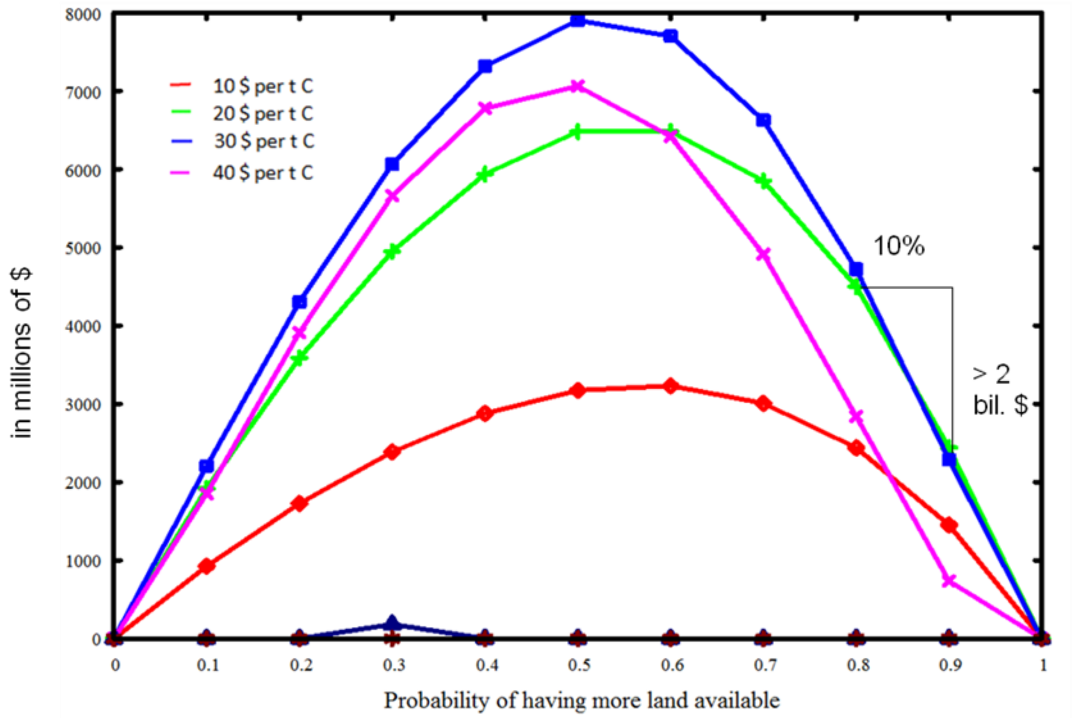

Figure 4: Expected value of information in millions of $

Future efforts will include scenarios on land availability which will stay the same, but we'll further investigate the relationship between options. For example, the promotion of biofuels and avoiding deforestation will compete for land and thus the costs of these options will not be independent of each other, as was the case in the previous application. On the other hand, there could be options that would be complementary, e.g. intensification of agricultural production systems would save emissions, but free up land for measures such as biofuels and REDD. Furthermore, evaluation of existing and/or planned US and EU bioenergy mandates is planned.

2.4 Africa & Congo Basin: With and without protected areas (Biodiversity)

The Congo Basin region encompasses six Central African countries – Cameroon, Central African Republic (CAR), Republic of Congo, Democratic Republic of the Congo (DRC), Gabon and Equatorial Guinea. Forest covers approximately 80 % of the basin (GLC2000) with more than half classified as dense forest. Congo Basin contains the largest tropical forest surface in the world after Amazonia. However, in recent decades the tropical forest of the Congo Basin has been threatened less than the Amazonian forest with a rate of deforestation that averaged 0.17% between 1990 and 2000 (Atyi et al., 2009). This situation could however potentially change with ongoing and planned transport infrastructure changes and political stabilization after a decade of civil war in the DRC.

The transportation infrastructures in Congo Basin are characterized by a low density and a low quality. Quality of infrastructures depends on huge investments which are mostly financed by the public sector and on important continuous maintenance efforts. War and civil disturbances in combination with difficult terrain and climatic conditions have deterred the development and up-keep of road infrastructure. In Cameroon in 2003, only one fourth of the roads which were inspected were considered in an acceptable state and the rest required urgent reparations (Plan Directeur Routier du Cameroun, 2006). In the DRC, most of the road network is in very bad condition with important sections almost impassable (MINTEN and KYLE, 1999). In the CAR a recent report mentioned insufficient infrastructures which are scattered haphazardly across the vast territory and which are usable only a very short period of the year (Development partner consultation, 2007). However, in a certain extent, these factors could have protected the forests which haven't been as damaged as in the other tropical regions with only 0.17% of annual deforestation rate over the period 1990-2000 (ATYI et al., 2009; IWG-FR, 2006). After identifying the development of the transportation network as one of the highest priority in the region, governments and donors have already approved important investments in this sector for the next years.

This situation could however potentially change with ongoing and planned transport infrastructure changes.

2.4.1 GLOBIOM model

We use GLOBIOM, a bottom-up, global partial equilibrium model which integrates the main land based sectors i.e. agriculture, forestry and bioenergy. The main advantage of using GLOBIOM for this analysis is the global scale and the detailed spatial resolution of land use. The global scale is important, even for case studies, because many drivers and consequences of land use change are of global extent (HEISTERMANN et al., 2006; MEYFROIDT et al., 2010). Spatial differentiation of land use is crucial due to the heterogeneity of transportation costs over the territory and the differences in soil fertility according to bio-physical characteristics. Moreover, the cost and the impact of land use change on environment are very much related to the initial land use and the location of the frontier between different land use types. 28 regions are differentiated and the maximization of the sum of producer and consumer surplus subject to the resource, technological, and policy constraints, gives the equilibrium prices and quantities for the different activities in each region.

A global database has been built which includes information on soil types, climate, topography, land cover and crop management (SKALSKY et al., 2008). The global distribution of the different land covers for 2000 comes from the Global Land Cover database (GLC 2000) which is developed at the Joint Research Center (JRC) and the global crop distribution maps are compiled at IFPRI (YOU and WOOD, 2006). In the Congo Basin, agricultural and forestry production and land use change are represented at the intersection between a 0.5 degree grid and country boundaries which represents 1386 simulation units which size varies between 10*10 km to 50*50 km.

18 crops are currently included at the global level and for the Congo Basin case study we have also integrated cocoa and coffee in Sub-Saharan Africa. Consistently with the IFPRI crop distribution map classification we differentiate 4 management systems: subsistence, low input-rain fed, high input-rain fed and high input-irrigated. For each system and each simulation unit, crop yields and input use are estimated with the Environmental Policy Integrated Climate model (EPIC), currently for 17 crops.

2.4.2 Baseline

The baseline is a situation where technical parameters remain identical to the 2000 level; new results are driven only by increases in food, wood and bioenergy demand. The projection of the food consumption by 2030 is introduced based on population growth (Special Report on Emissions Scenarios) and the evolution of the per capita average intake of animal calories and vegetal calories per region (FAO). According to these estimations, the total world population should reach

8 billion inhabitants in 2030 and population in Congo Basin will double. Moreover, biofuels constitute a growing market for crops. The projections of biofuels demand by 2030 are taken from the World Economic Outlook 2007. It is estimated that biofuel use will remain marginal in the Congo Basin, however, higher demand for biofuels in the other regions affects global agricultural markets and thus land use elsewhere. Demand for wood products is implemented through minimum quantity constraints. The evolution of sawn wood and pulp wood consumption is based on the evolution of the GDP while bioenergy use per category and traditional fuel wood consumption by 2030 come also from POLES estimates. In the Congo Basin, fuel wood demand is spatially explicit and based on the projections of population over the region and the current average fuel wood use per capita (GRÜBLER et al., 2008; FAO). There is no change in yields, annual increments, production costs, transportation costs or trade policies. Subsistence farming is also fixed at its 2000 level. No environmental policies are implemented other than the 2000 protected areas. This baseline should be regarded as a “status quo” situation which allows us to isolate the impacts of different drivers of deforestation in the Congo Basin in the different scenarios.

2.4.3 Scenarios

The following two scenarios will be implemented in the Congo Basin:

1. a run with and without internal transportation costs to show the value of adding this kind of information.
2. with and without additional information on land use (protected areas + concessions + permanent forest domain)

1- For this study, we use a methodology developed by Nelson (2006) using several GIS datasets - existing transport infrastructures and navigable rivers, elevation, slope, country boundaries, land cover- to compute the time needed to travel from a pixel to the nearest location of interest. This approach has already been used in several studies on the impact of infrastructures (DOROSH et al., 2009; ULIMWENGU et al., 2010). For existing infrastructures, we have compiled information from different sources (CIRCA 2000; Référentiel Géographique Commun for DRC). We use the same adjustment factors for slope and elevation than Nelson. Then, we assigned an average speed to each transportation infrastructure in consultation with local experts. For crops, we consider cities above 300 thousands inhabitants to be the closest market and for wood products and cash crops, the time to access the closest port has been computed since most of the production is exported. Then, this time is converted in transport cost using a cost function with a fixed component, a kilometric component and a time component. The fixed cost reflects the investment cost, the kilometric cost depends on the fuel price, the fuel consumption and the maintenance cost and finally the time cost depends on the labor cost. To parameterize the cost function, we use information from TERAVANINTHORN and RABALLAND (2009) based on truck companies surveys in Central African corridors.

2- In Congo Basin, almost all the forests belong to the State. This national domain is then split in two components: the permanent forest domain which cannot be converted to other land use and the non permanent forest domain. In the permanent forest domain we usually find the forest concessions and the protected areas. In the non permanent forest domain, temporary logging permits can be attributed or forests can also be under the responsibility of a community. In the model, concessions and protected areas have been delineated according to FORAF maps (Figure 5) and it is not possible to convert these forests in other use. For Cameroon, the permanent forest domain which encompasses municipality forests and forest reserves has been defined more precisely thanks to larger data availability (Atlas Forestier Interactif, WRI).

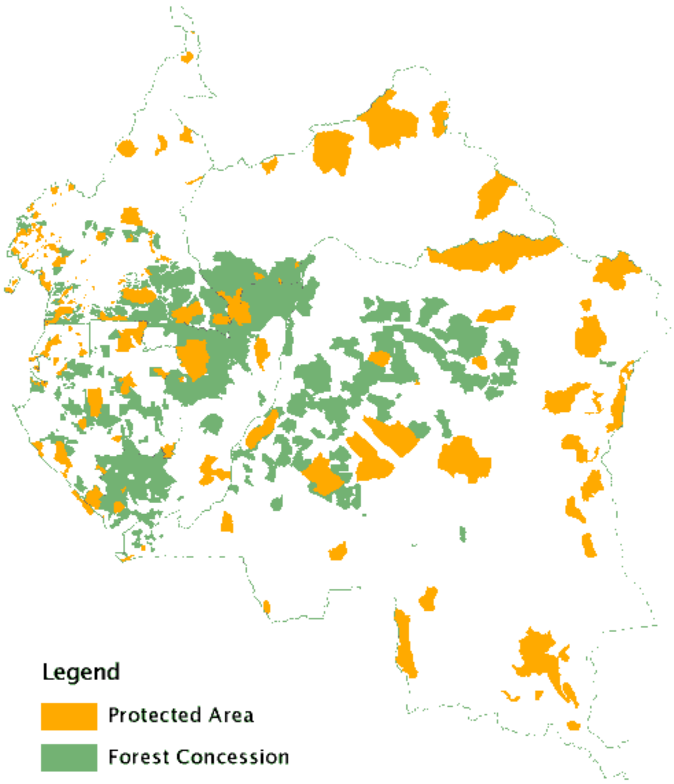

Figure 5: Concessions and protected areas in Congo Basin. Source: FORAF

3 SUMMARY

In summary, this deliverable has presented four case studies which will be implemented within WP6, in part to address the assessment of benefit derived from SDI. Overall, WP6 is tasked with developing methodologies and tools to assess societal benefits of INSPIRE and GEOSS for the 3 thematic areas of the EuroGEOSS project (Forestry, Drought, Biodiversity) as well as the other societal benefit areas of GEOSS. One of the tools undertaken by WP6 involves modelling to assess the potential benefits of GEOSS, and the baseline definition and scenario selection are key to this process. Various additional methods are applied in WP6 to assess the benefits of SDI, including survey techniques, meta-study analyses and more, but are described elsewhere.

The four methodologies represented here as case studies include: wetland biodiversity, systems dynamics modelling, value of information and Africa and the Congo basin. Within each of these we provide a description of the baseline (business as usual) and the scenarios.

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