EuroGEOSS, GENESIS, and UncertWeb FP7 Projects

e-Habitat & Species Occurrences Use Scenario in the GEOSS Architecture Implementation Pilot – Phase 3 (AIP-3)

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EuroGEOSS, GENESIS, and UncertWeb FP7 projects Response to the GEOSS AIP-3 CFP

1 Overview

Natural ecosystems are in rapid decline. Major habitats are disappearing at a speed never observed before. The current rate of species extinction is several orders of magnitude higher than the background rate from the fossil record (Condition and Trends Working Group, 2005).

Protected Areas (PAs) and Protected Area Systems are designed to conserve natural and cultural resources, to maintain biodiversity (ecosystems, species, genes) and ecosystem services. In this proposal we describe a use scenario that will aid protected area system designers and protected area managers to understand the representativeness of the system or PA, and to qualify its status, trends and threats.

This scenario will make use of modeling components whereby a variety of geospatial data is integrated with species presence/absence and/or abundance data and processed using one or more modeling algorithms to predict evolution of PAs ecosystems.

This proposal is based on the previous experiences of GEOSS IP3 (Nativi et al., 2007; Khalsa et al., 2009) and AIP-2 (GEOSS AIP-2, 2009a, 2009b) for climate change and biodiversity. It aims to develop a multi-disciplinary use scenario (involving climate change and biodiversity SBAs) and to further enhance the IT framework developed in those contexts.

Part of this use scenario is taken from the FP7 EuroGEOSS (www.eurogeoss.eu) and from the FP7 UncertWeb (www.uncertweb.org) projects. Components and services underpinning the scenario are contributed by the same European project and by the FP7 GENESIS project (www.genesis-fp7.eu)

2 Proposed Contributions

2.1 Societal Benefit Area Alignment and Support

The use of protected areas to help preserve the planet's biodiversity is a well established practice. However, biodiversity loss does occur in protected areas. Habitat degradation and climate change are the primary contributing factors to loss, yet their impacts are difficult to monitor accurately and forecast.

The proposed contribution consists of a web based decision-making tool for assessing environmental changes due to anthropogenic activities, including climate change. In particular, the development of the modelling web service for habitat computation will allow the community to assess possible environmental consequences, an issue requiring interoperability of information across disciplines and advanced modelling from multi-scale heterogeneous data sources. The use of open standards for spatial data and of open source tools for the development of the core functionalities of the system are further expected to encourage the participation of the scientific community beyond the current partnerships.

The starting point for this scenario will be represented by e-Habitat, currently developed as a web processing service (WPS) by the Monitoring Natural Resources for Development (MONDE) group of the Institute for Environment and Sustainability (IES) of the Joint Research Centre (JRC) of the European Commission, and by species occurrence data mediated via GBIF (Global Biodiversity Information Facility).

The purpose of the original developments made in MONDE was to assess the state and pressure of Protected Areas (PAs) and to prioritize them accordingly, in order to support decision making and fund allocation processes (Hartley et al. 2007). Among the main indicators proposed by this research for assessing the vulnerability of regions of ecological interest, the Habitat Irreplaceability Index (HRI) is one that can take very different values depending on the choice of the thematic maps used to define habitats (Farber & Katmon, 2003). By setting up e-Habitat as a WPS capable of computing the Habitat Irreplaceability Index (HRI) from a selection of thematic maps defined by the end-users, some flexibility on the information used to define these habitats is provided. By fine tuning the definition of the habitats, end-users can either focus on habitats that are suitable for a given species only or, inversely, extend the definition of the habitat set by default to choosing broader ecological conditions. A simple illustration of the computation of the HRI is given in Figure 1.

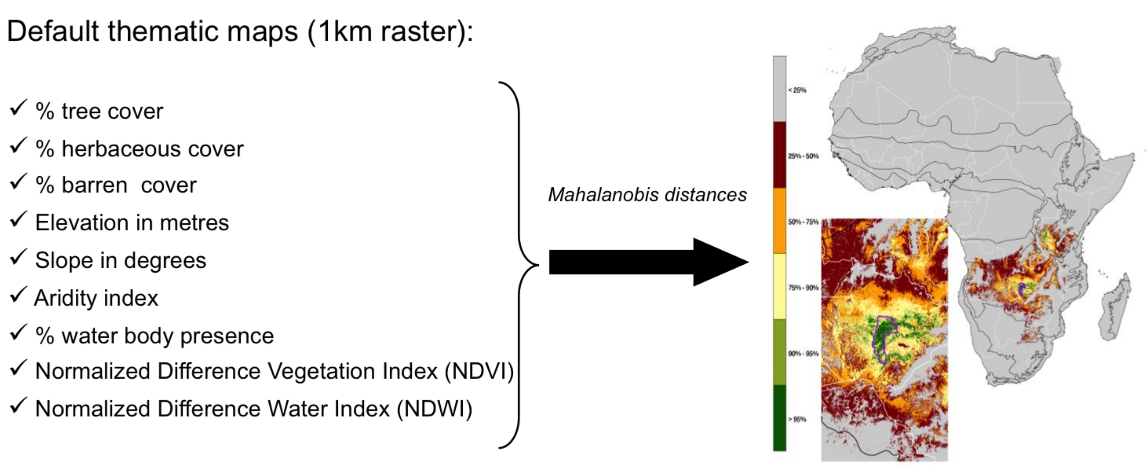

Figure 1 - Example of computation of the HRI for protected area of Kafue, Zambia –nine thematisms are considered

PAs are characterized according to indicators of their how irreplaceable they are in terms of species composition and uniqueness of habitat, and exposure to pressure from anthropogenic sources. In contrast to regular surveys of fauna and flora that can be expensive to conduct, monitoring habitats can benefit from well established earth observation systems and techniques that can systematically and cost-effectively capture most of the environmental parameters that characterize habitats.

The e-Habitat model is currently used in the context of DOPA (Digital Observatory for Protected Areas) – a biodiversity information system currently being developed as a set of interoperable web services. DOPA uses various datasets acquired from a wide range of biodiversity stakeholders world wide and from remote sensing information. Models of habitats are derived from these data; the search for additional datasets coming from other thematic areas (e.g. agriculture, land-use, etc.) is potentially very beneficial.

To achieve that, the proposed scenario will integrate the e-Habitat framework with the EuroGEOSS brokering framework which is based on the successful experimentation conducted in AIP-2 for the climate change and biodiversity area (GEOSS AIP-2, 2009a, 2009b). Semantics and workflow services will be integrated making use of the framework which has been developed by the GENESIS project.

This framework contributes to facilitate the prediction of climate change impact on PAs. In fact, the broker allows to submit the outputs of climate models as inputs to the e-Habitat model. Besides, the proposed framework enables involving information from other domains (agriculture, drought, etc.) into the habitat computation.

2.1.1 Use Scenario

From an end-user point of view, the main steps composing the scenario are the following –let us consider a user interested in modeling habitats of elephants in a region of Africa:

1. Through the web client, the end-user displays species occurrences to identify the areas in Africa where observations have been reported –this allows the user to first define the area (denoted as *origin area*, from now on) from which a standard model of habitat needs to be computed.
2. The user selects the *Area Of Interest* (denoted as *AOI*, from now on): the area for which the habitat will be computed.
3. Through the web client, the user accesses a catalog service allowing him/her to discover and select further thematic layers that can be potentially used for modeling the habitat.
4. Default settings in the web client launch the automatic computation of a probability map using the nine thematic layers shown in Figure 1. The result will be a raster map with values ranging between 0-100% showing the likelihood to find, in the *AOI*, habitats with characteristics similar to the *origin area*.
5. These default settings can be skipped and the catalog can be used to select other thematic maps for the region of interest.
6. The process is repeated several times considering different meaningful habitats.

The repetitive process of simulating various habitats allows for contrasting species occurrences with various combinations of thematic maps/ecological parameters. This approach permits the identification of the main factors to be considered when defining ecological niches. In Figure 2 the steps above are depicted by a business process sequence diagram.

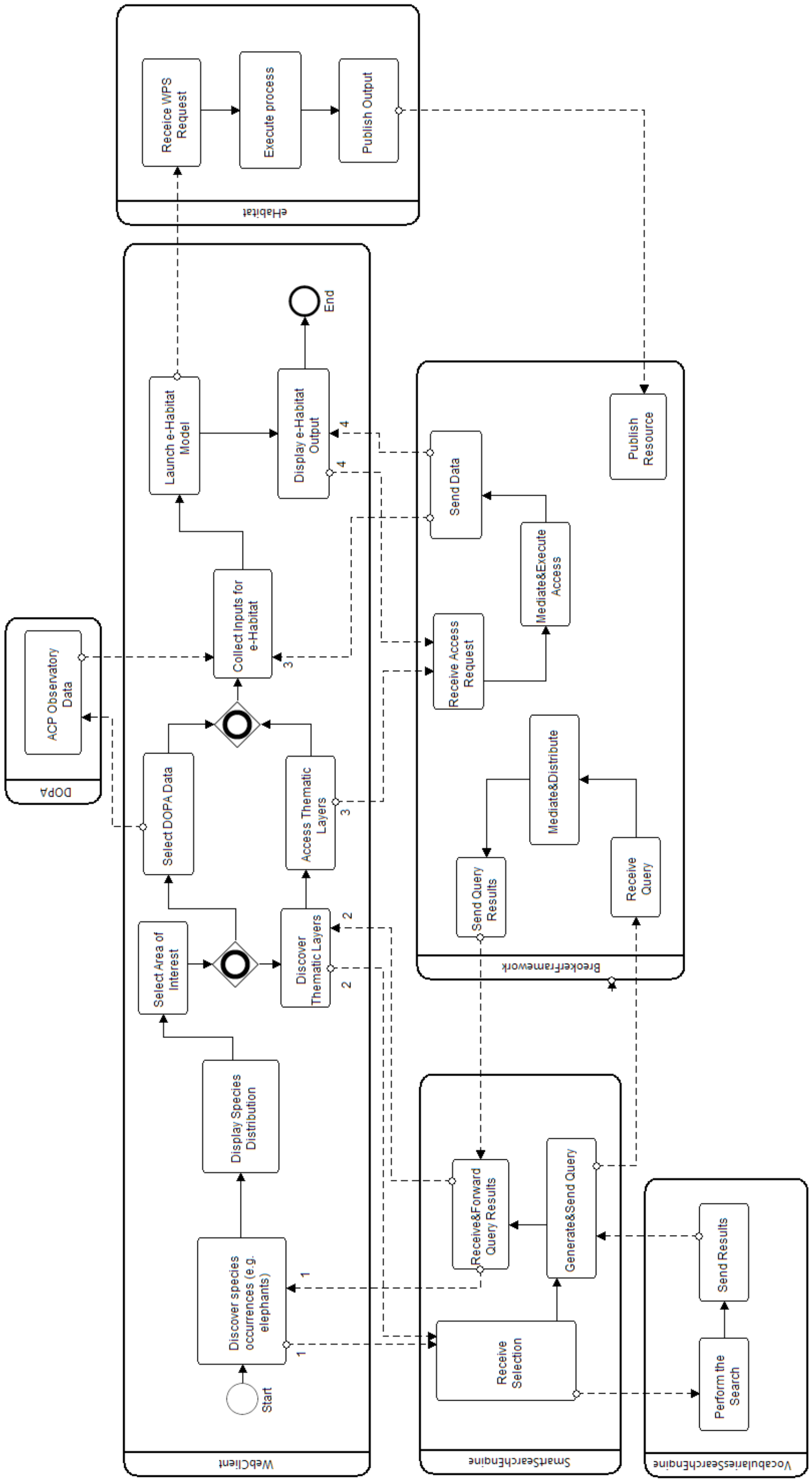

Figure 2 – Simplified Business Process of Use Scenario Steps

2.1.2 Users

Users for this scenario are:

Governmental and International Organizations

Many governmental and international organizations, such as the United Nations Environment Program, and the European Commission, are responsible for policy formulation and programming of environmental and forestry actions in developing countries. The work described in this pilot could drastically improve the monitoring of protected areas, and thus benefit these organizations when designing and implementing policies, programs and projects.

Similarly, the African nations and Regional Economic Communities (RECs) have national services in charge of protected area management, which could easily access important information on biodiversity value and threats in a systematic way; this is essential to prioritize their interventions in the same way as other services.

Countries

Most countries have their own projects of biodiversity conservation in African areas and could put in perspective their interventions with other protected areas. These national projects might also contribute to the richness of the information system developed in the frame of this work.

Non Governmental Organizations

Many NGOs have developed “hot spots” of biodiversity (based on values and threats) at a broad scale (e.g. Conservation International with an important analysis by Myers et al., 2000). For the first time, this analysis is done at the level of individual protected areas. The efforts of the conservation NGOs can be better spatially focused with this approach.

Civil Society

There is an increasing request for scientific information on biodiversity by the wider public. Giving access to robust and consistent information on the biodiversity value of and the threats on protected areas can augment and sustain the interest of civil society in conservation issues.

2.2 Component and Service Contributions

The EuroGEOSS/GENESIS/UncertWeb FP7 projects will host, register and operate a broker component –developed by EuroGEOSS and based on the IP3/AIP-2 Brokering&Mediation component (GEOSS AIP-2, 2009a, 2009b); this framework will be advanced with the semantics and workflow services implemented by the GENESIS and UncertWeb projects. This component enables the federation of resources (datasets, services, etc.) from several domains, exposing them through standard interfaces:

- OGC CSW Core;
- OGC CSW ISO Application Profile;

- OGC CSW ebRIM/EO Extension Package;
- OGC CSW ebRIM/CIM;
- OGC CSW OpenSearch Extension.

Moreover, it implements mediation services (i.e. implements specific interoperability arrangements) important for the Biodiversity and Climate Change Communities, namely:

- GBIF RESTful protocols and data models;
- THREDDS/OPeNDAP/netCDF protocols and data models.

The EuroGEOSS broker may interoperate with other registered components and services to assist in the realization of the CFP SBA scenarios.

It may contribute to the implementation and testing of GEOSS functionalities, such as:

1) Access functionalities: once a resource is discovered it must be accessed;
    a. Broker solutions to manage heterogeneity.
    b. Mediation and adaptation solutions.
2) Workflow functionalities: resource chaining.
    a. Light and flexible environments.
    b. Mediation and adaptation solutions.
3) Models composability through services chaining solutions.
4) Semantics based services (e.g. advanced discovery and queries).

The e-Habitat model will be developed and registered in GEOSS as a WPS resource –part of the EuroGEOSS and UncertWeb activities.

A basic composition service (i.e. composition as a service approach) for managing the discovery, access and chaining (translucent approach) of services and models will be developed and registered in order to perform the scenario steps.

2.3 Architecture and Interoperability Arrangement Development

The main objective of this scenario is to illustrate the interoperability benefit of coupling the e-Habitat model with a discovery and access broker framework enhanced by ontology capabilities for discovering and selecting thematic maps.

Further, the linking of e-Habitat outputs with the species occurrence data accessed through the GBIF network (an interoperability arrangement and related mediation service are required) will allow end-users to define various possible Ecological Niche Models (ENMs) for given species, as well as to identify areas with similar habitats.

In a model web context (Geller & Turner, 2007), outputs of other web processing services generating environmental data (e.g. outputs derived from climate change models) can be beneficial for impact assessments on the HRI. Similarly, the use of different sources of thematic maps can also help in assessing the sensitivity to changes of a habitat model.

As far as system architecture is concerned, the scenario will be implemented leveraging the IT framework developed in the context of GEOSS IP3 (Nativi et al., 2007; Khalsa et al., 2009) and AIP-2 (GEOSS AIP-2, 2009a, 2009b) for the climate change and biodiversity SBAs.

The brokering framework will be enhanced in order to support an ontology based discovery mechanism. In fact, this is considered a crucial requirement when dealing with composition of environmental models –*A mature model web will need mature ontologies, for example, as well as descriptors of models and the services they offer* (GEO, 2009). From this point of view the EuroGEOSS/GENESIS/UncertWeb FP7 projects aim to contribute to the definition/refinement of existing standards.

EuroGEOSS, GENESIS, and UncertWeb FP7 projects will contribute to the refinement of the GEOSS AIP architecture including how the broker and Model Web components fit into the GEOSS Architecture Engineering Viewpoint.

EuroGEOSS, GENESIS, and UncertWeb FP7 projects will recommend where open standards are not currently meeting the needs of the disciplines including draft recommendations to the standards developing organizations based upon the GEOSS “Special Arrangements."

EuroGEOSS, GENESIS, and UncertWeb FP7 projects will compare the proposed Special Arrangements of the discipline systems with the Interoperability Arrangements based on open standards. Where the open standards are unable to fulfill the functionality achieved with the Special Arrangements, the EuroGEOSS, GENESIS, and UncertWeb FP7 projects will convey these gaps to the SIF and to the relevant standards developing organizations, including recommendations on further development of open standards based upon the Special Arrangements.

EuroGEOSS, GENESIS, and UncertWeb FP7 projects will help to test and experiment with the Special Arrangements recognized by the SIF. EuroGEOSS, GENESIS, and UncertWeb FP7 projects will help investigating the full integration of components which implement "interoperability arrangements" services. EuroGEOSS, GENESIS, and UncertWeb FP7 projects will contribute and refine the overall architecture of GEO Task AR-09-01b

The EuroGEOSS, GENESIS, and UncertWeb FP7 projects will provide a demonstration framework for the GEOSS *Model Web Development* (GEO, 2009) in order to experiment with model components interoperability.

3 Description of Responding Organization

The proposers of this response are three European FP7 Projects:

1. EuroGEOSS project
2. GENESIS project
3. UncertWeb project

As for projects members, the main contributing organizations are:

1. Joint Research Centre (JRC) of the European Commission.
2. Global Biodiversity Information Facility (GBIF).
3. Italian National Research Council (CNR).
4. BRGM - Centre scientifique et technique (BRGM).
5. Aston University (AU).
6. University of Munster (UOM).

3.1 FP7 EuroGEOSS Project

The EuroGEOSS project will contribute to an increased capacity for scientists from different disciplines to work together, sharing data and models with less effort. This collaboration will develop better understanding and better predictions of environmental phenomena and their social impacts. While the program is focused initially on the European information infrastructure, the developments have global implications for advanced monitoring of the health of our planet. Improved knowledge is crucial to underpin action by government, and industry, but also by individuals, who can make a real difference through changes in their daily activities. For this reason, EuroGEOSS will exploit the latest development of the Web that allow for social networks and communities to contribute information, and share their knowledge on their local environment.

More information is available at: http://www.eurogeoss.eu

3.2 FP7 GENESIS project

The Genesis project has the objective of providing those involved in environment management and health services in Europe with an efficient, web-based solution for monitoring air quality, fresh and coastal water quality and their impacts on health. The advanced, ICT-based solution that will result from this research and development will combine open, collaborative information networks while integrating systems that already exist in Europe.

More information is available at: http://genesis-fp7.eu/

3.3 FP7 UncertWeb project

Increasingly data and model components are being exposed as services, typically web services. Integrating components to form a processing chain that addresses a particular problem provides a very flexible method for modeling.

When chaining services of limited, or unknown, quality, uncertainty must be accounted for if rational decisions are to be made. UncertWeb develops mechanisms, standards, tools and testbeds for accountable uncertainty propagation within an interoperable model web context.

More information is available at: http://www.uncertweb.org/

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