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An introduction to the Digital Observatory for Protected Areas (DOPA) and the DOPA Explorer (Beta)

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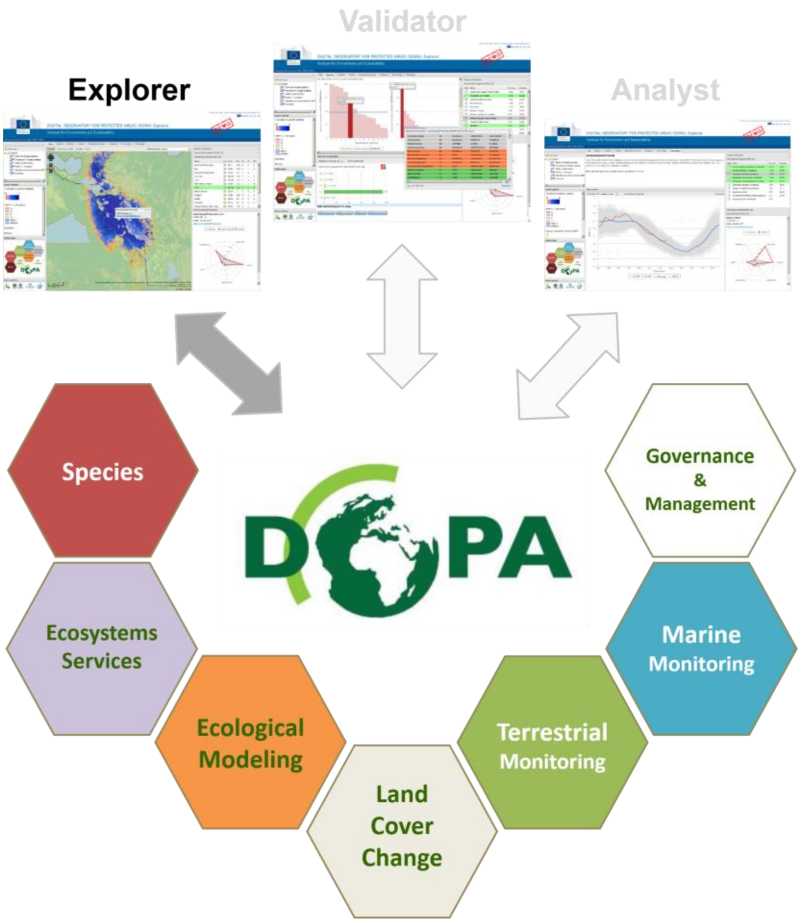

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"*We are drowning in information, while starving for wisdom. The world henceforth will be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely*."

E. Wilson, 1998, Consilience

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Abstract

The Digital Observatory for Protected Areas (DOPA) has been developed in collaboration with the UNEP World Conservation Monitoring Centre (UNEP-WCMC), the International Union for Conservation of Nature (IUCN), the Global Biodiversity Information Facility (GBIF), and BirdLife International to support the European Union's efforts "*to substantially strengthen the effectiveness of international governance for biodiversity and ecosystem services* (EC/COM/2006/0216 final)" and more generally for "*strengthening the capacity to mobilize and use biodiversity data, information and forecasts so that they are readily accessible to policymakers, managers, experts and other users"* (UNEP/CBD/COP/10/27).

DOPA is conceived as a set of distributed Critical Biodiversity Informatics Infrastructures (databases, web modelling services, broadcasting services, ...) combined with interoperable web services to provide a large variety of end-users including park managers, decision-makers and researchers with means to assess, monitor and possibly forecast the state and pressure of protected areas at local, regional and global scale.

In particular, DOPA aims to

1) **provide the best available material** (data, indicators, models) agreed on by contributing institutions which can serve for establishing baselines for research and reporting (i.e. Protected Planet Report, National Biodiversity Strategies and Action Plans, …);

2) **provide free analytical tools** to support the discovery, access, exchange and execution of web services (databases and modelling) designed to generate the best available material but also for research purposes, decision making and capacity building activities for conservation;

3) **provide an interoperable and, as much as possible, open source framework** to allow institutions to get their own means to assess, monitor and forecast the state and pressure of protected areas and help these to further engage with the organizations hosting critical biodiversity informatics infrastructures.

It is the purpose of this document to introduce the readers to a first version of one of the tree main windows to the services provided by the DOPA, **DOPA Explorer** (Beta version). As a web based tool available to everyone with an access to the internet, DOPA Explorer provides simple means to explore around 9000 marine and terrestrial protected areas that are greater than 150 km^2, identify those with most unique ecosystems and species, and assess the pressures they are exposed to because of human development. Ecological data derived from near real-time earth observations are also made available although currently limited to African protected areas.

Two other main interfaces to our web services are in planned for the period 2014-1016:

DOPA Validator will allow registered users to validate/invalidate the information summarized in DOPA Explorer and provide additional observations about individual protected areas. Because DOPA Explorer is generating the core indicators automatically, ground truth validation is essential, in particular for those areas where information is scarce or where our models give poor results.

DOPA Analyst will be providing end-users with a broad range of modelling tools for forecasting climate change impact on protected areas, assessing connectivity, computing niche models or to allow end-users to simulate consequences of adding or removing a protected area on regional indicators.

Most important, this document should also be seen as an invitation for the readers to engage in discussions with us and help improve our work to support the safeguarding of biodiversity.

Keywords: Protected areas, biodiversity, pressures, indicators, ecological monitoring and modelling, web services, OGC

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Core data sets and web services used in DOPA have also been made available by the following organizations: UNEP-WCMC, IUCN, GBIF and BirdLife International,

Additional data sets used in the analyses have been made available by the following organizations and projects: CIESIN, USGS, NASA, UNEP, UN-MDG, VGT4Africa, VMAP, WorldClim, WRI and WWF. We also acknowledge NASA EOSDIS FIRMS, LANCE as the data source of the active fire data and the University of Maryland for providing the MCD45 product on burned areas.

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1. Introduction

Protected areas play a key role in conservation programs and in the sustainable use of natural resources. Science-based conservation requires that one has access to a wealth of information on species, ecosystems and threats at the level of the protected area but also at the regional scale to assess priorities, an information that is frequently difficult to access and needs to be regularly verified.

The Digital Observatory for Protected Areas (DOPA) has been developed in collaboration with the UNEP World Conservation Monitoring Centre (UNEP-WCMC), the International Union for Conservation of Nature (IUCN), the Global Biodiversity Information Facility (GBIF), and BirdLife International to support the European Union's efforts "*to substantially strengthen the effectiveness of international governance for biodiversity and ecosystem services* (EC/COM/2006/0216 final)" and more generally for "*strengthening the capacity to mobilize and use biodiversity data, information and forecasts so that they are readily accessible to policymakers, managers, experts and other users"* (UNEP/CBD/COP/10/27).

The DOPA is derived from an earlier effort where African protected areas were assessed using objective continent-wide data sets (Hartley et al., 2007) to provide decision makers with a tool, the African Protected Areas Assessment Tool (APAAT[1]), to assess the state of African protected areas and to prioritize them according to biodiversity values and threats to support decision making and funding allocation processes. In contrast to the APAAT where most of the data was collected only once and then processed to generate a static set of indicators published on a web site, the DOPA is built around a set of interoperable web services hosted at different institutions. This architecture greatly eases the overall update of the selected data sets and indicators and allows developers to propose an almost infinite number of web based tools for different end-users. Last but not least, although focusing on developing countries, the DOPA allows for global assessments (Dubois et al., 2009, 2010).

Assessing protected areas for biodiversity conservation at national, regional and international scale, implies that methods and tools are in place to evaluate their physical features such as their proximity to one another, their species assemblages including the frequency and abundance of threatened species, the uniqueness of their ecosystems as well as the threats these areas are exposed to. Typical requirements for such tasks are data on protected areas, information on species distributions and abundance as well as their status on the IUCN Red List of Threatened Species, and information on ecosystems to assess their irreplaceability and monitor changes. By integrating all these data consistently in various indicators, protected areas can not only be evaluated individually but also contrasted against each other for setting conservation priorities. Given the huge amount of information potentially available, information systems need to be developed to ease the processes of collecting, preparing and integrating the data required by the computation of the indicators (Figure 1).

1.1. The African Protected Areas Assessment Tool (APAAT) legacy

The African Protected Areas Assessment Tool (APAAT) was a first step towards the development of such an information system to assess 741 Sub Saharan protected areas across 50 countries. In contrast to existing systematic assessments of conservation priorities tending to focus on large bio-geographical units which are relevant at either the country or regional level, the APAAT was looking at systematic assessments of the conservation value of existing planning units at continental scales. Hartley et al. (2007) used information on 280 mammals, 381 birds and 930 amphibian species, and a wide range of climatic, environmental and socio-economic data to generate a number of key indicators designed to assess the state and pressure of protected areas and to prioritize them accordingly, in order to support decision making and funding allocation processes.

[1] http://bioval.jrc.ec.europa.eu/APAAT/

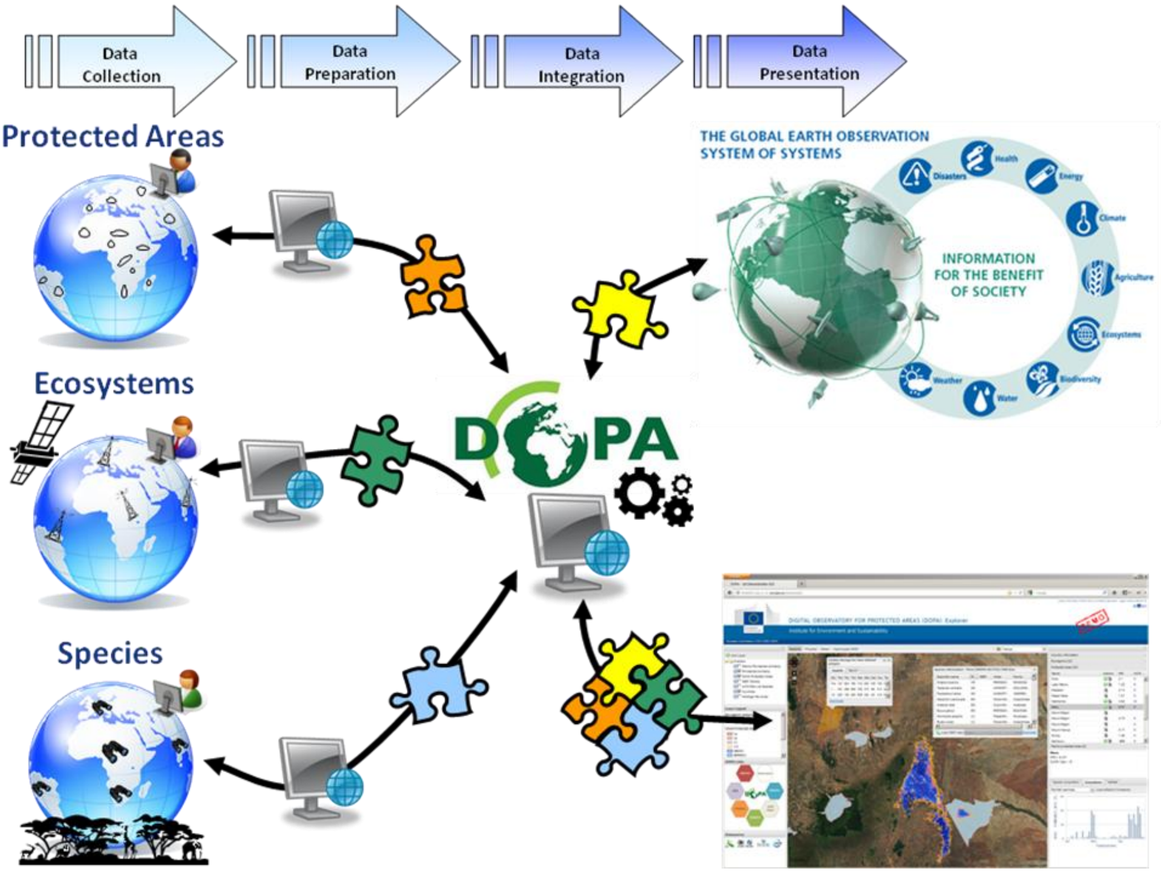

FIGURE 1. FROM GROUND BASED AND REMOTE SENSING OBSERVATIONS TO ENVIRONMENTAL INDICATORS: DATA NEED TO BE COLLECTED, PROCESSED AND PREPARED TO ALLOW THEIR COMBINED USE AND INTEGRATION

A biodiversity value for each protected area was derived from indicators assessing the irreplaceability of the habitat and of the species computed for three taxa (mammals, birds and amphibians). The higher the values of these indicators, the higher the ranking of the protected area in any potential prioritization scheme. Similarly, two pressure indicators estimating (i) the population pressure and (ii) the amount of agriculture found in the vicinity of the protected area were also derived.

An experimental environmental monitoring system was also put in place to detect anomalies in observations of fires, rainfall or vegetation growth. These data were collected on a dekadal (10 days) basis in each protected area and contrasted against 10 years of historical records.

1.2. From the APAAT to DOPA, evolving from web pages to web services

The growing number of requests for global assessments and for reference information for other regions motivated the development of the APAAT beyond Africa as well as beyond terrestrial ecosystems. The increasing interest of policy makers in measuring management effectiveness of protected areas further stimulated the setting up of a new information system capable of capturing observations from the field and generate regular assessments. However, as for most environmental information systems, the large variety of data types and sources used by the APAAT render its maintenance and further developments uneasy. Indicators are interlinked and any change to a dataset will affect the values of all connected indicators at the level of the country and ecoregion. Changes to protected areas (e.g. changes to park boundaries, gazetting of a protected area) and the availability of new information on species, threats, etc. also require from the information system to have all indicators routinely updated. Such regular changes are possible only in an environment where data can be easily exchanged between data providers and processed by a large informatics infrastructure. This is not the case for the APAAT which is mainly a one-shot assessment using information downloaded from the Internet and supported by a basic infrastructure.

All of these limitations motivated the reorganization of the APAAT around a set of independent but interoperable web services managed by different institutions. This strategy is encouraged by GEOSS, the Global Earth Observation System of Systems[2], and its biodiversity component, GEO-BON[3] (Global Earth Observation Biodiversity Observation Network), which have been put in place to better coordinate the efforts to improve and streamline information systems.

Among the main recommendations made by these initiatives, the most commonly encountered when setting up infrastructures involving the exchange, processing and modelling of data are that data should be

1) managed as close as possible to its source;
2) collected once and documented to allow their use for many purposes;
3) easily retrievable and accessible by others;
4) interoperable at the syntactic and semantic level to allow their combination for multiple purposes;
5) scalable, when applicable, to match other scales;
6) shared and, possibly, processed through common, free open-source software tools;
7) preserved in persistent repositories and accessible for retrieval by future users.

Similarly, the main functions and models used to compute the indicators are likely to evolve as well and their update would require that these can be easily understood and tested thoroughly. This can be best achieved by adopting an interoperable, open source, development framework aiming to put in place a number of independent but interacting components (models, databases, visualization tools ...).

1.3. Contributions from Critical Biodiversity Data and Models Infrastructures

The Service Oriented Architecture (SOA) adopted for developing the DOPA is relying on a few institutions that have the mandate to maintain a number of essential databases and services (databases, web modelling services, broadcasting services, etc.). By relying mainly on the following critical infrastructures, DOPA is stimulating as much as possible a culture of "quality control" for robust science through the whole data process: from the harvesting of the data to their mixing with other sources by different experts when generating new information. The organisation of DOPA around a web based distributed computing technology should further ease the maintenance and processing of the information. End-users will require only an access to the internet and a web browser to access millions of records, run models and always access the latest information that is available. Similarly, the same infrastructure will allow end-users to contribute with their own information and knowledge to the global information.

The institutions hosting these critical infrastructures are briefly introduced hereafter but the list is likely to grow in the future to better address all aspects of the cross-disciplinary dimensions of biodiversity conservation.

[2] http://www.earthobservations.org/
[3] http://www.earthobservations.org/geobon.shtml

1.3.1. The UNEP World Conservation Monitoring Centre (UNEP-WCMC)

The UNEP World Conservation Monitoring Centre (UNEP-WCMC) is the biodiversity assessment and biodiversity policy support arm of the United Nations Environment Programme. The Centre's core business is locating data about biodiversity and its conservation, interpreting and analysing that data to provide assessments and policy analysis, and making the results available to both national and international decision makers and businesses. Since 1981 UNEP-WCMC has been identifying and compiling information on the protected areas of the world to produce a comprehensive global dataset and maps. The resulting dataset, known as the **World Database on Protected Areas (WDPA)**[4], is widely utilized by policy makers, park managers and by industry. UNEP-WCMC's work on protected areas is carried out in close collaboration with the IUCN World Commission on Protected Areas and the IUCN Programme on Protected Areas.

1.3.2. International Union for Conservation of Nature (IUCN)

The IUCN is the world's first and largest global environmental organization with more than 1,200 member organizations including 200+ government and 900+ non-government organizations. It is a network of almost 11,000 voluntary scientists and experts, grouped in six Commissions in some 160 countries. The IUCN has also Official Observer Status at the United Nations General Assembly. The IUCN is managing the **IUCN Red List of Threatened Species**[5] which is the most comprehensive and authoritative source on the conservation status of biodiversity. Currently, the Red List includes assessments for ~50,000 species, with many taxa having been globally assessed, including all mammals, birds, amphibians, freshwater crabs, conifers, and cycads.

1.3.3. BirdLife International

BirdLife International is a global partnership of conservation organizations focusing on birds, their habitats and global biodiversity. BirdLife International is also the official **Red List Authority for birds** for the IUCN Red List, supplying the categories and associated detailed documentation for all the world's birds to the IUCN Red List each year. Key activities for DOPA are the **Important Bird Area** (IBA) **Programme**[6] and the **World Birds database**[7]. The purpose of the IBA programme is to identify, protect and manage a network of sites that are significant for the long-term viability of naturally occurring bird populations, across the geographical range of those bird species for which a site-based approach is appropriate. The IBA Programme is global in scale and, to date, over 10,000 sites have been identified world-wide, using standard, internationally recognized criteria for selection. The World Birds Database is an authoritative source of high-quality data, amassed by a global conservation partnership of over 115 leading national organisations.

1.3.4. The Global Biodiversity Information Facility (GBIF) Secretariat

The Global Biodiversity Information Facility (GBIF) Secretariat is facilitating free and open access to **species data** worldwide via the Internet to underpin sustainable development. GBIF provides currently access to almost 400 million records derived from **specimen collections and field observations**[8]. Priorities, with an emphasis on promoting participation and working through partners, include mobilizing biodiversity data, developing protocols and standards to ensure scientific integrity and interoperability, building an informatics architecture to allow the interlinking of diverse data types from disparate sources, promoting capacity building and catalysing development of analytical tools for improved decision-making.

1.3.5. The Joint Research Centre of the European Commission

Satellite-based approaches are a cost effective method to support monitoring efforts of protected areas and can provide historical as well as up to date information on a broad range of bio-climatic variables that can be used to characterize ecosystems and their changes as well as their functions.

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[4] http://www.wdpa.org/
[5] http://www.iucnredlist.org/
[6] http://www.birdlife.org/datazone/site
[7] http://www.worldbirds.org/
[8] http://data.gbif.org/welcome.htm

The Institute for Environment and Sustainability (IES)[9] at the European Commission's Joint Research Centre (JRC), has been leading efforts in **assessing global ecosystem conditions and land cover changes** as well as the health of the marine environment using **earth observations**. Close to policy makers, the LRM unit is working on further making available more than 10 years of historical records of ecological conditions of protected areas. More recently, it started coordinating the development of a number of web based modelling services to assess impact of EU policies and of climate change on biodiversity.

1.4. Open Data and Model services supporting DOPA

While most end-users of services provided by DOPA are expected to access these over the internet, the development strategy and the **open source and interoperable framework** of the main functionalities of DOPA will allow the deployment of local instances of DOPA. This approach is expected to encourage, where needed, the adoption of a number of international standards that are already in use by the community as well as to engage with the institutions that are responsible for the critical biodiversity data and model infrastructures. More than ever, the global dimension of biodiversity related issues requires that a common language is used for collecting, interpreting and synthesizing the information handled (Edwards, Lane, Nielsen, 2000).

By encouraging everyone to adopt an open access to non-sensitive biodiversity data, in particular the **Conservation Commons** and **GEOSS Data Sharing Principles**, we expect the community of end-users and data providers to largely contribute to the improvement of the material made available. On the modelling side, the open source models (using mainly R and python) are also expected to be more easily shared and tested and eventually adapted to local needs where required.

For various technical, scientific and even managerial reasons, the development of DOPA was articulated around 7 core data and model services (Figure 2). The scopes of these services will be summarized in the following sections and advanced users and software developers will find at the following address a more detailed list of the web services underpinning the DOPA: http://dopa-services.jrc.ec.europa.eu/services/. This directory of services is continually updated.

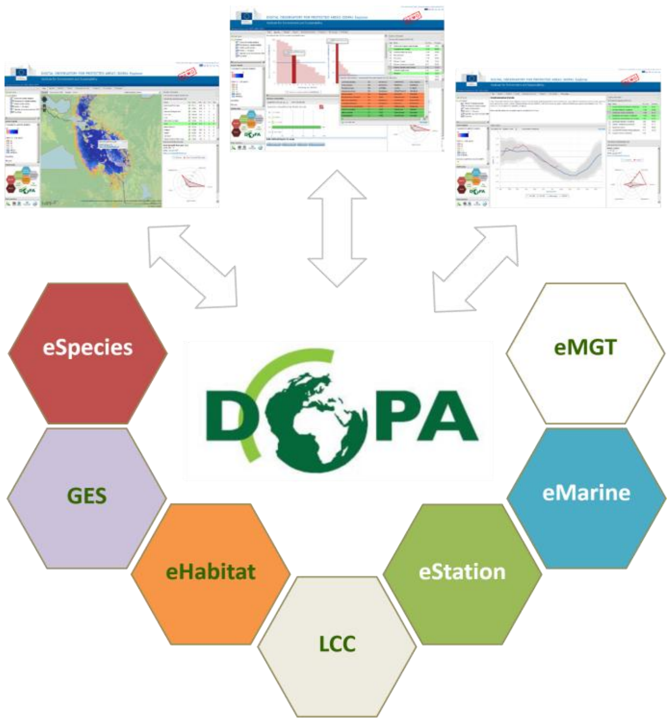


FIGURE 2. ORGANIZATION OF THE CORE DATA AND MODEL SERVICES SUPPORTING THE DOPA

[9] http://ies.jrc.ec.europa.eu/

1.4.1. eSpecies for indicators on species richness and diversity

eSpecies, the Species Analyst in Figure 2, is mainly conceived as a node of the DOPA to process species data, generally hosted by other key institutions such as BirdLife International, GBIF or IUCN, in view to compute a number of indicators on species compositions, species richness and irreplaceability. eSpecies will also provide end-users with means to give these partners feedback on the presence/absence of species in protected areas. As a result, web clients and services of eSpecies will allow end-users to easily map species diversity for their own purposes and further validate species information.

Access eSpecies from http://especies.jrc.ec.europa.eu/

1.4.2. Ecosystem services

The mapping of Global Ecosystem Services (**GES**) is an initiative of the JRC to supply maps of Ecosystem Services provided by different types of ecosystems across various spatial scales (Maes et al., 2012). The "benefits that humans derive from ecosystems", as ecosystem services are defined, support human societies globally through food and water provision, regulation of water flows, use of natural areas for recreation etc. In support to the Ecosystem Service Partnership (http://www.es-partnership.org/), this mapping service is focusing in DOPA on the main ecosystem services provided by protected areas. The Ecosystem Service Mapping service will further provide end-users with quantitative information on an ecosystem service of interest for a specific protected area, its surroundings, or an entire region.

Access the GES from http://ges.jrc.ec.europa.eu/

1.4.3. eHabitat for habitat and ecological niche modelling

eHabitat is conceived as a Web Processing Service (WPS) for computing the likelihood of finding ecosystems with similar properties. A variety of web clients have been developed for different end-users to allow for ecological forecasting in protected areas considering different climate change scenarios, for performing ecological niche modelling or for identifying unique habitats. End-users of the WPS can define the thematic layers for input to the model from various sources, including their own ones. These input layers include data ranging from remote sensing data to socio-economic indicators, thus offering a huge potential for multi-disciplinary modelling (see e.g. Skøien et al., 2012, Dubois et al., 2013)

Access eHabitat from http://ehabitat.jrc.ec.europa.eu/

1.4.4. eStation for the monitoring of terrestrial ecosystems

The **eStation** is a collecting and processing service designed by JRC to automatically deal with the reception, processing, analysis and dissemination of key environmental parameters derived from remotely sensed data. The measurements are obtained from the SPOT/VGT, SEVIRI/MSG and TERRA-AQUA/MODIS Earth Observation systems. In addition to the web processing service, the eStation offers a number of web clients made available to different end-users for computing ad-hoc thematic products and environmental indicators. Focusing on terrestrial ecosystems, all processing steps of the eStation are easily configurable allowing the user to modify the generated environmental indicators and to implement new ones. The eStation exist as a standalone service and has been distributed in 43 African countries (see Clerici et al., 2013).

Access eStation from http://estation.jrc.ec.europa.eu/

1.4.5. eMarine for the monitoring of marine ecosystems

In essence similar to the eStation, **eMarine** is dealing with earth observations for the marine environment. Monitored physical variables are typically the sea surface temperature and bathymetry. Bio-optical variables used are the coefficients of absorption and particulate backscatter, data on chlorophyll concentration as well as the surface productive layer.

Access eMarine from http://gmis.jrc.ec.europa.eu/

1.4.6. Land cover change and threats to protected areas

Land cover change (**LCC**) is among the main threats to protected areas and the JRC is working on means to quantify these changes in and around protected areas using web based tools. A web based tool for assessing the impact of protection on land cover in and around protected areas is already in use in a systematic sampling exercise carried out by BirdLife International and RSPB (Beresford et al. 2013). 100m sample boxes are placed at regular intervals across an Important Bird Area and the 20km buffer zone surrounding it. In the frame of the DOPA, the tool proposed by Bastin et al. (2012) will be integrated in the DOPA Validator to assess pressures on protected areas.

Access the landcover change site from http://landcover-change.jrc.ec.europa.eu/

1.4.7. Protected areas governance and management effectiveness

In its infancy, this service will focus on management effectiveness (**eMGT**) and protected area governance. It will include means for collecting and analysing information from the field on management and governance (see Hockings 2003) and a service for mapping conservation and research activities in protected areas, ranging from NGOs to governments and universities.

2. The DOPA Explorer

DOPA was developed in response to the European Parliament's call to support the ambitious Convention on Biological Diversity (CBD) mission for 2020: to halt the loss of biodiversity and to share the values and benefits of biodiversity and ecosystem services equitably. In decision X/2, the tenth meeting of the Conference of the Parties (October 2010, Nagoya, Aichi Prefecture, Japan) adopted a revised and updated Strategic Plan for Biodiversity, including the Aichi Biodiversity Targets[10], for the 2011-2020 period. This new plan is the overarching framework on biodiversity, not only for the biodiversity-related conventions, but for the entire United Nations system. It consists of five strategic goals, including twenty Aichi Biodiversity Targets which comprise both aspirations for achievement at the global level, and a flexible framework for the establishment of national or regional targets. Among the targets, Parties agreed to at least halve and where feasible bring close to zero the rate of loss of natural habitats including forests and they established a target of 17 % of terrestrial and inland water areas and 10 % of marine and coastal areas to be conserved through area-based conservation measures. Parties also agreed on a strategy on resource mobilisation, with a substantial increase in the level of financial resources in support of implementation of the Convention. Parties agreed to translate this overarching international framework into national biodiversity strategy and action plans within two years.

The EU is strongly committed to further strengthening the CBD as the key international instrument for achieving global biodiversity targets and to making sure that it is effectively implemented. Because protected areas are the cornerstone of biodiversity conservation, DOPA has been developed by the Joint Research Centre of the European Commission to assess the state of and pressures on protected areas on a global scale to support policy making. It can also help prioritising protected areas according to their biodiversity and the pressures to which they are exposed, and consequently supports decision making and funding allocation processes. Built around the distributed computing technology discussed in the introductory chapter, DOPA has also the ambition to become a reference information system to assess, monitor and possibly forecast biodiversity in protected areas at the global scale with a focus on developing countries.

Available to everyone with an access to the internet, DOPA proposes a set of selected interfaces to access more easily the underpinning reference data and model services. Our first interface, **DOPA Explorer (Beta, 2013-10-24 , Rev. 3069), provides simple means to explore, analyse and compare the existing reference information on species and ecosystems that is available on protected areas at the country and ecoregion levels**. End-users can use DOPA Explorer to identify the protected areas with the most unique ecosystems and species or assess the level of pressure coming from agriculture or population. DOPA Explorer also includes a monitoring system based on earth observations to assess every 10 days the situation on the ground for a number of critical variables (fires, NDVI, rainfall, etc.).

By exposing all possible errors and inconsistencies that are present in the data and/or derived from the models, DOPA Explorer is also encouraging improvements and feedback from all experts. It is therefore the objective to have in a second stage the **DOPA Validator** (first version planned for 2014-2015) which will allow registered users to update/validate/invalidate the information presented in DOPA Explorer. DOPA Validator has the ambition to become a bidirectional information exchange system which can **bring together all actors** on the ground, from park managers to researchers and decision makers.

[10] http://www.cbd.int/sp/targets/

A third component planned for 2015-2016, **DOPA Analyst,** will be designed to allow end-users to benefit more from the modelling infrastructure to compute, for example, the impact of a climate change scenario on the habitats of a selected species (see e.g. the use of eHabitat for such purpose as discussed in Dubois et al., 2013), the indicators in the DOPA Explorer for any area specified by the end-user, or the potential loss of biodiversity when deleting a protected area (Figure 3).

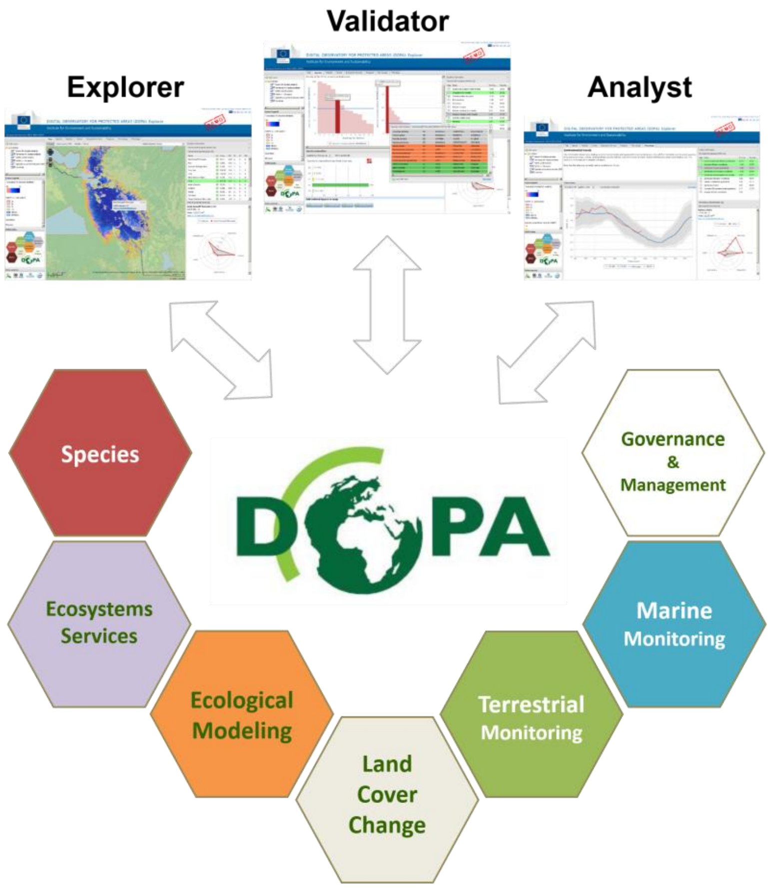


FIGURE 3. THREE MAIN WEB CLIENTS WILL BE PRODUCED FOR END USERS. DOPA EXPLORER WILL PROVIDE THE INFORMATION FOR A SET OF REFERENCE INDICATORS, DOPA VALIDATOR WILL ALLOW EXPERTS TO VALIDATE/INVALIDATE THE REFERENCE MATERIAL AND THE DOPA ANALYST WILL PROVIDE THE MEANS TO GENERATE SIMULATIONS OF DIFFERENT ENVIRONMENTAL AND POLICY SCENARIOS.

2.1. End Users

As for the APAAT, DOPA Explorer is "*intended to aid policy and decision makers in the allocation of development funds for sustainable management of natural resources. In identifying the protected areas with the greatest need for attention, and the countries with the greatest need to meet internationally agreed development goals, our aim is to encourage the more effective allocation of conservation related development assistance*".

The user groups of DOPA Explorer are therefore expected to be similar to the end-users of the APAAT, as listed below:

European Commission (EC)

DG DEVCO. Development and Cooperation – EuropeAid is the Directorate–General (DG) responsible for designing EU development policies and delivering aid through programmes and projects across the world. For the past 20 years, the European Commission has been an important donor for protected area conservation, especially in Africa. Commission projects and programmes aim to improve the management of protected areas and to develop conservation techniques. The EU also seeks to boost regional co-operation and help people to share information on good practice.

DG ENV. The DG Environment makes sure that Member States correctly apply EU environmental law. In doing so it investigates complaints made by citizens and non-governmental organisations and can take legal action if it deems that EU law has been infringed. The DG also finances projects that contribute to environmental protection in the EU. Since 1992 some 2,600 projects have received some financing from LIFE, the EU's financial instrument for the environment. DG Environment represents the European Union in a number of environmental matters at international meetings, in particular the Convention on Biological Diversity, and further supports the establishment of an Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

EEAS. The European External Action Service (EEAS) are in charge of the day-to-day management of EC policies, programs and projects since the devolution process, which aims to bring decision making and implementation closer to the beneficiaries. This tool can provide valuable information both for programming at the national and regional level and for implementing programs and projects at the local level.

UN organisations (CBD, UNEP) and Multilateral Environmental Agreements

National Biodiversity Strategies and Action Plans (NBSAPs) are the principal instruments for implementing the Convention on Biological Diversity (CBD) at the national level. The Convention requires countries to prepare a national biodiversity strategy (or equivalent instrument) and to ensure that this strategy is mainstreamed into the planning and activities of all those sectors whose activities can have an impact (positive and negative) on biodiversity. The United Nations Environment Programme (UNEP) is the United Nations system's designated entity for addressing environmental issues at the global and regional level. Its mandate is to coordinate the development of environmental policy consensus by keeping the global environment under review and bringing emerging issues to the attention of governments and the international community for action. DOPA Explorer can support these organisations by facilitating access to integrated baseline information, providing the web services required to generate their information and contribute to the monitoring of the progress towards the 2020 Aichi targets. Similar contributions can be expected to support the International Platform on Biodiversity and Ecosystem Services (IPBES). The prioritization approach of DOPA Explorer can also help the Global Environment Facility (GEF), the financial mechanism of the CBD, in supporting developing countries and countries with economies in transition to achieve the objectives of the CBD and generate global environmental benefits in the area of biodiversity.

Governments

Governments have their own local, national and international biodiversity conservation projects. National and regional services in charge of protected area management can easily access important information on biodiversity value and threats in a systematic way and prioritise their interventions in the same way than EC services or simply compare their indicators with those proposed here.

Non-Governmental Organisations (NGOs)

NGOs have a long history in contributing to biodiversity conservation - from local to global activities. DOPA Explorer provides a unique tool providing information at the level of individual protected areas facilitating the definition of local priorities. Often active in situ, NGOs will find in DOPA Explorer simple access to the reference information which can sometimes be very different from the reality. Local experts can therefore easily assess how well the local situation is assessed and, in a second stage, get back to the data providers to correct the information used by the decision makers.

Researchers

In contrast to the APAAT, the information proposed in DOPA Explorer is global and can be extracted in raw formats. Plots, tables and maps can be downloaded and reused for further analysis. DOPA Explorer is also designed to ease as much as possible access to data which are usually time consuming to access and process.

2.2. DOPA Explorer Beta

DOPA Explorer (Beta, release 2013-10-24, Rev. 3069) is our first version of DOPA Explorer and it should be seen as a mock up, an experimental information system to be assessed and discussed with a broad range of potential end-users. The concept of web services is often too complex to communicate to non-experts and the development of this Beta version illustrates well the benefits of bringing together a broad range of data types and models using a web based distributed computing technology. We do hope it will help us to capture better user requirements, and to improve the proposed indicators and interfaces before releasing DOPA Explorer 1.0 in 2014. All of the information presented in DOPA Explorer is available directly from the DOPA REST Services[11] and can be used outside of the DOPA Explorer – DOPA Explorer is a web client, in other words, one possible view of the underlying information.

DOPA Explorer Beta is currently limited to all protected areas from the WDPA that are larger than 150 km^2, i.e. around 9 000 protected areas across the globe, and information on around 50 000 species from the IUCN Red List. Although recognizing the essential contribution of smaller areas in preserving biodiversity as well as of other types of conservation areas, in particular Indigenous Peoples' and Community Conserved Territories and Areas (ICCAs) to preserving biodiversity, we had to restrict ourselves for the time being to the processing of a limited amount of geospatial information. As a comparison, the complete WDPA database (May 2013)[12] consists of 206.000 protected areas, of which 31.000 do not have information about the boundaries. The protected areas included in DOPA Explorer Beta cover 90 percent of the area covered by WDPA (89 percent of the terrestrial area and 91 percent of the marine area).

The web client has the same core objectives as those of the APAAT, in particular to provide decision makers with a tool to assess the state of protected areas and to prioritize them according to biodiversity values and threats so as to support decision making and fund allocation processes. Users of the APAAT will therefore be familiar with most of the concepts and indicators described in this report.

DOPA Explorer Beta has many limitations which we hope to reduce with time. Putting aside the computational challenges in distributing data from different services (they all need to be running 24/7) to potentially a large number of users, some of the services in DOPA Explorer Beta are restricted to a region. The ecological monitoring of rainfall and vegetation activity is limited to Africa; the maps of carbon storage are globally available only for the tropical regions. Although perfectly scalable, DOPA Explorer currently provides information on a global 1km^2 grid in Mollweide projection (4 km^2 grid for some marine applications). Last but not least, marine protected areas have not been analysed as well as the terrestrial areas, a huge gap which will be at the centre of our attention for the release of the next version. Similarly, we do not show yet any information about the past and ongoing funded activities occurring in protected areas. This information will be made available in DOPA Explorer 1.0 planned for 2014.

In the following, readers will find a manual on how to use the DOPA Explorer (Section 3) as well as more details about the information proposed and the possibilities offered by the tool (Section 4). Those who are already familiar with the APAAT will easily recognize the core indicators even if the navigation process has been completely revised.

[11] http://dopa-services.jrc.ec.europa.eu/services/

[12] http://www.wdpa.org/

3. Using the graphical user interface of DOPA Explorer Beta in 6 steps

Step 1: Accessing DOPA Explorer and language selection

Open up your web browser, **preferably Google Chrome or Firefox,** and go to http://dopa.jrc.ec.europa.eu/explorer/

An interface similar to the one shown below (
Figure 4) should open up and display a global map with protected areas. The figures shown in this chapter are simplified when compared to the interfaces developed.

The default setting is English but you will find a selection of other possible languages (en/fr/es/pt) in the upper right corner of the browser. Note that selecting another language will relaunch your web page and that previous interactions with DOPA Explorer will be reset.

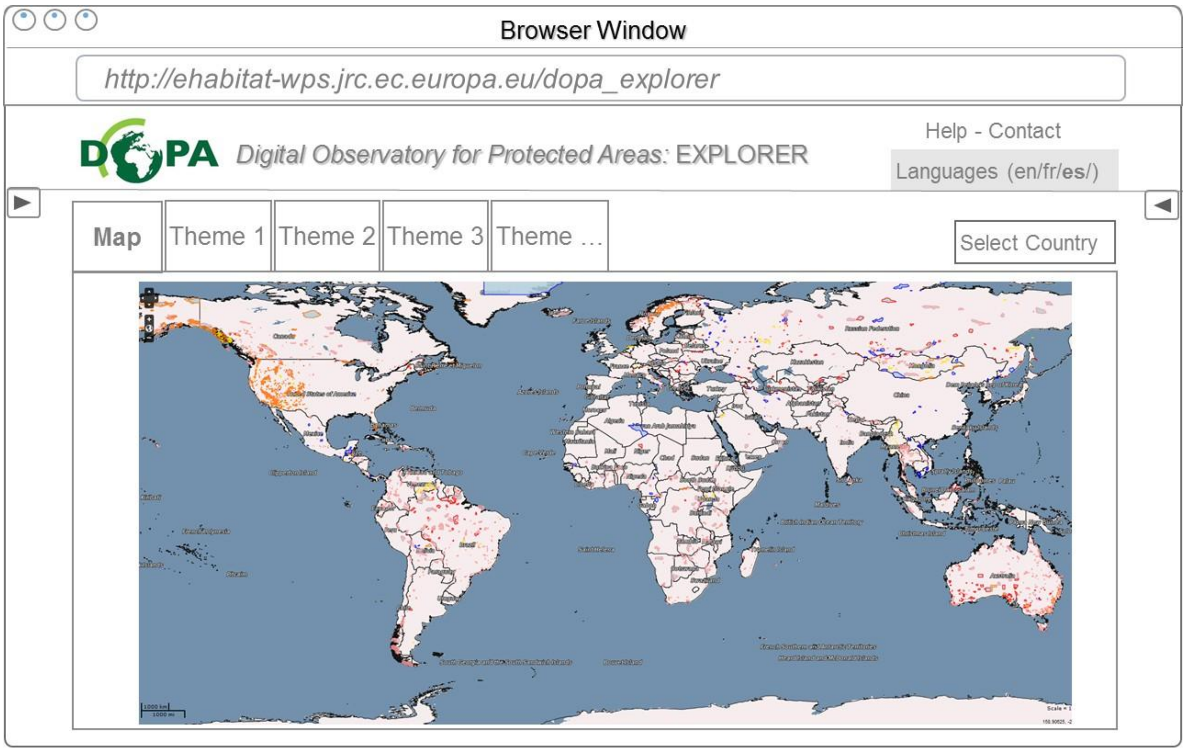


FIGURE 4. MOCK-UP REPRESENTATION OF THE MAIN INTERFACE OF DOPA EXPLORER BETA. FIRST STEPS REQUIRE THE SELECTION OF A WORKING LANGUAGE (GREY SHADED)

Tips:

You can increase/decrease the size of the text and figures from the interfaces by pointing the mouse to any region of the web browser and using Ctrl and + (magnifying) or Ctrl and - (minimising). This can be particularly useful if you are using a small screen.

Step 2: Selecting the area of interest

Selecting protected areas can be done in various ways (Figure 5).

- Either geographically, by selecting a protected area directly from the map (double click with the mouse over a protected area);
- By name, that is by selecting first the country of interest from the drop down list (upper right corner) and then by picking the protected area from a list of protected areas (see step 3);
- By indicators (pressure, species richness) by interacting with the tables and histograms. This will be discussed in a later stage.

As soon as a country /protected area is selected, a new navigation panel will appear in the right of the browser (see next step)

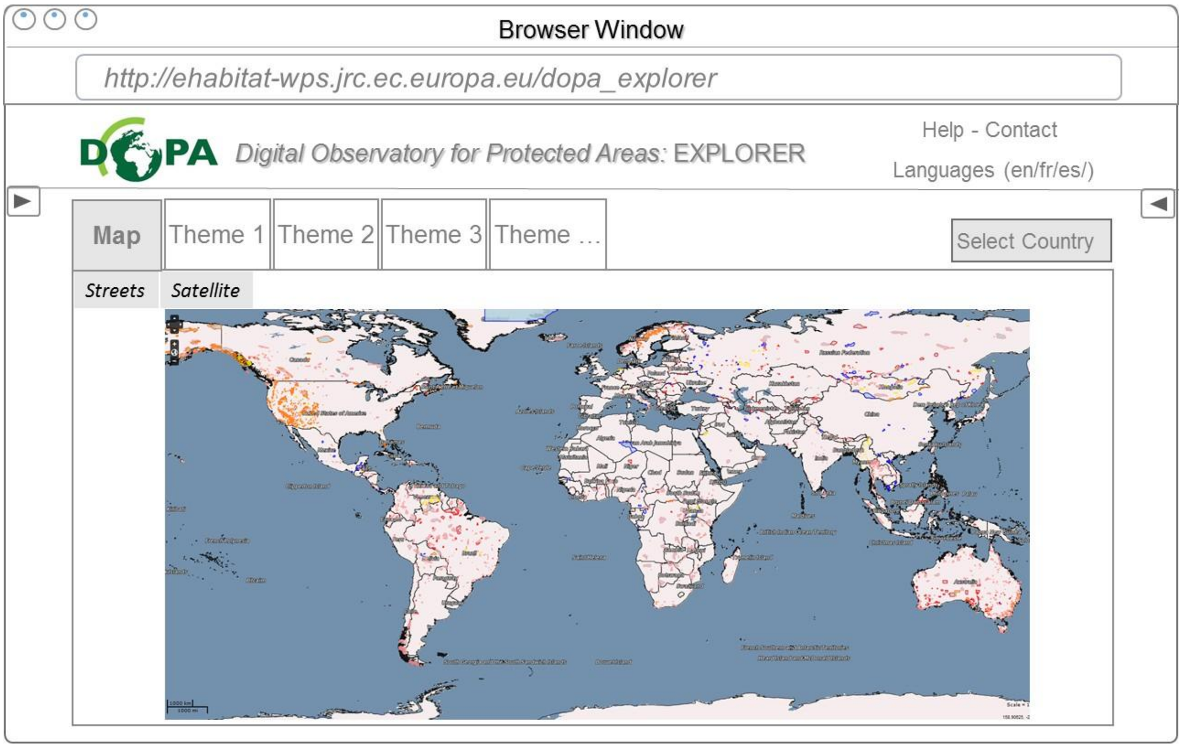


FIGURE 5. MOCK-UP REPRESENTATION OF THE MAIN INTERFACE OF DOPA EXPLORER BETA SHOWING THE MAIN PANEL. DIFFERENT BACKGROUND MAPS CAN BE CHOSEN AND THE COUNTRY SELECTION WILL DISPLAY THE RIGHT NAVIGATION PANEL (GREY SHADED)

Tips:

You can interact with the map using the navigation buttons from the map window (upper left corner), by selecting the area of interest with the mouse (left click button and delineate the area), or by double clicking on the protected area. The middle scrolling button of the mouse also allows zooming in and out of the map.

Should the loading of the background maps be too slow, you can select the Open Layers maps that are faster to load in the browser. The other background maps that are available are Satellite, Physical and Street (see upper left options from the map window).

Step 3: Summary statistics from the right navigation panel

Selecting a country will open the right navigation panel (Figure 6). This panel can be opened or closed any time using the arrow button » on the upper right corner of the map window.

The panel will allow you to display summary information on the selected area. From the top to the bottom, one will find

- Country information describing the percentage of the protected surface and the type of protected areas
- Two tabs providing information on the ecoregions and their level of protection. The coverage statistics can be obtained for whole of the WDPA (first tab) or only for the subset analysed in DOPA Explorer (second tab). The number of ecoregions found in the country will appear in brackets near the section “Ecoregions”.
- List of protected areas (one tab is for terrestrial areas, the other one is for the marine areas) found in the country and their respective indicators. The number of documented protected areas found in the country will appear in brackets near the section “Protected Areas”.

Each of these levels can be opened by clicking on the corresponding + buttons present on the right side of each tab.

Further explanation about these indicators and figures are provided in Section 4 of this manual.

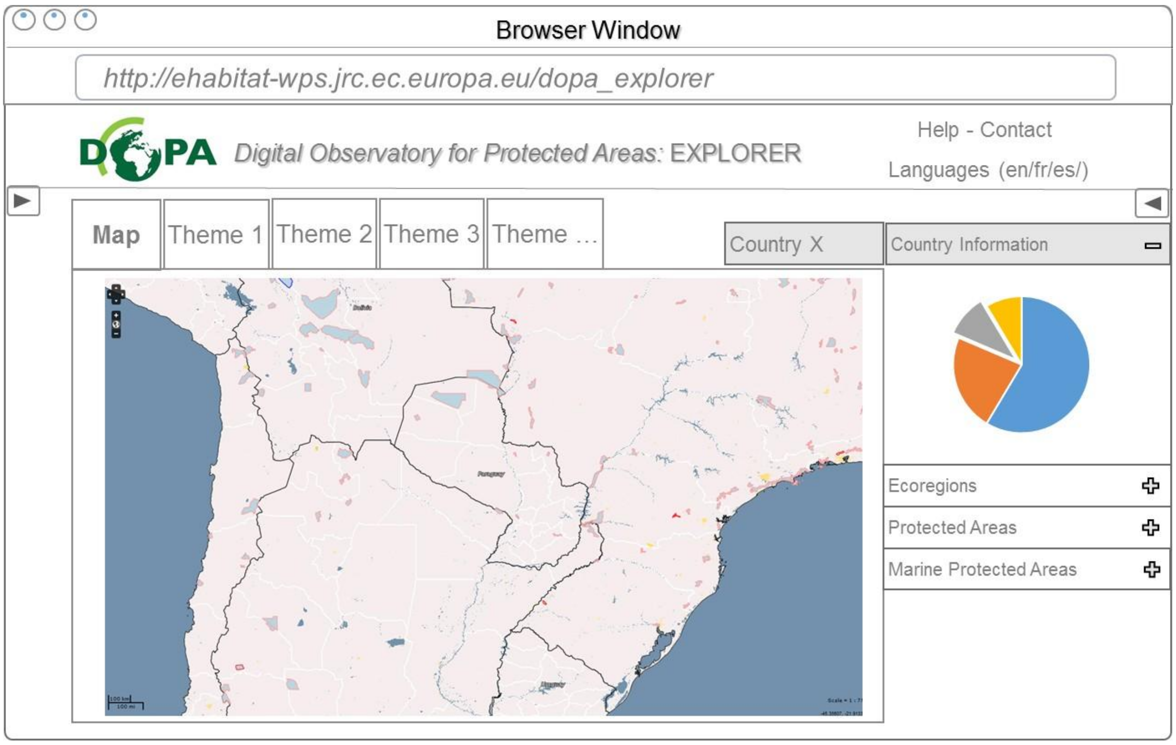


FIGURE 6. MOCK-UP REPRESENTATION OF THE MAIN INTERFACE OF DOPA EXPLORER BETA SHOWING THE RIGHT PANEL PROVIDING ACCESS TO COUNTRY AND ECOREGION STATISTICS (GREY SHADED)

Tips:

Leaving the pointer of the mouse for a few seconds on most headings of the tables will trigger the display of tooltips providing more information on the meaning of the headers.

Step 4: Selecting a protected area

A protected area can be analysed either by directly selecting it from the map (double click on the area) or by opening the table of protected areas from the right navigation panel (the table can be opened by clicking on the + button of the bar with the title "Protected Areas") and by selecting the name of the protected area. When a protected area is selected, the associated row will be highlighted in green in the table, the map will automatically be centred on the selected area and a radar plot presenting the main indicators will appear in the lower right window (Figure 7). More details about each of these indicators and figures are provided in Section 4.

The table with the protected areas, for which a count is indicated in brackets near the header, will show from left to the right

- the name of the protected area
- an action (display map) button

and a set of indicators (Ind. 1., Ind. 2, Ind. 3) for the protected area, namely

- the surface of the protected areas and their IUCN Category (see Section 4.2)
- the Species Irreplaceability indicator (see Section 4.3.)
- the Habitat Replaceability Indicator (see Section 4.4)
- the Population and Agricultural Pressure Indicators (see Section 4.7)

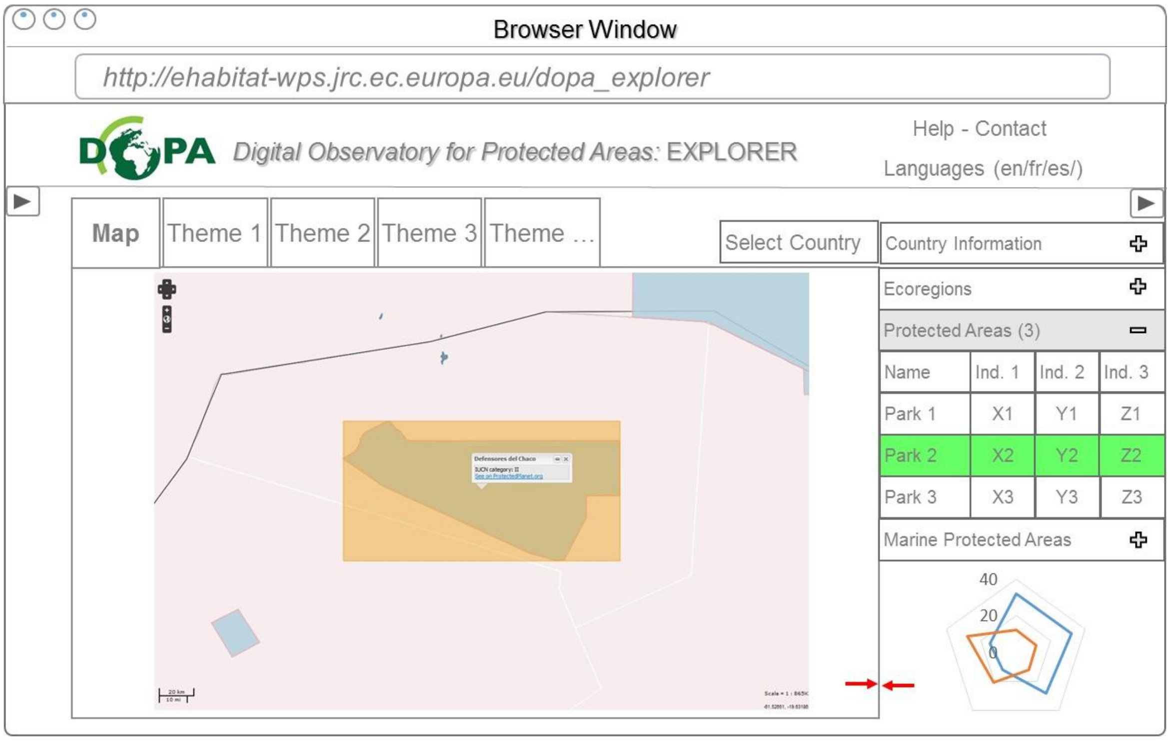


FIGURE 7. MOCK-UP REPRESENTATION OF THE MAIN INTERFACE OF DOPA EXPLORER BETA SHOWING A SELECTED PROTECTED AREA (GREY SHADED) AND THE RIGHT PANEL PROVIDING ACCESS TO THE LIST OF PROTECTED AREAS FOUND IN A COUNTRY AS WELL AS SUMMARY STATISTICS OF THE CORE INDICATORS. THE SIZES OF THE PANELS CAN BE CHANGED BY SLIDING THE BORDERS WITH THE MOUSE (RED ARROWS)

Tips:

Each of these columns can be sorted alphabetically/numerically by click on the header of each column.

Moving the mouse over the name of a protected area will highlight on the map the protected area with an orange bounding box.

The size of the tables and panels can be changed by shifting the borders of the windows and tables with left button hold mouse click. The order of the columns and their width can also be changed.

The tables can be exported to an Excel spreadsheet by selecting the icon on the right of the title bar of each table.

Step 5: Thematic information on protected areas

Once a protected area is selected, a set of indicators and statistics relative to the protected area can be generated and the results visualized in the thematic tabs right to the main mapping window tab (Figure 8).

The current themes are
- Species (theoretical list of species from the IUCN Red List, indicators on species irreplaceability SI);
- Habitats (land cover types, Habitat Replaceability Indicator, HRI)
- Climate (climatic trends and current observations);
- Ecosystem Services (carbon storage);
- Pressures (estimated pressures coming from population density and agriculture);
- Fire Ecology
- Phenology (time series derived from earth observations, i.e. NDVI, NDWI, rainfall)

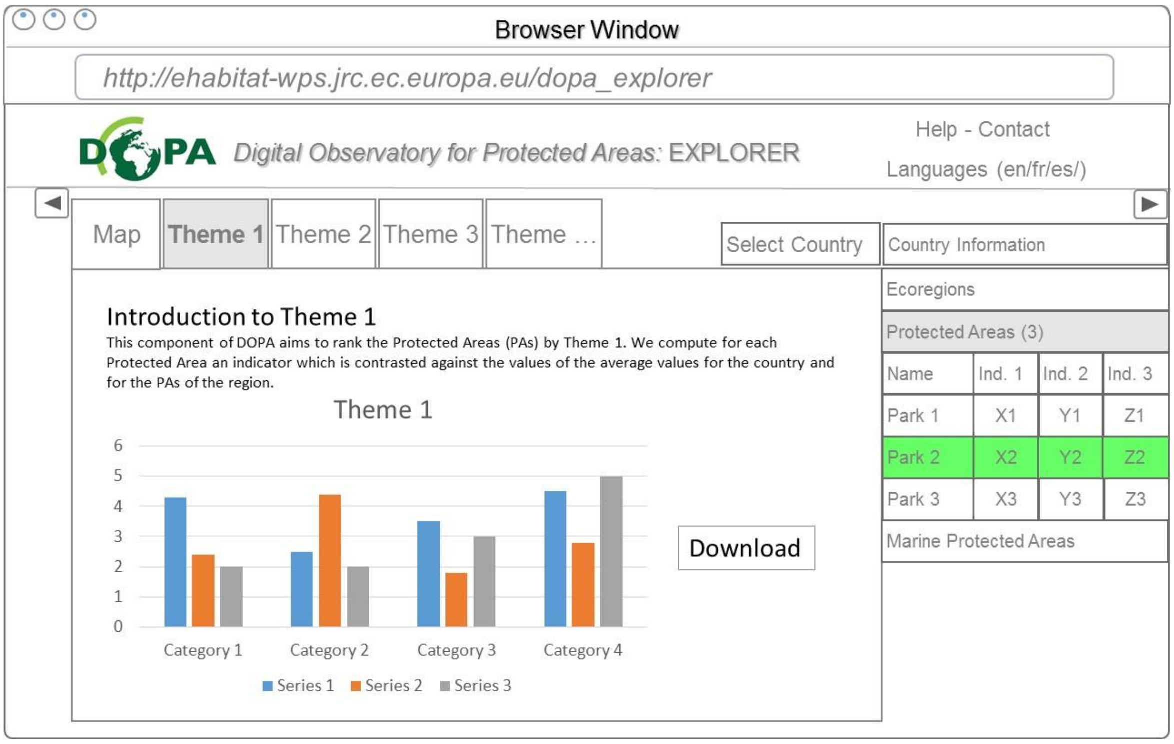


FIGURE 8. MOCK-UP REPRESENTATION OF THE MAIN INTERFACE OF DOPA EXPLORER BETA SHOWING THE DIFFERENT THEMATIC PANELS (GREY SHADED) PROVIDING THE INFORMATION ASSOCIATED TO THE SELECTED PROTECTED AREA.

Each thematic tab will further propose at the bottom of the window a set of related thematic maps available from other sources which can be displayed in the map window. The legend of these maps are accessible from the left navigation panel (see Step 6).

<u>Tips</u>:

Most charts are interactive and can be used to identify other protected areas. Selecting, for example, the protected area with the highest score in terms of species irreplaceability in a histogram, will update the map, tables and charts to match the newly selected protected area.

A few indicators allow protected areas to be ranked against other protected areas of the country. Selecting an ecoregion will further provide the end user with the possibility to compare the scores of the indicators against all protected areas from the same ecoregion.

Step 6: Summary information from the left navigation panel

A left navigation panel can be opened or closed any time using the arrow button on the upper left corner of the map window (Figure 9). As for the right panel, you can resize the left panel by sliding the left border of the map window (indicated with red arrows in Figure 9) with left button hold mouse click.

The navigation panel will allow you to select the information to be displayed in the map window, add maps that are available from other web services and show the legends of all the displayed information. These possibilities are further detailed hereunder.

The “Add layer” button opens a window with a short list of mapping resources available over the web. Selecting the web map service (WMS) of the Center for International Earth Science Information Network (CIESIN-SEDAC WMS) will provide you with a list of popular global datasets, from population densities to regions with natural hazards. Selecting any map from the WMS and adding it to the list of layers (click on “add” in the lower right corner of the window) will update the list of available maps as well as the legend of the information.

The list of layers indicates available maps but displayed are those only with the check box activated. Note that the order of the active maps in the list has an impact on the information shown. The first active map in the list is the top layer that is displayed. You can rearrange the order of the overlays by shifting the name of the layers. This will also affect the order of the information provided in the legend window. A preselected list of maps is proposed but end-users can easily reorganize this by deleting layers (right mouse click) and by loading new layers from the Web Mapping Service (WMS) window.

The last element of the left navigation panel is symbolizing the web services of DOPA that are supporting the DOPA Explorer. In the future, you will access the individual web services from DOPA by selecting the relevant hexagon in the logo.

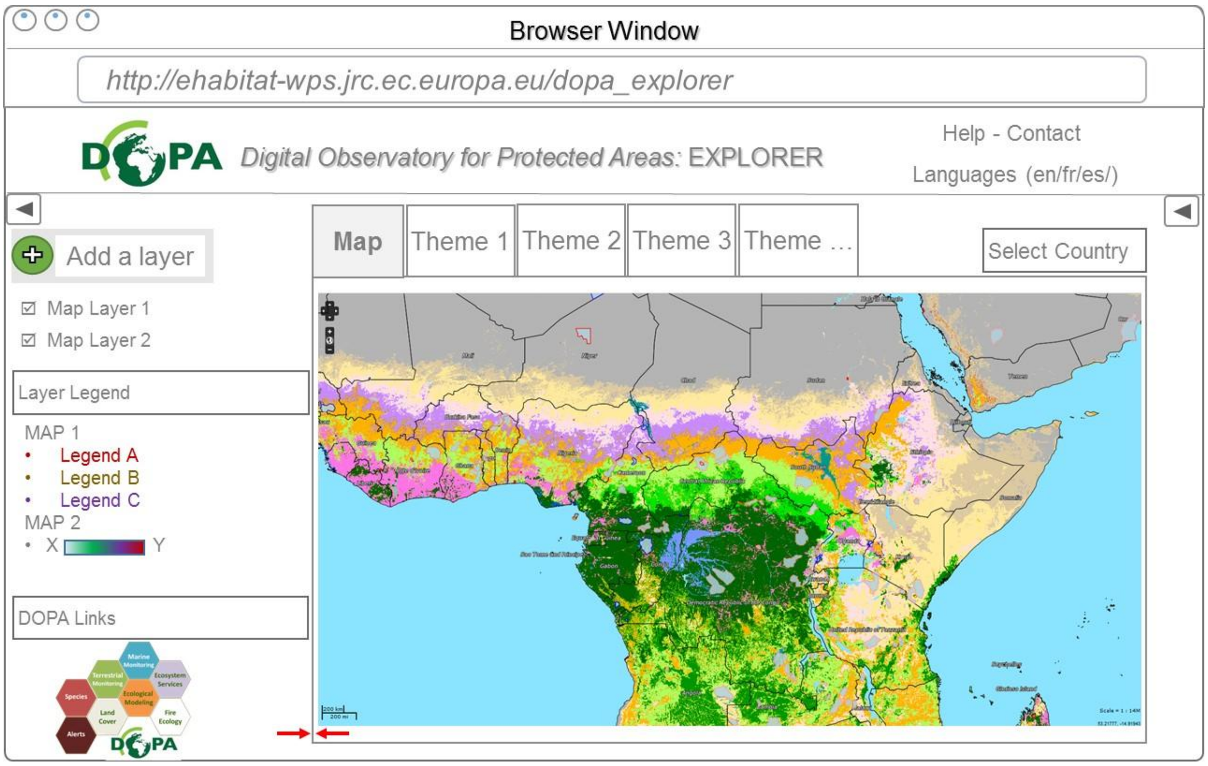


Figure 9. Mock-up representation of the main interface of DOPA Explorer Beta showing the use of the left navigation panel (grey shaded) providing additional means to access and manipulate maps

Tips:

A right mouse click on the name of a layer will allow you to delete the layer or change its opacity.

A left mouse click on the name of a layer will allow you to move the layers and change their order of appearance.

Additional web mapping resources can be added to the list of WMS by entering the address of the WMS (such as http://neowms.sci.gsfc.nasa.gov/wms/wms?) in the right edit box of the add WMS window and using “Load”.

4. Indicators and data sources

4.1. Summary information: stratification by country and ecoregion

The overall objectives of DOPA Explorer are:

1) To contribute to a systematic identification of the protected areas which have the greatest value, in terms of biological resources, and of those which are the most threatened by human development.
2) To contribute to the distribution of baseline information for subsequent validation.
3) To propose means for repeated assessments in a pressure – state – response information system, where threats are "pressures", species and habitat irreplaceability are "state" and decision is "response"
4) To provide means and tools for accessing raw data and maps for further research, management and/or reporting purposes.

DOPA Explorer summarizes most indicators computed at the site level by means of histograms, radar plots and tables at the country and ecoregion level as these are most useful for decision making. For example, each protected area is characterized by a radar plot showing the "scores" of the indicators against the country average (Figure 10). Similarly, the same indicators are contrasted by means of histograms against the indicators of all other protected areas found within the same ecoregion. Should an indicator not be available for a given protected area, the red dot associated to this indicators will not be shown. This can happen for a number of computational reasons that are usually due to topographic errors in the input datasets. Remember that all indicators are computed automatically for all of the 9000 protected areas!

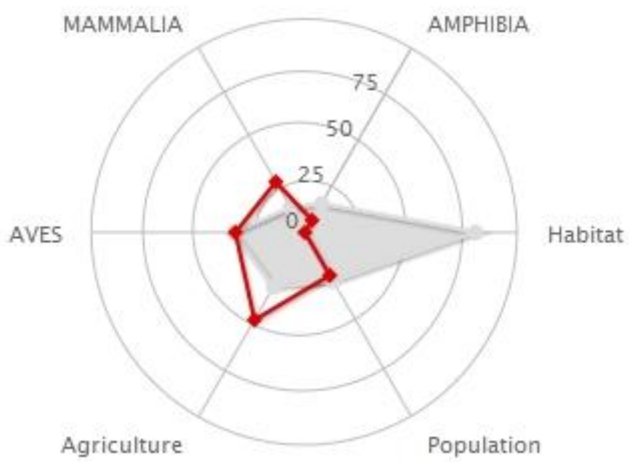


FIGURE 10. RADAR PLOT SHOWING SIX INDICATORS FROM 4 THEMATIC AREAS (SPECIES, HABITAT, AGRICULTURE, POPULATION DENSITY) FOR A SELECTED PROTECTED AREA (IN RED) CONTRASTED AGAINST THE AVERAGE VALUES (IN GREY) OF THE SAME INDICATORS COMPUTED OVER THE AVERAGE OF ALL THE PROTECTED AREAS FOUND IN THE COUNTRY. EACH INDICATOR HAS BEEN SCALED FROM 0 (LOWEST) TO 100 (HIGHEST) TO ALLOW COMPARISON. THE RED DOTS INDICATE THE INDICATORS WHICH COULD BE COMPUTED (IN THIS CASE SHOW HERE ALL INDICATORS COULD BE GENERATED). THE FIGURE CAN BE INTERPRETED AS A PROTECTED AREA WITH A RICHNESS IN BIRDS AND MAMMALS THAT IS ABOVE THE AVERAGE OF THE COUNTRY AND EXPOSED TO HIGH AGRICULTURAL AND POPULATION PRESSURES. ON THE OTHER HAND, THE ECOSYSTEM HOSTING THE SPECIES IN THIS PROTECTED AREA IS VERY LIKELY TO BE RETRIEVED ELSEWHERE, EVEN IF THE COUNTRY IS HOSTING MAINLY PROTECTED AREAS WITH UNIQUE ECOLOGICAL FEATURES.

4.2. Protected areas and regional coverage

Since 1981 UNEP-WCMC has been identifying and compiling information on the protected areas of the world to produce comprehensive global dataset and maps. The resulting dataset, known as the **World Database on Protected Areas (WDPA)**, is widely utilized by policy makers, park managers and by industry. UNEP-WCMC's work on protected areas is carried out in close collaboration with the IUCN World Commission on Protected Areas and the **IUCN Programme on Protected Areas.**

Protected areas are classified by the IUCN according to their management objectives (see e.g. Dudley, 2008). The IUCN Protected Areas Management Categories are recognised by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such is increasingly being incorporated into government legislation.

DOPA Explorer (Beta version) is currently limited to a subset of protected areas from the WDPA. From a total of around 206 000 protected areas hosted in the WDPA in 2013, only those protected areas with a surface greater or equal to 150 km^2 have been used here. We are also describing only protected areas covering mainly terrestrial and marine ecosystems and have not made any distinction for freshwater ecosystems.

From an initial dataset of 9 335 protected areas (situation of August 31 2013) extracted from the WDPA (Version of May 2013) we computed terrestrial indicators for 8 769 protected areas. We processed marine indicators for 868 protected areas, of these 426 also have terrestrial indicators. This means that there were 110 protected areas that were not processed. There are different reasons for this, in some cases computational issues are generating unresolved errors, in other cases the areas represented lakes and glaciers, which are currently not properly assessed by the indicators used here.

4.2.1. Country statistics

The country information panel in DOPA Explorer shows the total surface of the country, the surface that is covered by all of the protected areas (in km2 or % of the country) found in the WDPA and a pie chart that highlights the contribution of the different categories of protected areas (Figure 11).

Country boundaries are provided by GAUL (2013).

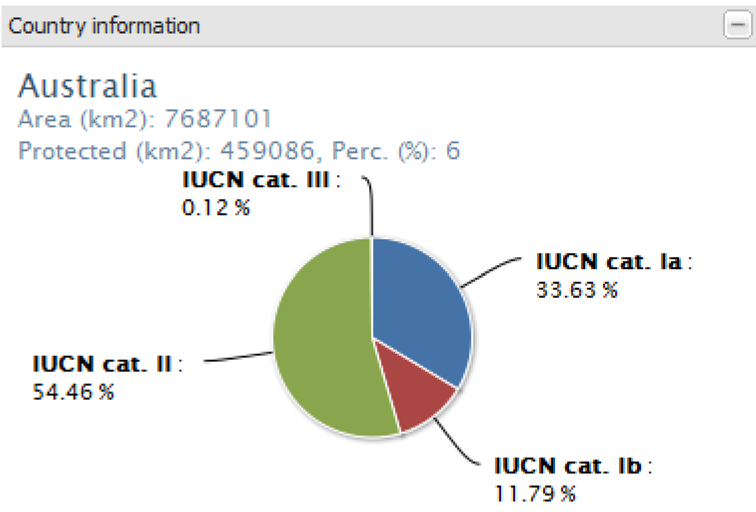


FIGURE 11. COUNTRY INFORMATION IN DOPA EXPLORER SHOWING THE SURFACE OF THE COUNTRY AND THE SURFACE PROTECTED BY THE DIFFERENT MANAGEMENT CATEGORIES OF PROTECTED AREAS. THE RELATIVE CONTRIBUTION OF EACH CATEGORY CAN BE OBTAINED BY MOVING THE MOUSE OVER THE PIE CHART.

The IUCN categories of protected areas[13] are given hereafter.

Ia Strict Nature Reserve
Category Ia are strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphical features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values.

Ib Wilderness Area
Category Ib protected areas are usually large unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.

II National Park
Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities

III Natural Monument or Feature
Category III protected areas are set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.

IV Habitat/Species Management Area
Category IV protected areas aim to protect particular species or habitats and management reflects this priority. Many Category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

V Protected Landscape/ Seascape
A protected area where the interaction of people and nature over time has produced an area of distinct character with significant, ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected area with sustainable use of natural resources
Category VI is a more encompassing classification that is based on a mutually beneficial relationship between nature conservation and the sustainable management of natural resources in correspondence the livelihoods of surrounding communities. A wide range of socio-economic factors are taken into consideration in creating local, regional and national approaches to the use of natural resources..

A number of protected areas will fall in the “not reported” category. Boundaries of terrestrial and marine protected areas are submitted to the UNEP-WCMC by national authorities and they do not provide any indication on their management in some cases. There are also some cases where only the area and a central point location are submitted to UNEP-WCMC, but the exact boundaries are missing. We have chosen to exclude these protected areas from our analyses as the exact location is of high importance for the computation of our indicators.

4.2.2. Ecoregion statistics

We further provide information at the ecoregion level. The coverage statistics can be obtained both for the whole of the WDPA or only for the subset analysed in DOPA Explorer. The ecoregions are provided by the WWF for the terrestrial, freshwater, and marine environments. The Terrestrial

[13] http://www.iucn.org/about/work/programmes/gpap_home/gpap_quality/gpap_pacategories/

Ecoregions of the World (TEOW) data set[14] (Olsen et al., 2001) identifies 827 terrestrial ecoregions. The Marine Ecoregions of the World (MEOW) data set includes 232 ecoregions (Spalding et al., 2007). The ecoregion statistics will show for the selected country the number and the list of terrestrial ecoregions, their coverage of the country (in %), and the percentage that is protected in the country considering all of the WDPA or only for the subset which encompasses all protected areas that are larger than 150 km^2 (Figure 12). Each ecoregion can be displayed on the map.

Terrestrial Ecoregions (WWF) (9)

Map	Name	% of country	% protected	% ecoregion protected
☐	Angolan Miombo woodlands	50.43	10.76	10.29
☐	Western Congolian forest-savanna mosaic	13.58	0.03	3.42
☐	Zambezian Baikiaea woodlands	10.48	35.77	41.81
☐	Angolan scarp savanna and woodlands	5.92	11.62	11.61
☐	Angolan Mopane woodlands	4.08	6.73	12.59
☐	Central Zambezian Miombo woodlands	3.26	0.26	21.02
☐	Namibian savanna woodlands	2.69	36.41	10.48
☐	Kaokoveld desert	1.65	41.50	45.63
☐	Zambezian flooded grasslands	0.26	84.75	57.75

FIGURE 12. ECOREGION INFORMATION IN DOPA EXPLORER SHOWING THE ECOREGIONS FOUND IN THE COUNTRY, THE PERCENTAGE OF THE COUNTRY COVERED BY EACH ECOREGION, THE PERCENTAGE OF THE ECOREGION PROTECTED IN THE COUNTRY, THE PERCENTAGE OF THE PROTECTION OF THE WHOLE ECOREGION. THE TABLES CAN BE EXPORTED IN AN EXCEL SPREADSHEET BY CLICKING ON THE UPPER RIGHT ICON OF THE TITLE BAR.

4.3. Species data and Species Irreplaceability (SI) Indicator

This species component of DOPA Explorer aims to describe the level of coverage provided by the protected areas (PAs) to the species theoretically found in each PA. We therefore compute for each PA a species irreplaceability indicator (SI) that will take into account the number of species found in the PA and the level of coverage provided by other protected areas found in the same country and ecoregion. The higher the SI, the more important is the role of the PA in preserving the species. The SI is derived from the species range maps from the IUCN Red List of Threatened Species (version of November 2011).

4.3.1. The IUCN Red List of Threatened Species (RLTS)

The IUCN Red List of Threatened Species is the most comprehensive and authoritative source on the conservation status of biodiversity. Currently, the Red List includes assessments for ~50,000 species, with many taxa having been globally assessed, including all known mammals, birds, amphibians, freshwater crabs, conifers, and cycads. We use here distribution range maps for more than 30,000 species made available by the IUCN Red List website, or via partners such as BirdLife International. These maps invariably represent current, known limits of distribution for individual species within their native historical range. Although these maps have many uses, they generally have a coarse resolution and consequent limitations. To inform decision-making at the site level, the level at which conservation implementation actually takes place, much finer spatial data are required. For example, the identification of Important Bird Areas (IBAs), developed and promoted by BirdLife International since the early 1980s, has been facilitated by the compilation of locality data for threatened species in, among others, Red Data Books, which subsequently enables 'site-specific synthesis'. This work has subsequently been expanded to include other taxa under the auspices of IUCN and partners to facilitate the identification of Key Biodiversity Areas – sites of known global conservation importance based on confirmed presence of either threatened or irreplaceable biodiversity (where irreplaceable includes restricted-range, congregatory or biome-restricted species). Finally, a third process to identify important conservation sites will involve access to biodiversity information through GBIF, which would serve to make data available for species that

[14] http://worldwildlife.org/publications/terrestrial-ecoregions-of-the-world

have not yet been assessed under the IUCN process (and could permit independent assessment of IUCN species ranges for some taxa). This would also provide point data to allow an outline assessment of the habitat requirements of species, establishing the potential for ecological niche modelling.

Species are classified by the IUCN Red List[15] into nine groups set through criteria such as rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation.

- Extinct (EX) – No known individuals remaining.
- Extinct in the Wild (EW) – Known only to survive in captivity, or as a naturalized population outside its historic range.

Threatened species fall into one of the following three categories

- Critically Endangered (CR) – Extremely high risk of extinction in the wild.
- Endangered (EN) – High risk of extinction in the wild.
- Vulnerable (VU) – High risk of endangerment in the wild.

All other species fall in these last categories

- Near Threatened (NT) – Likely to become endangered in the near future.
- Least Concern (LC) – Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category.
- Data Deficient (DD) – Not enough data to make an assessment of its risk of extinction.
- Not Evaluated (NE) – Has not yet been evaluated against the criteria.

DOPA Explorer Beta uses the IUCN Red List range maps from November 2011.

4.3.2. Species occurrences

The **Global Biodiversity Information Facility Secretariat** (GBIF) is facilitating free and open access to **species data** worldwide via the Internet to underpin sustainable development and provides currently access to almost 400 million records derived from specimen collections and field observations.

4.3.3. Displaying species lists and composition in DOPA Explorer

Selecting a protected area in DOPA Explorer will automatically trigger a number of requests to eSpecies which will provide in return the theoretical list of species from the Red List found in the protected area. A histogram will first appear in the bottom of the Species Tab (see Step 5 in Section 3) displaying the number of species from the Red List according to their taxonomy or their category on the Red List (Figure 12). The further selection of a single bar from the histogram allows end-users to further assess only the selected taxon or Red List category.

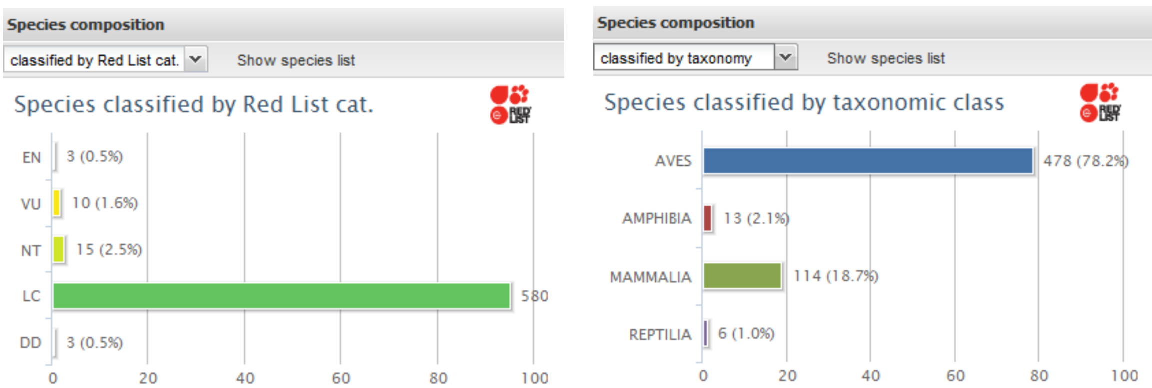
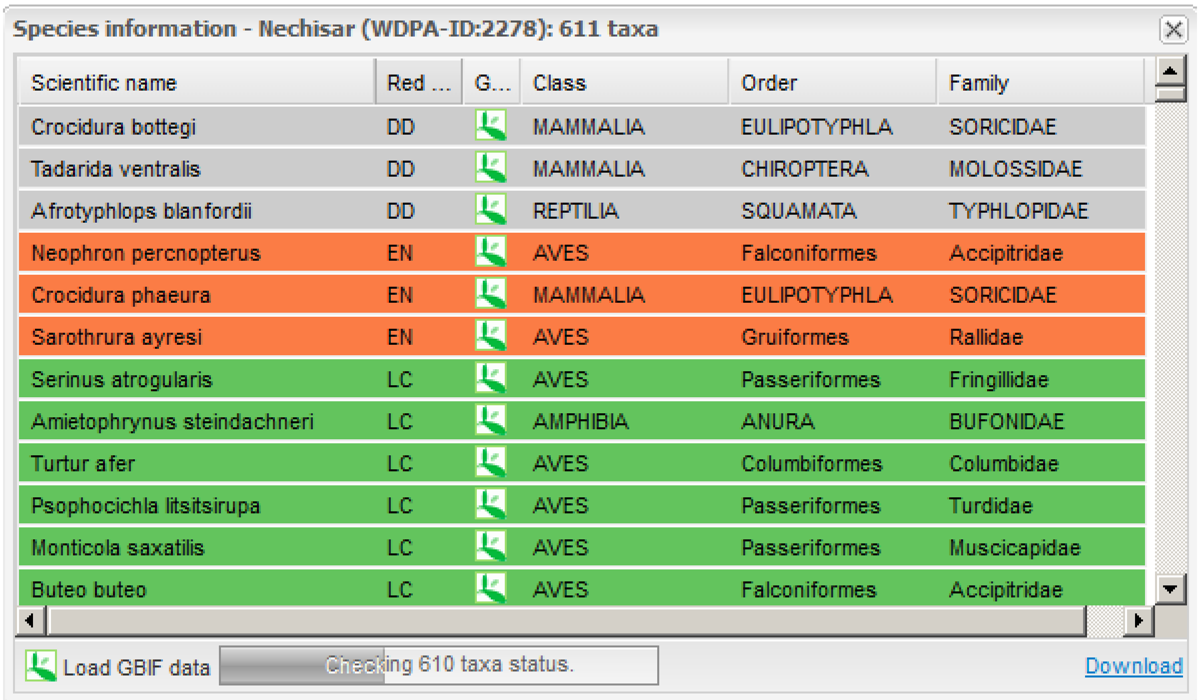


FIGURE 12. THEORETICAL SPECIES COMPOSITION FROM THE IUCN RED LIST FOR A SELECTED PROTECTED AREA. THE CLASSIFICATION CAN BE DISPLAYED ACCORDING TO RED LIST CATEGORIES (LEFT) OR THEIR TAXONOMY (RIGHT)

[15] http://www.iucnredlist.org/

Selecting the “Show species list” option from the interface, one will get a table with the list of species. The Download button (lower right corner) will allow you to get the data in an Excel format. Note that each column allows the sorting of the table (Figure 13).



Species information - Nechisar (WDPA-ID:2278): 611 taxa

Scientific name	Red ...	G...	Class	Order	Family
Crocidura bottegi	DD		MAMMALIA	EULIPOTYPHLA	SORICIDAE
Tadarida ventralis	DD		MAMMALIA	CHIROPTERA	MOLOSSIDAE
Afrotyphlops blanfordii	DD		REPTILIA	SQUAMATA	TYPHLOPIDAE
Neophron percnopterus	EN		AVES	Falconiformes	Accipitridae
Crocidura phaeura	EN		MAMMALIA	EULIPOTYPHLA	SORICIDAE
Sarothrura ayresi	EN		AVES	Gruiformes	Rallidae
Serinus atrogularis	LC		AVES	Passeriformes	Fringillidae
Amietophrynus steindachneri	LC		AMPHIBIA	ANURA	BUFONIDAE
Turtur afer	LC		AVES	Columbiformes	Columbidae
Psophocichla litsitsirupa	LC		AVES	Passeriformes	Turdidae
Monticola saxatilis	LC		AVES	Passeriformes	Muscicapidae
Buteo buteo	LC		AVES	Falconiformes	Accipitridae

Load GBIF data   Checking 610 taxa status.   Download

Figure 13. Theoretical species composition from the IUCN Red List for a selected protected area extracted in a tabular format. Loading GBIF data will further allow access to additional information on species occurrences

The further use of the “Load GBIF data” (lower left corner) will query the GBIF database for species occurrences. In the affirmative, a GBIF logo (green leaf) will appear near the species name. Clicking on the GBIF logo will provide access to common names of the selected species, sometimes in different languages, and a link to the IUCN detailed description of the species (Figure 14).

Figure 14. Screenshots of the windows appearing when selecting the GBIF logo for a selected species (Egyptian vulture) from the list of species obtained for a protected areas. When available, a list of common names will appear (upper figure) as well as a link to the species description on the web site of the IUCN (lower figure)

Note that the DOPA Explorer Beta does not tell you whether some of the species occurrences from GBIF are actually located in the selected protected area. Still, selecting a species from the species table using the GBIF logo will further allow you to visualise the recorded occurrences on the map (yellow squares) (Figure 15).

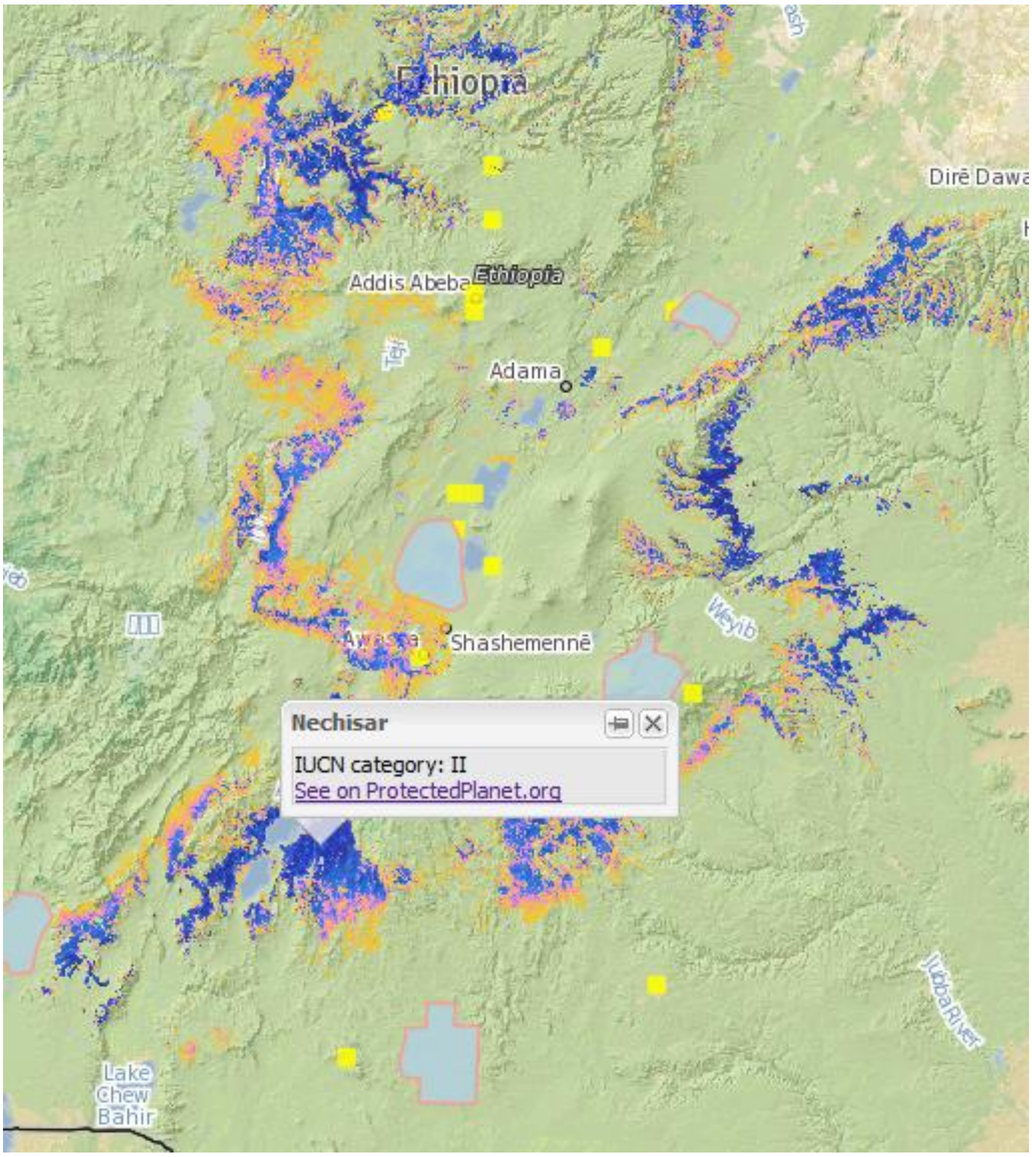


FIGURE 15. SCREENSHOTS OF THE MAPPING WINDOW OF DOPA EXPLORER SHOWING IN YELLOW THE OCCURRENCES OF THE EGYPTIAN VULTURE AFTER SELECTION FROM THE SPECIES TABLES OF THE NECHISAR PROTECTED AREA (ETHIOPIA)

To reduce computational burden, we provide only limited access to GBIF services and recommend end-users to select only a subset of the species to analyse using the interactive histograms before loading the GBIF information. Large (> 300) numbers of species found in the table will also prevent the loading of all of the GBIF information (the GBIF logo will stop appearing in the species table after 300 species have been assessed).

4.3.4. Limitations of species lists

The species distribution data included in this analysis reflect the current state of knowledge of the geographical distributions of the taxon assessed. They do not, of course, represent all amphibian, mammal and bird species in existence, but instead they are used as indicators of the diversity within that taxon.

Currently, the IUCN Red List Data is largely based on expert opinion and the range maps are broad approximations for many species (especially species of least concern). Mapping scales also vary between taxa and species. Amphibians with an extent of occurrence of a few kilometres are likely to be mapped more precisely than a mammal which has a range of thousands of kilometres. Range maps are also often generated as a combination of models and expert consensus and the results inevitably contain uncertainties which can be very large. One will therefore regularly find discrepancies between the theoretical species list produced in DOPA Explorer and the actual number of species present in a given protected area. It is the objective of the forthcoming DOPA Validator to improve these theoretical lists by inviting experts and park managers to validate these lists for the most significant species and to further provide information on species abundance, an information that is currently absent from DOPA Explorer, although GBIF data can provide some information.

4.3.5. Species Irreplaceability (SI) Indicator

The SI proposed by Hartley et al. (2007) is derived here from the 2011 species range maps from the IUCN Red List generated for three taxa (birds, mammals, amphibians). More exactly, the species irreplaceability (SI) indicator was calculated for each protected area by counting how many protected areas a species occurs in (*n*), and adding 1/*n* to the SI index of each of those protected areas. The same procedure was carried out for all species in a given taxon. The higher the value of the SI for a protected area, the higher the number of species found in very few other protected areas and/or the higher the number of endemic species in the PA. In other words, the higher the SI, the more important is the role of this PA for conserving biodiversity. This approach has the benefit of accounting for the network of protected area. Any change to the network or the size of the protected areas will impact the SI.

Further normalizing the SI indicators on a scale of 1-100, one can have an idea of the relative conservation value of the protected area for each taxon by means of the radar plot (Figure 16) or by a bar chart showing the ranking of each indicator of the protected area (Figure 17). The SI suffers from the limitations indicated in 4.3.4. Species with smaller ranges are more likely to trigger a higher SI and species with large ranges will suffer from the fact that connectivity of protected areas is not taken into account and the critical role of corridors in maintaining viable habitats therefore not considered. There is also a concern that the species maps are sometime not accurate enough to be used in conjunction with small protected areas. Hartley et al. (2007) have tried various combinations of species maps and found that the ranking of protected areas based on the SI is robust to changes in the species maps although this observation still needs to be further assessed with a multi-scale analysis of the SIs, from country down to protected area level.

One should note that the SI attributes the same weight to all species independently of their taxon or their threat category on the IUCN Red List of Threatened Species. Because threatened species tend to have smaller distributions, and are therefore found in fewer protected areas, they have a greater effect on the indicator score of the protected area. However, this will still give more emphasize to small endemic species in comparison to larger species which might need to be protected by larger areas and more protected areas, such as rhinoceros and lions.

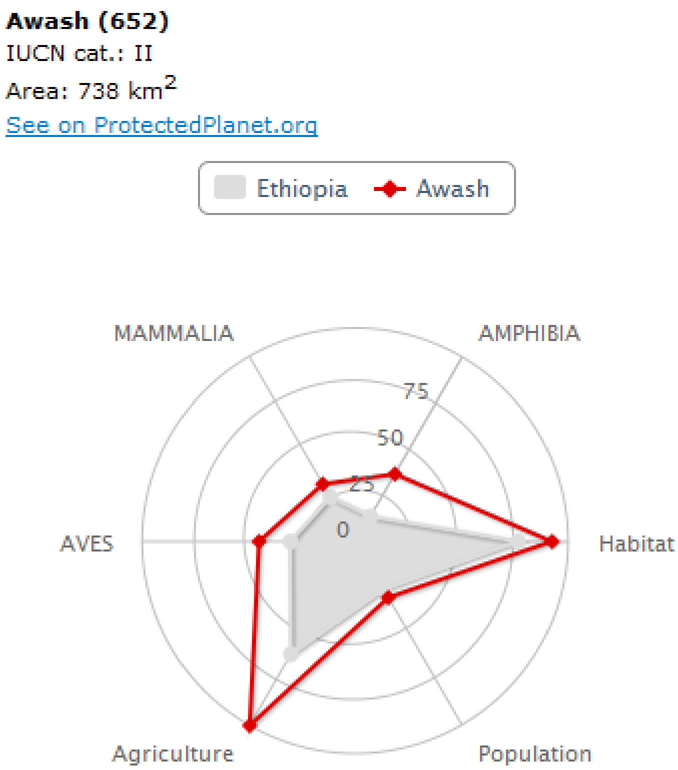


FIGURE 16. RADAR PLOT OF A PROTECTED AREA (AWASH NP) WHERE INDICATORS IN RED ARE CONTRASTED AGAINST THE COUNTRY AVERAGES IN GREY. EACH INDICATOR HAS BEEN SCALED FROM 0 (LOWEST) TO 100 (HIGHEST) TO ALLOW EASY COMPARISON.

The ranking of the protected areas can also be analyzed at the level of the ecoregion (Figure 17) provided that an ecoregion has been selected in DOPA Explorer from the ecoregion table (right navigation panel).

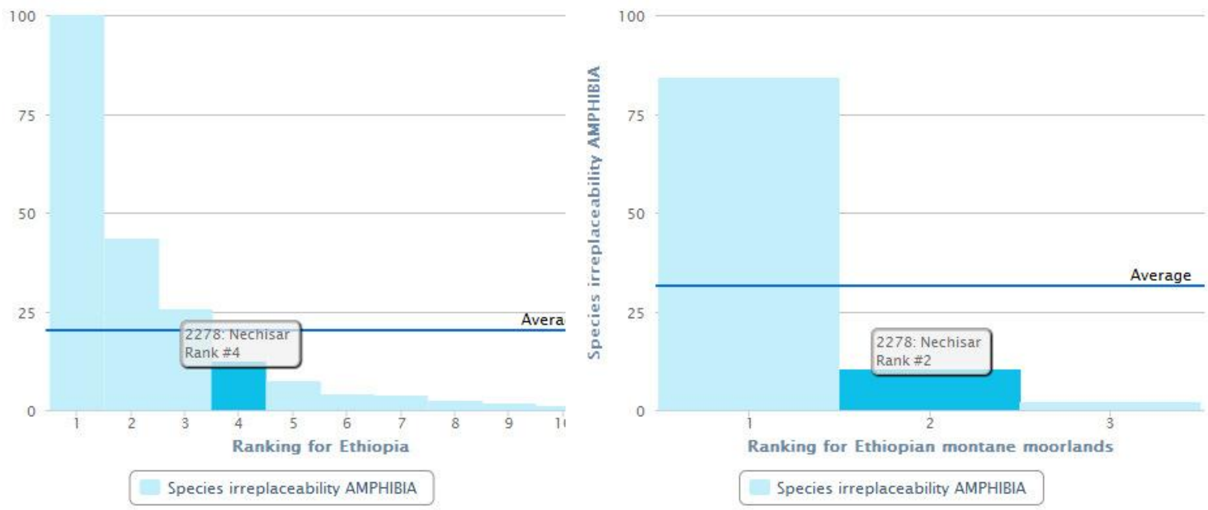
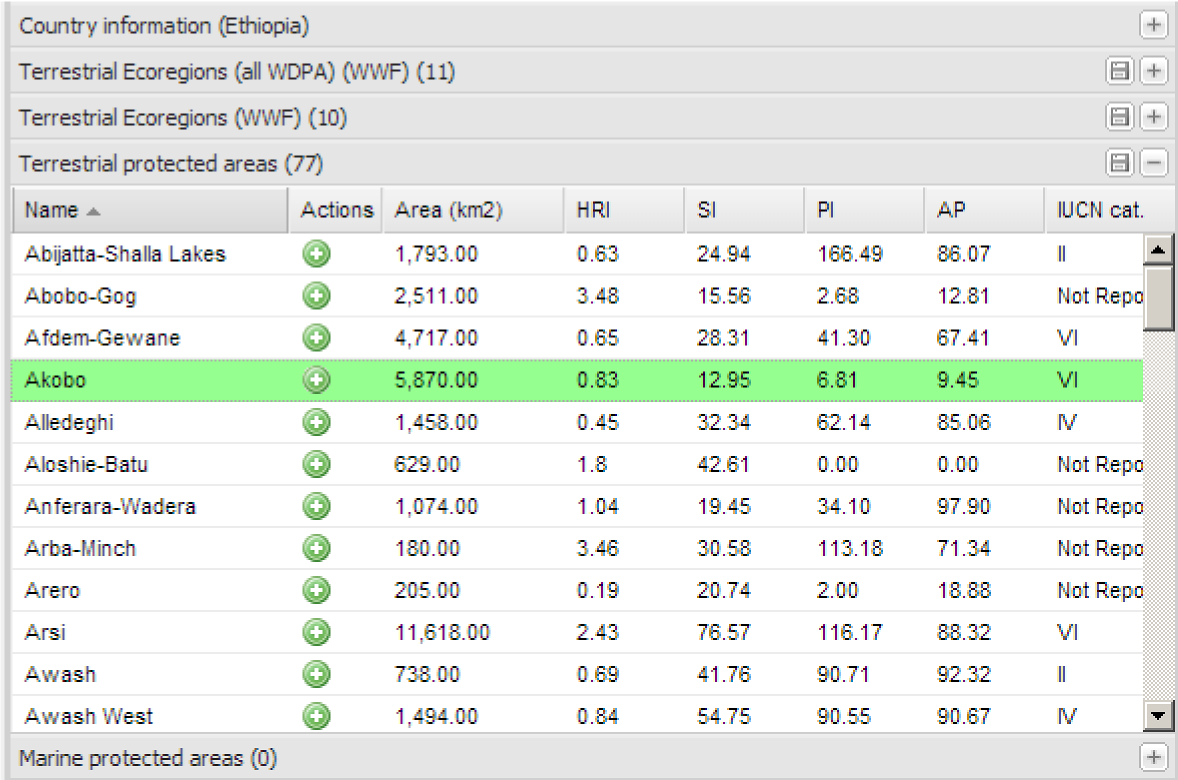


FIGURE 17. BAR CHARTS OF THE RELATIVE VALUE OF THE NECHISAR PROTECTED AREA IN ETHIOPIA AT THE COUNTRY (LEFT) AND ECOREGION (RIGHT) LEVEL.

An average value of the SI indicators is also computed for each protected area and reported in the main table “Terrestrial Protected Areas” of the right navigation panel (Figure 18).



Country information (Ethiopia)

Terrestrial Ecoregions (all WDPA) (WWF) (11)

Terrestrial Ecoregions (WWF) (10)

Terrestrial protected areas (77)

Name	Actions	Area (km2)	HRI	SI	PI	AP	IUCN cat.
Abijatta-Shalla Lakes		1,793.00	0.63	24.94	166.49	86.07	II
Abobo-Gog		2,511.00	3.48	15.56	2.68	12.81	Not Repo
Afdem-Gewane		4,717.00	0.65	28.31	41.30	67.41	VI
Akobo		5,870.00	0.83	12.95	6.81	9.45	VI
Alledeghi		1,458.00	0.45	32.34	62.14	85.06	IV
Aloshie-Batu		629.00	1.8	42.61	0.00	0.00	Not Repo
Anferara-Wadera		1,074.00	1.04	19.45	34.10	97.90	Not Repo
Arba-Minch		180.00	3.46	30.58	113.18	71.34	Not Repo
Arero		205.00	0.19	20.74	2.00	18.88	Not Repo
Arsi		11,618.00	2.43	76.57	116.17	88.32	VI
Awash		738.00	0.69	41.76	90.71	92.32	II
Awash West		1,494.00	0.84	54.75	90.55	90.67	IV

Marine protected areas (0)

Figure 18. Summary table reporting the indicators for the Terrestrial protected areas in DOPA Explorer. After selecting a country, one will find the list of all ecoregions encountered in the country (here 11), the list of ecoregions where protected areas >= 150 km^2 are found in the country (here 10) and the number of protected areas >= 150 km^2 (77) which have been assessed by the following indicators. From left to right, the table provides the name of the protected area, an action icon allowing the map of habitat similarities (see next chapter) to be displayed, the surface of the protected area in km^2, the Habitat Irreplaceability indicator (HRI), the Species Irreplaceability (SI) indicator, the population pressure (PI) indicator, the Agricultural Pressure (AP) indicator and the IUCN Category.

4.4. Habitat Replaceability Index and land cover types (HRI)

4.4.1. Assessing uniqueness and connectivity of ecosystems with the HRI

The HRI is an index generated by the eHabitat modelling service to quantify, for a given protected area, the likelihood to find anywhere in the ecoregion a set of ecological characteristics that is similar to the one found in the protected area. A high value of the HRI will indicate that one will easily find outside of the protected area similar ecological conditions, and therefore probably similar species to those found inside of the protected area. Inversely, small values of HRI will highlight the unique characteristics of the protected area and a higher probability to find there endemic species.

The method used to generate the HRI is very similar to the approach used for ecological niche modelling where a set of selected thematic ecological maps (e.g. climatic and land cover data, elevation and slopes…) is used to identify areas where a given species has highest probability to be found. To compute for each pixel the similarity to a reference location, one popular approach is based on the Mahalanobis distance (Mahalanobis, 1936). Mathematically simple and fairly easy to understand, the model performs relatively well compared with most other models (Tsoar et al., 2007) and is computationally fast. For each protected area, a similarity map as in Figure 19 can be displayed where the dark blue colours will highlight areas that are most similar to those of the protected area. Areas beyond the orange and yellow areas have no colour because of a total dissimilarity with the area of interest. The final result allows end-users to assess how ecologically isolated a protected area is as well as the internal ecological variability. We used here 9 thematic variables as input for computing the HRI for terrestrial ecosystems (see Table 1).

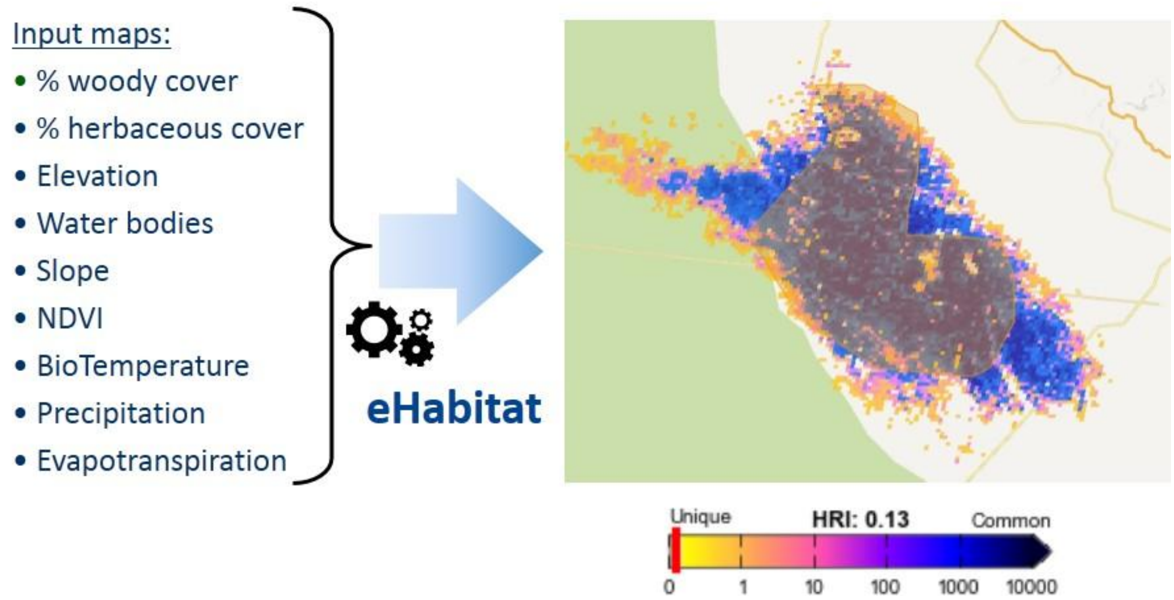


FIGURE 19. THE HABITAT REPLACEABILITY INDEX (HRI) IS DERIVED FROM THE PROBABILITIES OF FINDING AREAS THAT ARE ECOLOGICALLY SIMILAR TO A REFERENCE AREA, HERE A PROTECTED AREA (ORANGE POLYGON). BLUE PIXELS SHOW THOSE AREAS THAT ARE VERY SIMILAR TO THOSE FOUND IN THE PROTECTED AREA.

As for the species indicators, a ranking of the protected areas according to their HRI can be done at the country and the ecoregion level.

Table 1. List of input data used to compute the HRI for the Terrestrial protected areas

Thematic layers (terrestrial)	Source
% woody vegetation % herbaceous cover	Derived from the Vegetation Continuous Fields collection which contains proportional estimates for vegetative cover types: woody vegetation, herbaceous vegetation, and bare ground. Only the first two variables are used as the third one is a function of the first two. The product is derived from all seven bands of the MODerate-resolution Imaging Spectroradiometer (MODIS) sensor on board NASA's Terra satellite. Reference: DiMiceli, C.M., M.L. Carroll, R.A. Sohlberg, C. Huang, M.C. Hansen, and J.R.G. Townshend (2011), Annual Global Automated MODIS Vegetation Continuous Fields (MOD44B) at 250 m Spatial Resolution for Data Years Beginning Day 65, 2000 - 2010, Collection 5 Percent Tree Cover, University of Maryland, College Park, MD, USA.. Digital data accessed 1 July 2013 from http://glcf.umd.edu/data/vcf/
NDVI	The MODIS Normalized Difference Vegetation Index (NDVI) data set is available on a 16 day basis for the six year period between 2001 and 2006. The product is derived from bands 1 and 2 of the MODerate-resolution Imaging Spectroradiometer on board NASA's Terra satellite. Reference: Carroll, M.L., C.M. DiMiceli, R.A. Sohlberg, and J.R.G. Townshend (2004). 250m MODIS Normalized Difference Vegetation Index, 250ndvi28920033435, Collection 4, University of Maryland, College Park, Maryland, Day 289, 2003. Digital data accessed 1 July 2013 from http://glcf.umd.edu/data/ndvi/
Elevation and Slope	Elevation and slopes have been derived from the Shuttle Radar Topography Mission (SRTM 30). Reference: USGS (2004). Shuttle Radar Topography Mission, 1 Arc Second scene SRTM_u03_n008e004, Unfilled Unfinished 2.0, Global Land Cover Facility, University of Maryland, College Park, Maryland, February 2000. Digital data accessed 1 July 2013 from http://www2.jpl.nasa.gov/srtm/
Water bodies	The Global Raster Water Mask at 250 meter spatial resolution is a product using the SWBD (SRTM Water Body Data) in combination with MODIS 250m data to create a complete global map of surface water at 250 m spatial resolution. Reference: Carroll, M., Townshend, J., DiMiceli, C., Noojipady, P., Sohlberg, R. 2009. A New Global Raster Water Mask at 250 Meter Resolution. *International Journal of Digital Earth*. 2(4): 291-308 Digital data accessed 1 July 2013 from http://glcf.umd.edu/data/watermask/
Biotemperature Precipitation Evapotranspiration	Climate variables (annual biotemperature, annual precipitation, annual evapotranspiration/precipitation ratio) are derived from WorlClim. The variables have been computed according to the definitions of Holdridge. References: Hijmans, R., S. E. Cameron, J. L. Parra, P. G. Jones, and A. Jarvis (2005), Very high resolution interpolated climate surfaces for global land areas, International Journal of Climatology, 25, 1965-1978. Holdridge, L. R. (1947), Determination of world plant formations from simple climatic data, *Science*, 105, 367-368. Digital data accessed 1 July 2013 from http://www.worldclim.org/

The same approach has been adopted to characterize the marine protected areas using a smaller set of variables (Table 2).

TABLE 2. LIST OF INPUT DATA USED TO COMPUTE THE HRI FOR THE MARINE PROTECTED AREAS

Thematic layers (marine)	Source
Sea Surface Temperature	Long term mean and annual standard deviations derived from monthly product of Aqua terra set (Feb. 2000 - Dec. 2011) - This data set consists of 4km monthly standard 11µm Non-Linear SST (NLSST) algorithm developed by the University of Miami's Rosenstiel School of Marine and Atmospheric Science (RSMAS). This data is equivalent to the standard NASA products available from http://oceancolor.gsfc.nasa.gov/ References: Brown, O.B., and P.J. Minnett, 1999, MODIS Infrared Sea Surface Temperature Algorithm Theoretical Basis Document, Ver 2.0, http://modis.gsfc.nasa.gov/data/atbd/atbd_mod25.pdf Digital data accessed 1 July 2013 from http://oceancolor.gsfc.nasa.gov/
Chlorophyll-a	Monthly mean sea surface Chlorophyll-a concentration in mg.m-3 derived from the MODIS-AQUA sensor. Mapped images are derived from monthly mean sea surface chlorophyll-a maps at 4km and 9km resolution (L3 product). Satellite ocean colour imagery is the only source of biological information routinely available on a global basis and is thus one of the few sources of information that can be used to validate phytoplankton distributions predicted by regional to global scale numerical models. The satellite-derived reflectance at the air-sea interface can be related to the concentration of an optically-significant constituent (e.g. chlorophyll). Processing information: Chlorophyll-a data is reprocessed using SeaDAS 6.4 and the standard OC3M algorithm. Quality/accuracy/calibration information: The 'standard' algorithm proposed by space agencies to process data from their sensors has a nominal accuracy of ~35% in the retrieval of surface chlorophyll in waters optically dominated by phytoplankton and associated products. References: O'Reilly, J.E. and co-authors, 2000: "Ocean color chlorophyll a algorithms for SeaWiFS, OC2, and OC4: Version 4." In: J.E. O'Reilly and co-authors, SeaWiFS Postlaunch Calibration and Validation Analyses, Part 3. NASA Tech. Memo. 2000-206892, Vol. 11, S.B. Hooker and E.R. Firestone, Eds., NASA Goddard Space Flight Center, Greenbelt, Maryland, 9-23. Digital data accessed 1 July 2013 from http://gmis.jrc.ec.europa.eu/amis_1_3.php
Bathymetry	Data from the General Bathymetric Chart of the Oceans (GEBCO) maintained by the British Oceanographic Data Centre on behalf of the International Hydrographic Organization (IHO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. The dataset is a global 1 minute grid generated by combining quality-controlled ship depth soundings with interpolation between sounding points guided by satellite-derived gravity data. When available, data sets generated by other methods have been included to improve local accuracy. Digital data accessed 1 July 2013 from http://www.gebco.net/data_and_products/gridded_bathymetry_data/

Maps of HRI are computed only within the same ecoregions plus a buffer of 250 kilometres to ensure coherence in the results and reinforce the concept of connectivity between similar ecosystems (Figure 20).

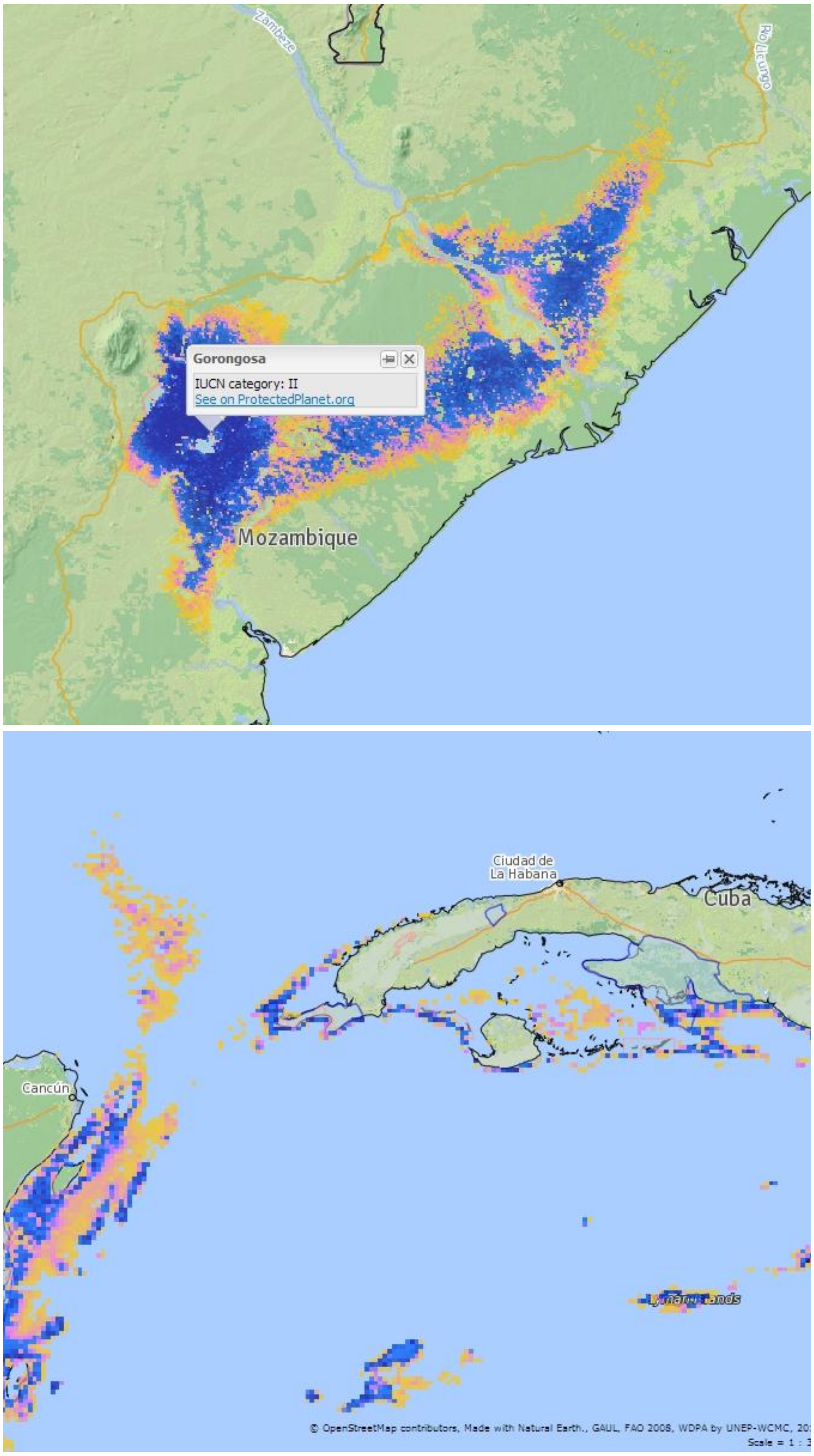


FIGURE 20. MAPS OF SIMILARITIES OF TERRESTRIAL (TOP) AND MARINE (BOTTOM) HABITATS FOR THE PROTECTED AREAS OF GORONGOSA (MOZAMBIQUE) AND PENINSULA DE GUANAHACABIBES (CUBA), RESPECTIVELY.

Being the outcome of a process that is purely statistical, the HRI needs to be interpreted with great care. Protected areas covering very diverse areas such as a mountain and a lake, or a coastal area and a rainforest, are likely to show a high HRI because of the higher probability to find somewhere at least one of the ecological features characterizing the protected area. Inversely, very homogeneous areas will show a very low likelihood to be found elsewhere because of the lack of statistical variability of the input data while areas that are ecologically similar might be actually found in the same ecoregion. We are working on alternative approaches for these cases.

4.4.2. Extracting land cover types of the protected area

Each protected area can be characterized by its land cover. We propose different land cover maps, namely the Global Land Cover 2000 (Bartholomé & Belward, 2005) and the products from GlobCover. GlobCover is an initiative of the European Space Agency (ESA) in partnership with JRC, EEA, FAO, UNEP, GOFC-GOLD and IGBP. The aim of the project was to develop a service capable of delivering global composites and land cover maps using as input observations from the 300m MERIS sensor on board the ENVISAT satellite mission. Two land cover maps from GlobCover are available[16]: one covering the period December 2004 - June 2006 and the other covering the period January - December 2009.

The classes of land cover types and their relative surfaces (in km2 and %) in the protected area can be visualized and downloaded in Excel (Figure 21).

GLC2000 | **GLOBCOVER2005**

Download

	Landcover class	% covered	Number cells
	110 - Mosaic forest or shrubland (50-70%) / grassland (20-50%)	14.1	132
	120 - Mosaic grassland (50-70%) / forest or shrubland (20-50%)	0.5	5
	130 - Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)	8.6	80
	150 - Sparse (<15%) vegetation	54.2	506
	200 - Bare areas	22.6	211

FIGURE 21. EXAMPLE OF LAND COVER CHART FOR A PROTECTED AREA AS DISPLAYED IN THE HABITATS TAB OF DOPA EXPLORER.

All these maps were produced using different mapping standards and algorithms and we invite the users to read the specialized literature to select the dataset that is most appropriate (see e.g. Thibaut et al., 2011)

4.5. Climate information

WordClim[17] provides gridded maps of current (1950-2000) and future climate variables at different latitude-longitude resolutions, i.e., 10 minutes, 5 minutes, 2.5 minutes and 30 seconds. The dataset for current climate (Hijmans et al., 2005) is the result of a spatial interpolation process using splines applied to measurements from climate stations. The 30 seconds resolution adopted here corresponds to grid cells of 0.86 km2 at equator, usually referred to as a 1 km grid.

The WorldClim data base gives long term monthly averages of precipitation and minimum, mean and maximum temperatures for each pixel. These variables are then averaged for each protected area and for each month (Figure 22).

[16] http://due.esrin.esa.int/globcover/
[17] http://www.worldclim.org/

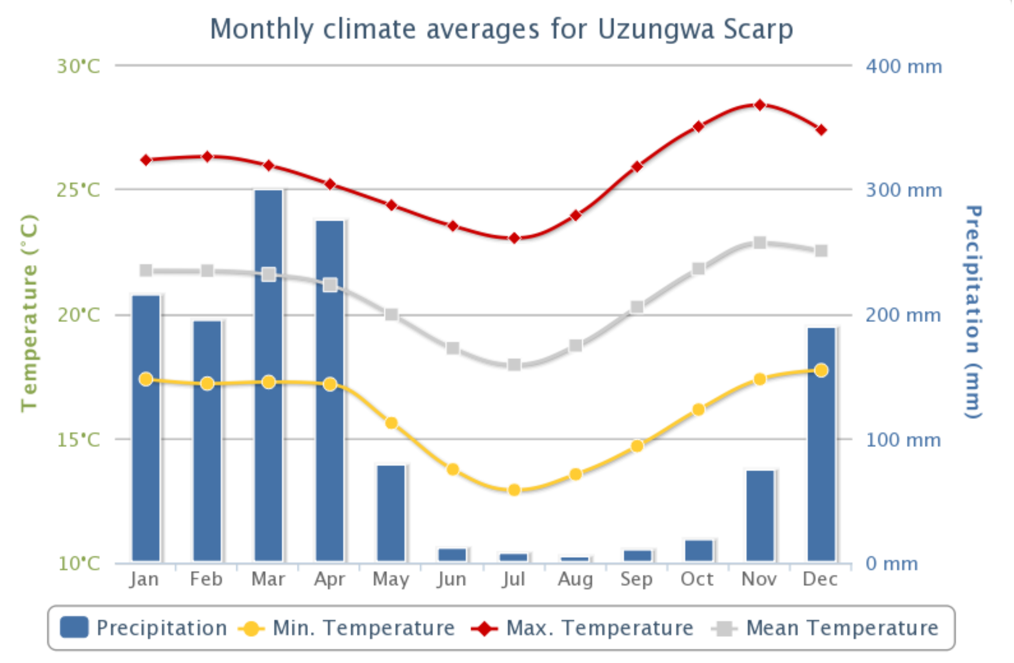
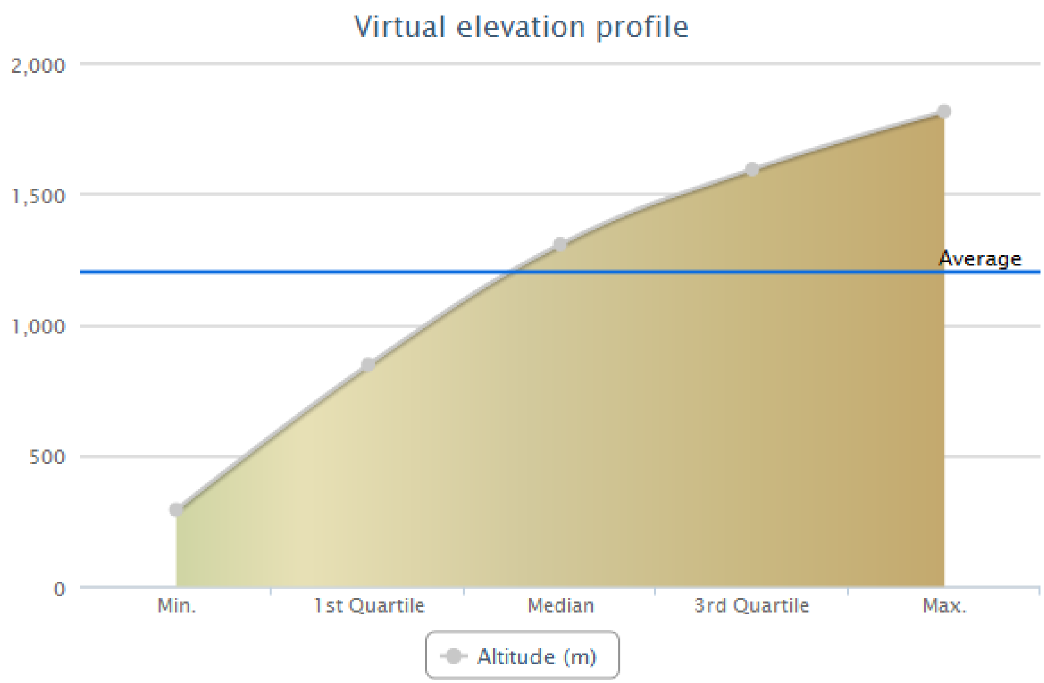


FIGURE 22. EXAMPLE OF CLIMATE CHART FOR A PROTECTED AREA AS DISPLAYED IN THE CLIMATE TAB OF DOPA EXPLORER.

A virtual elevation profile is also computed to highlight possible abrupt changes in the relief and as an additional explanatory variable for the climatic data, as all those variables are usually dependent on the elevation. Protected areas with climatic information will often report the climate of low altitudes, which might be different from the variables we present in DOPA (Figure 23).



Min.	1st Qtl.	Median	3rd Qtl.	Max.
293	847	1307	1594	1815

FIGURE 23. EXAMPLE OF THE VIRTUAL ELEVATION PROFILE AND ASSOCIATED STATISTICS (IN METERS) FOR THE SELECTED PROTECTED AREA AS DISPLAYED IN THE CLIMATE TAB OF DOPA EXPLORER.

4.6. Ecosystem Services

The “benefits that humans derive from ecosystems”, as ecosystem services are defined, support human societies globally through food and water provision, regulation of water flows, use of natural areas for recreation etc. Characterizing and quantifying ES is a multidisciplinary task and the methodologies followed vary depending on the service addressed, the spatial and temporal scale, the heterogeneity of the landscape, as well as a variety of socio-economic factors. While much progress has been made lately in mapping and modelling ES, much progress needs to be done in mapping, modelling and documenting ES. Similarly, visualisation tools and assessment standards are in their infancy (Burkhard et al., 2013).

The mapping of Global Ecosystem Services is an initiative of the JRC that is looking particularly into the provision of maps of Ecosystem Services (ES) provided by different types of ecosystems across various spatial scales. Focusing on protected areas in DOPA Explorer, the mapping of ES is currently limited to terrestrial carbon maps but other ecosystem services are considered for future versions.

4.6.1. Comparison of Terrestrial Carbon Maps

The reduction of emissions from forest degradation and deforestation and the conservation of forests and forest carbon stocks has been a major requirement for actions towards climate change mitigation. These actions have been interpreted into policy through the REDD+ instrument (Reducing Emissions from Deforestation and Forest Degradation) which falls under the UNFCCC framework established by the Conference of the Parties (2010) and is responsible for implementing among others conservation and enhancement of forest carbon stocks.

Given the contribution of carbon stocks to climate regulation, carbon storage and sequestration rates are among the most commonly used indicators for mapping related ecosystem services (Egoh et al., 2012; Crossman et al., 2013). Estimates of carbon stored in biomass per land use type is one of the simplest and most commonly used indicators to assess organic carbon content in the landscape (Crossman et al., 2013). Due to their importance a considerable amount of research projects and scientific literature has dealt with estimating forest carbon stocks globally while a variety of methods (satellite image interpretation, Landsat images, forest inventories, field measurements and ground truth data collection) has been used and no standards are yet existing. We therefore provide end-users with means to compare two popular maps of carbon stock estimates calculated using two different approaches. One has been proposed by Saatchi et al. (2011), the other one by Baccini et al. (2012). Some additional data from JRC and the FAO (M. Henry 2010) were also used for the production of the underlying data. The maps provided present the carbon stored in the total biomass (above and below-ground) in a selected region. The user can access and view the original data and generate statistics on the amount and distribution of carbon stored in total biomass of a selected protected area and visualize them as tables and comparative graphs (Figure 24).

The statistics generated are the total carbon stored in the selected protected area and that stored per land cover type. They include minimum, maximum, mean and standard deviation, as well as information on the amount of cells in the area and the coverage of each land cover type. The data used to define the land cover classes is based on the GLC 2000 (Bartholomé & Belward, 2005). The generated tables are also available for download in an Excel spreadsheet.

Note that the current data are limited to the pan-tropical regions.

Global carbon stock (Saatchi) | WHCR - carbon storage (Baccini)

Download — Original author information can be found here

GLC2000	Total (tC)	Tot. min (tC)	Tot. max (tC)	Mean (tC/km2)	Std. dev.(tC/km2)	Cells=Area (km2)	Coverage (%)	Total (tC) protected (%/LCC)
Total	279761850	181774637.5	377751200	17375.43	3714.21	16101	100	279761850.00 (100.0)
1 - Tree Cover, broadleaved, evergreen	236153575	153431025	318878200	17773.28	2900.4	13287	82.5	236153575.00 (100.0)
17 - Mosaic: Cropland / Tree Cover / Other natural vege	25946157.81	16779570.31	35112740.62	15869.21	5117.88	1635	10.2	25946157.81 (100.0)
7 - Tree Cover, regularly flooded, fresh water	16346448.44	10708659.38	21984240.62	18491.46	2901.73	884	5.5	16346448.44 (100.0)
12 - Shrub Cover, closed-open, deciduous	1221884.77	794102.29	1649667.19	4287.31	3350.23	285	1.8	1221884.77 (100.0)
13 - Herbaceous Cover, closed-open	93782.53	61308.15	126256.93	9378.25	7099.15	10	0.1	93782.53 (100.0)

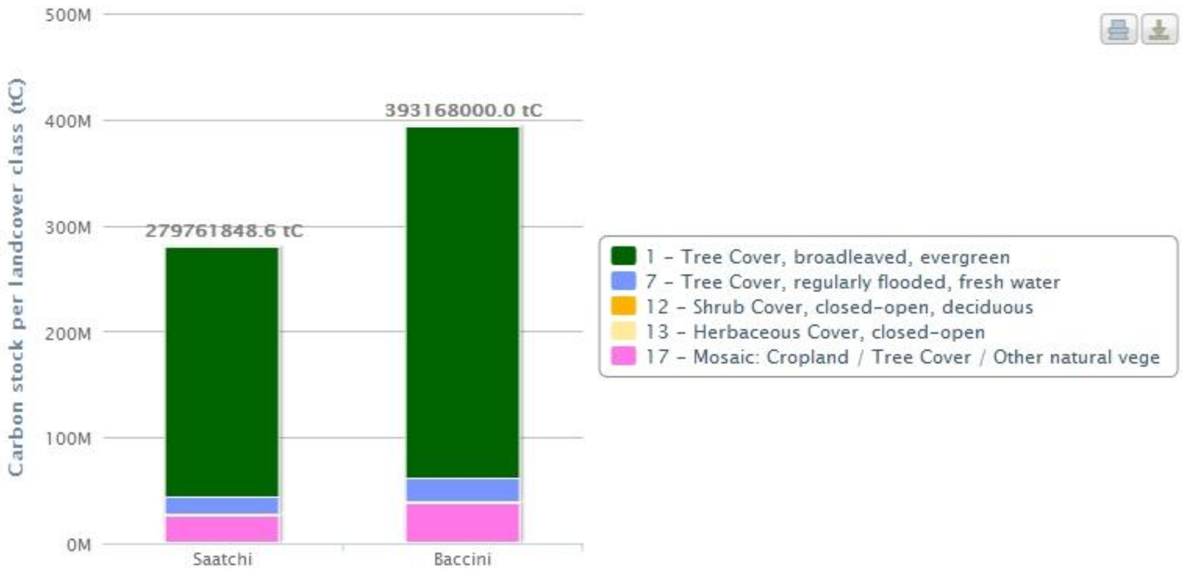


FIGURE 24. COMPARATIVE GRAPHS AND TABLES ON CARBON STOCK ESTIMATES ACCORDING TO SAATCHI AND BACCINI FOR THE NATIONAL PARK OF ODZALA-KOKOUA (CONGO). THE COLOUR CODING CORRESPONDS TO LAND COVER CLASSES FROM GLC 2000.

4.7. Pressure indicators

This component of DOPA Explorer tries to quantify theoretical pressures on protected areas, in particular by looking at the population densities and at the agricultural activities in the proximities of the protected areas. The higher the population and agriculture in the vicinity of a protected area, the greater is the risk for land conversion, poaching, deforestation for timber and fuel, poaching and encroachment. The ranking of the protected area in terms of pressures due to the population and the agriculture can also be visualized at the country and the ecoregion levels (Figure 25) provided that an ecoregion has been selected in DOPA Explorer from the ecoregion table (right navigation panel). Absolute values of the population pressure index (PI) and the agriculture pressure index (AP) are reported in the main table “Terrestrial Protected Areas” of the right navigation panel of DOPA Explorer. As for the previous indicators, these are also represented on the radar plots characterizing each protected area.

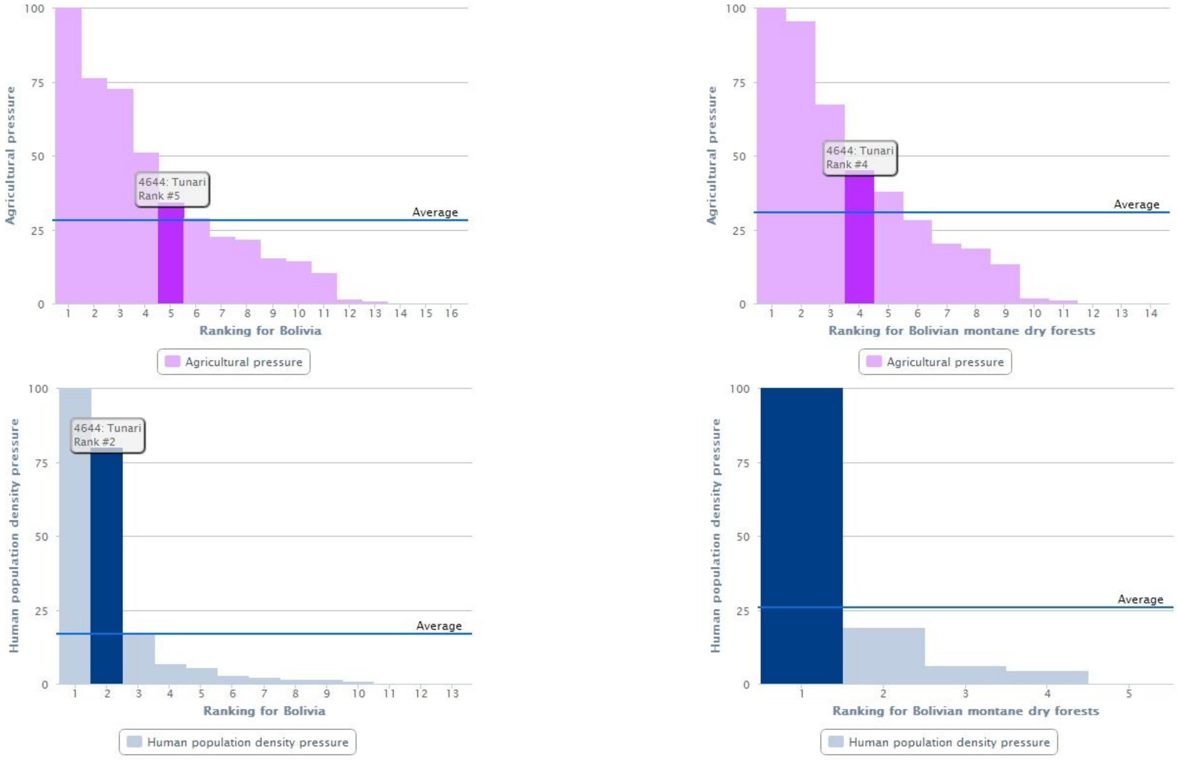


FIGURE 25. BAR CHARTS OF THE RELATIVE PRESSURES DUE TO AGRICULTURE (TOP) OR POPULATION DENSITY (BOTTOM) OF THE TUNARI PROTECTED AREA (BOLIVIA) AT THE COUNTRY (LEFT) AND AT THE ECOREGION (RIGHT) LEVEL.

The methods used for the computation of the PP and AP are the same ones as those of the APAAT (Hartley et al., 2007) where a cost distance function is used to quantify the impact of the neighbourhood on the selected protected area. In other words, we converted thematic maps into gridded data where each cell receives a weight reflecting the pressure level on the protected area. A land cover map for example, can be used to derive an accessibility map to a protected area by attributing high values to obstacles (rivers, mountains, hills) and low values when the terrain can be easily crossed (e.g. savannahs, grassland) as illustrated in Figure 266.

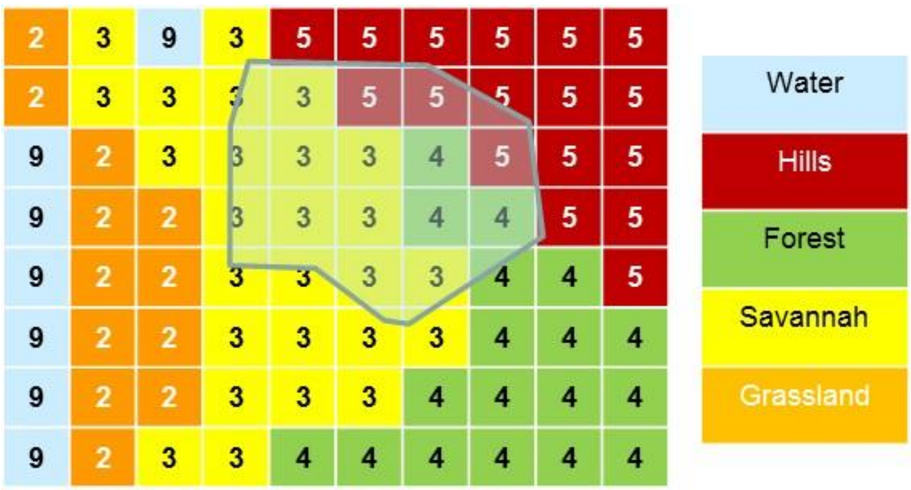


FIGURE 26. EXAMPLE OF AN ACCESSIBILITY MAP FOR A PROTECTED AREA (GREY POLYGON) WHERE LAND COVER CLASSES ARE USED TO DERIVE WEIGHTS AND GENERATE A COST-DISTANCE FUNCTION. HIGH VALUES ARE CORRESPONDING TO OBSTACLES WHILE EASIER ACCESS IS CORRESPONDING TO LOW VALUES.

4.7.1. Population Pressure Index (PP)

Population pressures on a protected area were estimated using the Gridded Population of the World map for the year 2000 (GPW, v3[18]) and a cost-distance function to quantify accessibility to the protected area and a buffer zone around each protected area. The cost distance function was derived from information on slopes, roads, rivers, land cover and international boundaries to compute a travel time from each point of the borders of the protected area. The weighting schema to generate the cost distance was the one used in the APAAT and we refer to Hartley et al. (2007) for details. As a result, a buffer area representing 3 hours of traveling could be delineated around each protected area and further used to calculate the average population density. This average population density in the buffer area is the Population Pressure index.

4.7.2. Agriculture Pressure Index (AP)

As for the PP, a cost distance map was used to assess pressures due to agriculture on each protected area. The Global Land Cover 2000 map (Bartholomé & Belward, 2005) was used to identify land cover classes which contained a high proportion of anthropogenic influence. The conversion table of GLC 2000 into a binary table with anthropogenic influence / no anthropogenic influence can be found in Hartley et al. (2007). The percentage of cells with anthropogenic influence was counted within an expanding buffer zone, using an interval of 1 km starting from the boundary of the protected area up to 30 km. Next, a weighting was applied to each 1 km buffer area to give lower weight to those buffer zones that are further away. This weighting was calculated using a bi-square function and applied to the boundary pressure score for each buffer in the 1 to 30 km range. Finally, a final score of anthropogenic pressure was obtained for each protected area by dividing the sum of all the weighted scores by the sum of all the bi-square weights. The equation for calculating the anthropogenic Boundary Pressure score (BP_p) on a protected area is defined as

$$BP_p = \frac{\sum_{n=1}^{n=30}(h_n W_n)}{\sum_{n=1}^{n=30} W_n}$$

where W_n is the weighting for buffer size, h is the percentage of cells with anthropogenic influence within a buffer of size n, and r is a constant equal to 30 km, the maximum buffer size.

Wn is thus defined by

$$W_n = \left(\frac{1-n^2}{r^2}\right)^2$$

[18] http://sedac.ciesin.columbia.edu/data/collection/gpw-v3

4.8. Fire Ecology

Fires are central in the ecology of tropical ecosystems and can act as a threat or a regenerating factor depending on the ecosystem adaptations to it. Many ecosystems in the world are fire-dependent and for them fire is essential to maintain their functionalities and their biodiversity. Hardesty, Myers and Fulks (2005) have estimated that "*around 84% of the ecoregions identified by scientists as critical for global conservation have altered fire regimes. This alteration can cause biodiversity loss and habitat degradation*". Besides its relevance for conservation, fire is also a common practice for land management in the tropical regions.

We therefore provide means to monitor fires over a 10-day period (dekad) using information derived four times a day from the MODIS sensors on board of the Terra and Aqua satellites. The MODIS team distributes two fire products: the active fires and the burned areas datasets[19]. The active fires dataset is used to locate fire events and derive their temporal distribution (seasonality) during the entire season. This satellite product provides the time of burning and refers to an area of approximately 1x1km on the earth surface. The burned areas dataset provide information on the extent of the surfaces affected by burning and allows identifying the fire events which occurred between satellite overpasses and have been undetected. The spatial resolution of the burned area maps is 500 by 500 meters and can provide useful information on the approximate date of burning (Roy et al., 2005). From all these datasets, active fires and burned areas, we derive statistics with a 10-day time step over a time series which spans from year 2002 to present. Most of the fires occur during the dry season, which, depending on the location, might include two different years. This is the case for the regions north of the equator where the dry season usually lasts from October until April, while the southern dry season goes on average from May to November.

DOPA Explorer provides in the "Fire Ecology" tab information on the fire occurrences in the protected area in the form of a cumulative plot. Average values are computed using data from 2002 until today (Figure 27). A similar plot is generated using the observations for burned surfaces. Note that burned areas becomes available with a delay of 1-2 months because of the more complex processing.

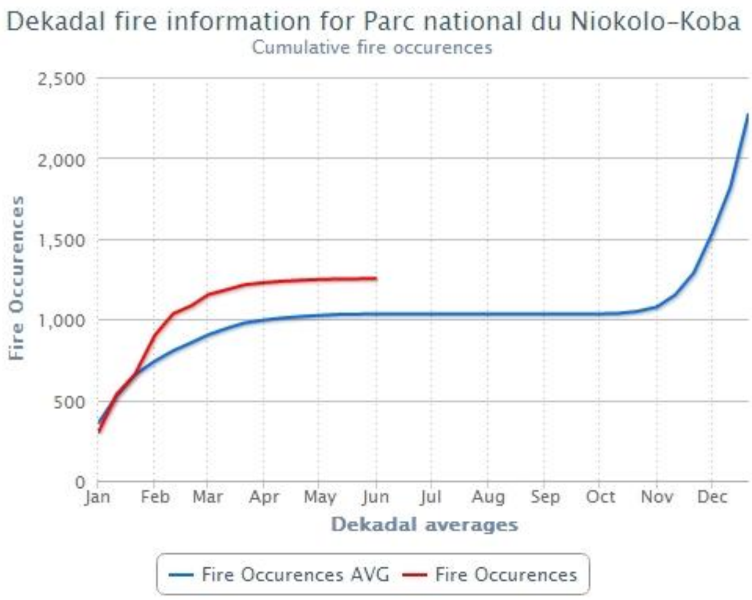


FIGURE 27. NUMBER OF FIRE OCCURRENCES IN THE NATIONAL PARK OF NIOKOLO-KOBA (SENEGAL). CURRENT OBSERVATIONS (IN RED) CAN BE CONTRASTED AGAINST VALUES AVERAGED SINCE 2002 (IN BLUE).

[19] http://earthdata.nasa.gov/firms

End-users will also find in the DOPA Explorer a link to the Fire Reporter. This new tool for fire monitoring is designed especially for people working in conservation and park management (Palumbo, et al., 2013). This web client aims at supporting ecologists and managers in their conservation activities, in particular by helping understanding the fire ecology of a protected area, its needs and the areas under pressure. The tool can be also a valuable mean to improve and verify the fire management plans in the protected area. More generally it allows to characterize specific fire regimes as well as their alteration in time.

The content and its graphical representation have been designed to provide a synthesis of the fire activity by season and by vegetation classes. The information on fire occurrences its updated daily and distributed 48 hours after the satellite acquisition. Information on burned areas is available later as indicated before.

The Fire Reporter also provides information on the immediate surroundings of the protected area using a buffer zone of 25km around the park. The difference in the fire density observed inside and outside a protected area is used as an indicator of the protected area's ecological condition in comparison to its context (Grégoire and Simonetti, 2010; Grégoire et al., 2012).

The maps of fire occurrence, fire density and burned area can be downloaded and used in a GIS environment or as simple images (Figure 28).

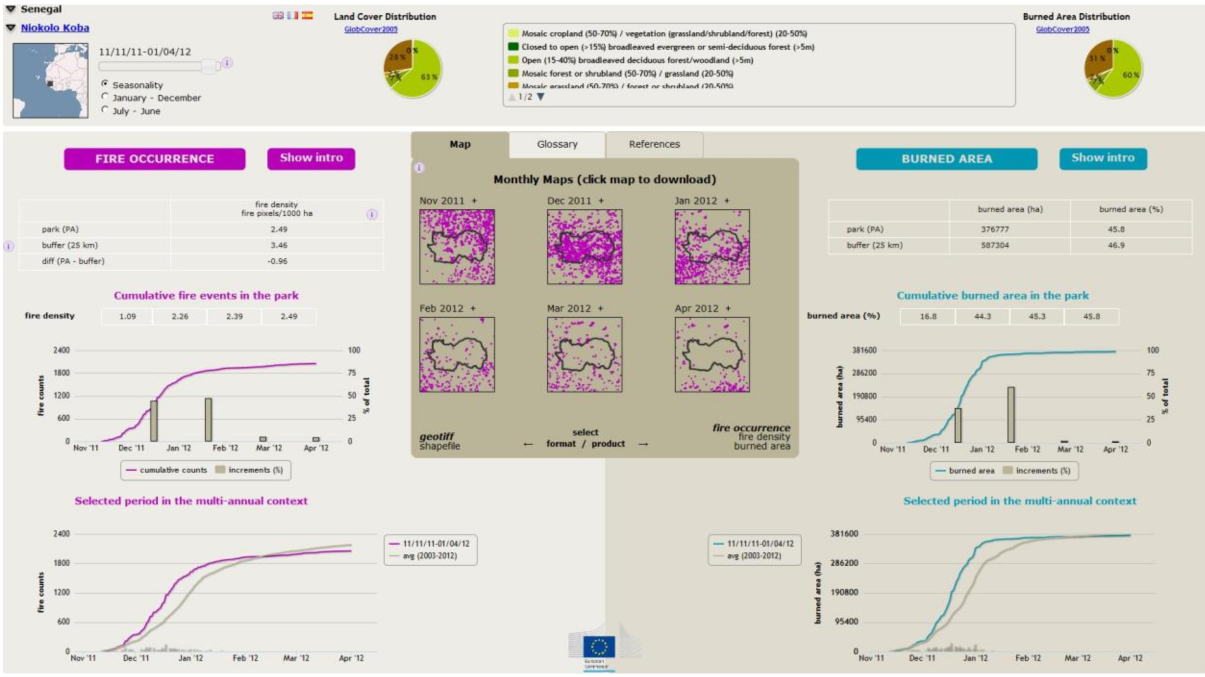


FIGURE 28. SCREEN CAPTURE OF THE FIRE REPORTER FOR THE NATIONAL PARK OF NIOKOLO-KOBA (SENEGAL). THE TOOL PROVIDES DETAILS ON SEASONALITY AND FIRE ACTIVITY IN THE 25 KM BUFFER AREA OF THE PROTECTED AREA.

4.9. Phenology

Earth observations can be used in phenology, the study of periodic life cycle events and how these are influenced by seasonal and inter annual variations in climate. As for the fires, rainfall and vegetation activity can be monitored in protected areas to identify anomalies and changes in trends against historical records. It is the objective of the eStation (Clerici et al., 2013) to provide 10 days observations of rainfall and of vegetation indexes (NDVI and NDWI). These observations are limited to Africa but we expect to provide more global datasets with the next version of DOPA Explorer.

4.9.1. Vegetation

The VEGETATION instruments on board the SPOT satellites allow the production of 10-day global coverage composites at 1 km resolution. VEGETATION data covering Africa are used to generate a series of products related to the monitoring of vegetation and surface water. The time series of normalized difference vegetation index (NDVI) allows identification of changes in vegetation vigour and density in response to bio-physical conditions (including plant type, weather and soil) and human activities. NDVI has also proven to be useful in predicting herbivore and non-herbivore distribution, abundance and life history traits in space and time (see e.g. Pettorelli et al., 2011). The normalized difference water index (NDWI) is rather related to the vegetation water content and presents some advantages in the usually cloudy equatorial areas due to the low sensitivity of the index to atmospheric conditions in comparison to the NDVI (Vancutsem et al., 2009).

The product provided is a 10-day synthesis, which means that it combines daily atmospherically corrected data of all VEGETATION measurements of the given dekad into a single image using the MVC (Maximum Value Composite) algorithm, which selects the pixels with the best ground reflectance values. The average values are based on the maximum NDVI value over the period 1998 to 2010. (Figure 29). Raw data used to generate the time series can be downloaded for further use.

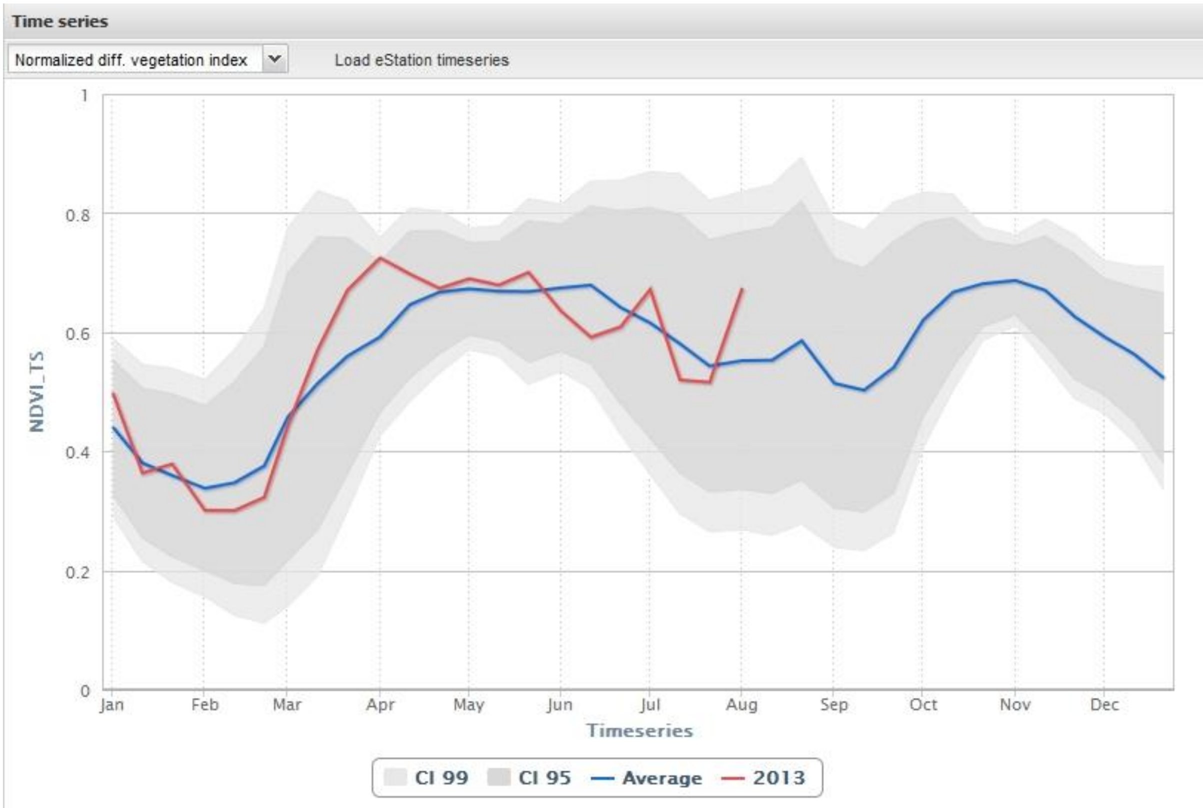


FIGURE 29. EXAMPLE OF A PHENOLOGICAL CHART (HERE NDVI) FOR THE KOGYAE PROTECTED AREA (GHANA). THE RED LINE SHOWS THE DEKADAL (10 DAYS) OBSERVATIONS, THE BLUE LINE THE AVERAGE OF THESE VALUES COMPUTED OVER 10 YEARS AND THE GREY SHADED AREAS SHOW THE CONFIDENCE INTERVALS (95% AND 99%).

4.9.2. Rainfall

Rainfall is one of the most important parts of the water balance. Due to financial and infrastructural constraints, rain-gauge and precipitation radar networks are often sparse in developing countries. For such areas the satellite rainfall estimate is a good alternative to overcome the shortcomings of measurements. Rainfall data shown in DOPA Explorer are coming from the USGS Famine Early Warning System (FEWS) NET Data Portal[20] which provides access to geo-spatial data, satellite image products, and derived data products in support of monitoring needs throughout the world.

Here as well, raw data used to generate the time series can be downloaded from DOPA Explorer for further use.

[20] http://earlywarning.usgs.gov/fews/index.php

5. Accessing external data with DOPA Explorer

5.1. Using selected Web Map Services (WMS)

The complex links that are governing the way environmental and anthropogenic factors affect our environment need to be understood. The ideal assessment tool for protected areas would therefore be able to capture a large variety of information covering multiple disciplines, ranging from biology to economy and sociology. If DOPA Explorer cannot encompass all possible datasets the end-users might want to use, it still provides means to access a wealth of information by accessing Web Map Services (WMS) available on the World Wide Web. A Web Map Service (WMS) is a standard protocol for serving maps over the Internet and the number of institutions serving their data through such services is growing every day.

DOPA Explorer provides a pre-selected list of popular WMS provided by JRC, NASA, CIESIN-SEDAC, to name a few. These services can be accessed from the left navigation panel of DOPA Explorer, using the green button “Add Layer” (see Chapter 3, Step 6). The selection of GeoBolivia for example, a Bolivian Institution managing geospatial data for the government, will list the maps made available by their WMS including a title and broader description of each map made available (Figure 30).

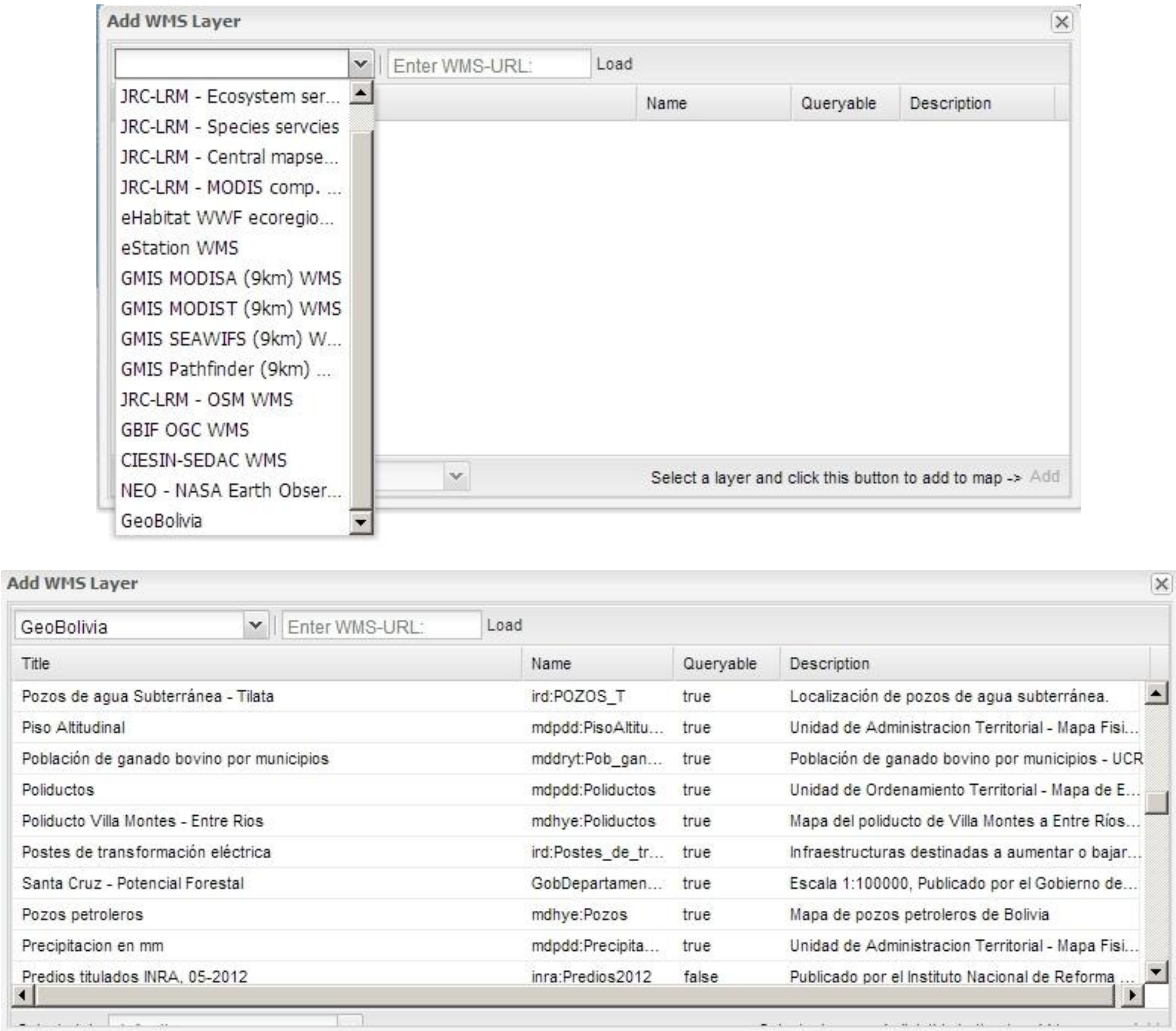


FIGURE 30. SCREEN CAPTURES OF THE WINDOW PROVIDING A DIRECT ACCESS TO SELECTED WEB MAP SERVICES (TOP) AND EXAMPLE OF MAPS LIST FROM THE SELECTED WMS (HERE GEOBOLIVIA) (BOTTOM). ACCESS TO OTHER WMS CAN BE OBTAINED BY ENTERING THE ADDRESS OF THE WMS IN THE UPPER RIGHT EDIT BOX AND USING THE “LOAD” BUTTON. NOTE THAT THE VISUALISATION OF EACH SELECTED MAP REQUIRES USERS TO USE THE “ADD” BUTTON (THE LOWER RIGHT CORNER).

Maps from different services can be used together as shown in Figure 31 where various maps from GeoBolivia, NASA, UNEP-WCMC and CIESIN-SEDAC are displayed together. These maps are organised like layers and the ordering choice needs to be carefully considered. The order of the maps can be changed any time by rearranging the order of the maps indicated in the left navigation panel (layers are reordered by dragging the names with mouse, see Chapter 3 step 6). Note that a right mouse click on the layer name allows the opacity of the layer to be changed.

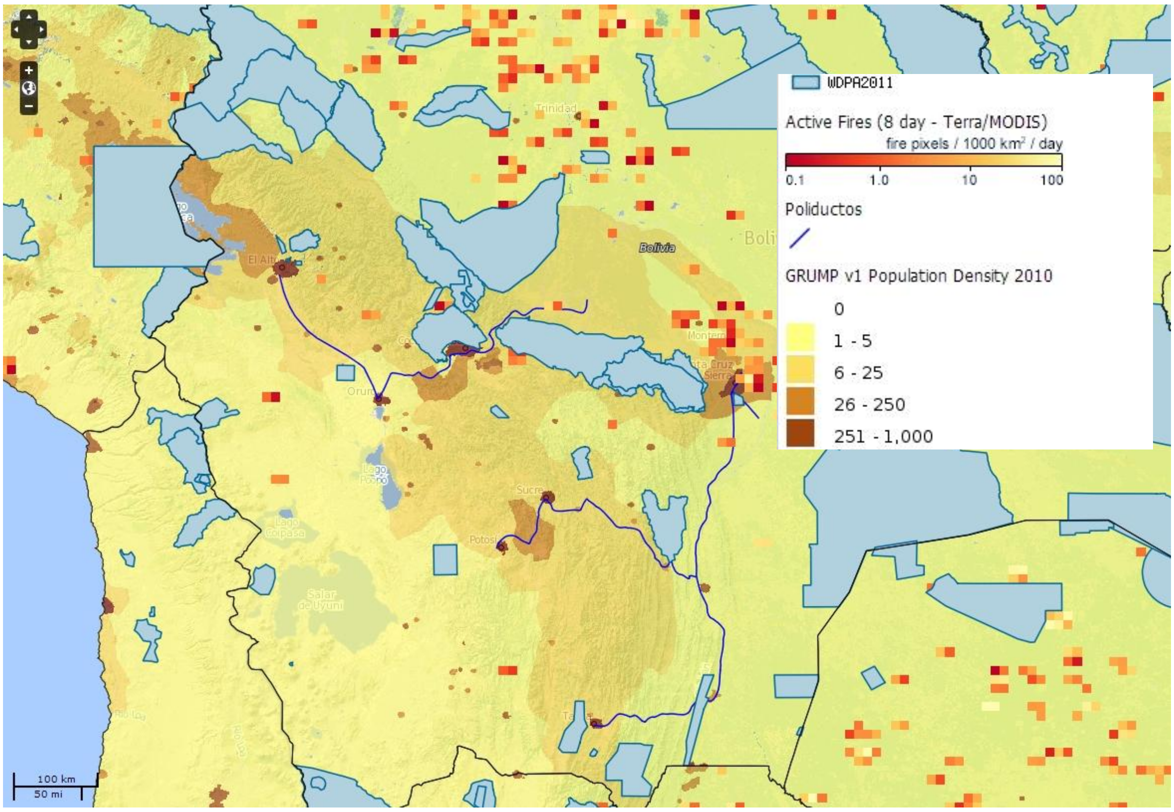


FIGURE 31. MAPS FROM DIFFERENT WMS CAN BE EASILY OVERLAID IN DOPA EXPLORER. THE FIGURE SHOWS BOLIVIAN PIPELINES (GEOBOLIVIA WMS) AND ACTIVE FIRES OBSERVED THE LAST 8 DAYS (NASA WMS) ON TOP OF A MAP SHOWING PROTECTED AREAS (WCMC WMS) AND A POPULATION DENSITY MAP FOR 2010 (CIESIN-SEDAC WMS) .

5.2. Using external Web Map Services (WMS)

The number of WMS's available over the internet is increasing on a daily basis and end-users of DOPA Explorer might want to access such services. DOPA Explorer accepts WMS versions 1.1.1. and 1.3.0.

Practically, end-users need to load an address of the type

http://dataprovidername.institution.country/wms/wms?

to access the maps made available by the institution. NASA's earth observations WMS, for example, is available from

http://neowms.sci.gsfc.nasa.gov/wms/wms?

Another WMS from the European Alien Species Information Network (EASIN) is accessible through

http://alien.jrc.ec.europa.eu/ws/11b/gis/ogc/grid10km?service=WMS&request=GetCapabilities&version=1.3.0

While these two addresses will not provide anything easily interpretable when used as such in a web browser, accessing these through the DOPA Explorer by copy/pasting these addresses in the "Enter WMS-URL" edit box will allow end-users to access directly all the maps provided by these institutions directly on our main visualisation panel. Figure 32 shows, for example, how data from EASIN[21], a service providing information from distributed resources on alien species in Europe, can be displayed within DOPA Explorer

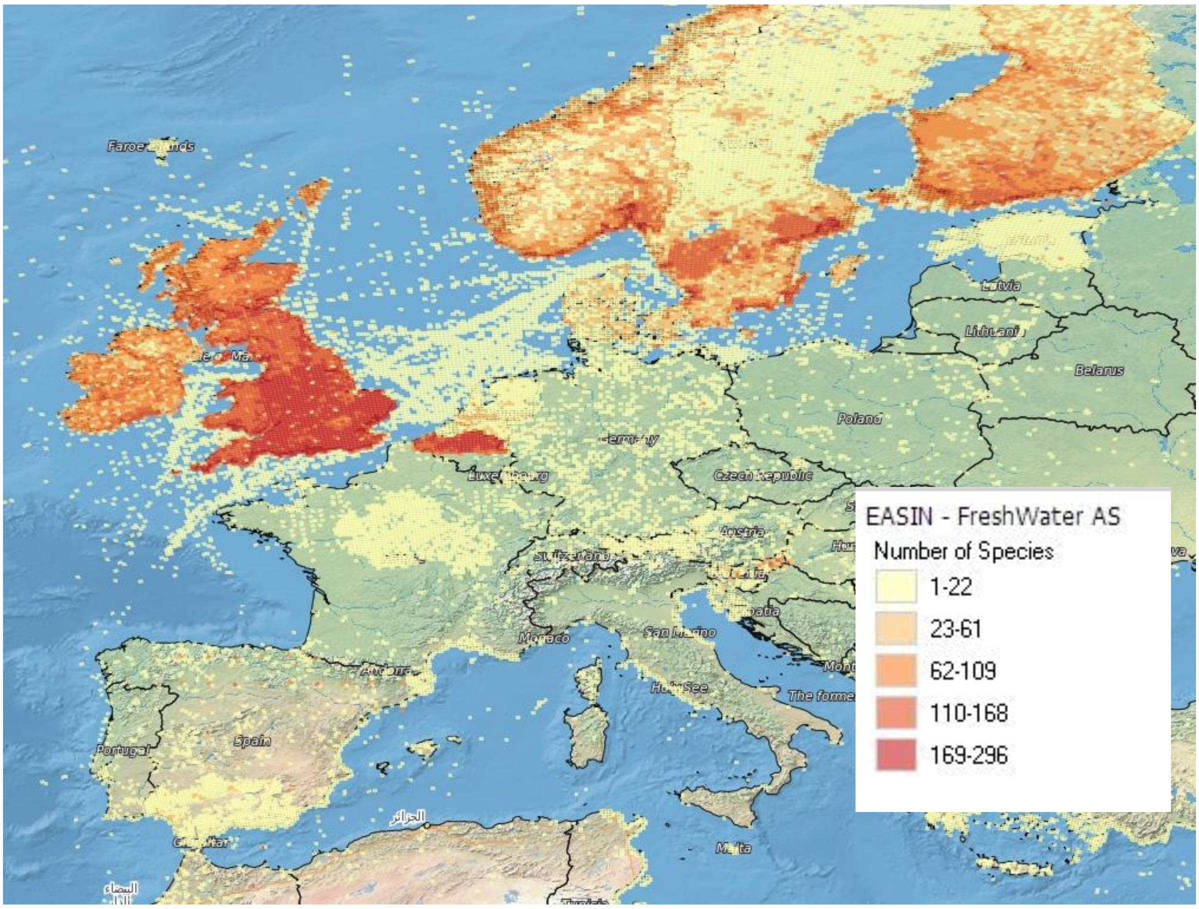


FIGURE 32. LOADING THE WMS OF THE EUROPEAN ALIEN SPECIES INFORMATION NETWORK (EASIN) ALLOWS US, FOR EXAMPLE, TO MAP IN DOPA EXPLORER ALL OCCURRENCES OF FRESHWATER ALIEN SPECIES RECORDED IN EUROPE OVER A 10 X 10 KM GRID.

Web Map Services require from their developer a strict management of the content and one will frequently encounter situations where the WMS is not providing a clear description of the information distributed or not a clear legend, if any, when displaying the maps. Still, the use of web based services is becoming part of the state of the art and the situation regarding data documentation is expected to improve significantly over time.

Note that web services providing the maps can sometimes be down and in such cases DOPA Explorer will usually display an empty pink layer.

[21] http://easin.jrc.ec.europa.eu/

6. Current status, known issues and next steps

Capitalizing on the experience gained with the African Protected Areas Assessment Tool (APAAT, Hartley et al. 2007), we have developed a new set of web services adopting the same continent wide and consistent methodology for assessing the value and pressures on protected areas across the globe. The assessment is based on quantifiable and objective measures using global information hosted by major Institutions, in particular from the EC-JRC, the UNEP-WCMC, the IUCN, BirdLife International, the NASA, CIESIN and the ESA.

DOPA Explorer Beta (version 2013-10-24, Rev. 3069) is our first attempt to make the information provided by these web services available to a wide range of potential end-users, from park managers to the researchers and decision-makers. DOPA Explorer provides simple means to explore terrestrial and marine protected areas greater than 150 km^2, identify those with most unique ecosystems and species and assess the pressures they are exposed to because of human development. Ecological data and earth observations have also been made available for African protected areas and are updated every 10 days.

DOPA Explorer Beta is also a means to engage with those that are not familiar with web services as it illustrates the benefits of accessing a broad range of databases and models hosted at different locations.

Inevitably, DOPA Explorer Beta also suffers from a number of limitations. As our first attempt to integrate such a broad range of data from different web services, the tool has been tested only by a limited number of users and a number of bugs are certainly remaining. If web services allow end-users to access information that is usually automatically up-to date, the distributed architecture makes it also more fragile to some extent. All web services need indeed to be running properly to guarantee an effective access to the data and models.

The complexity of our indicators and the frequent problems encountered when processing geospatial data containing errors inevitably leads to wrong results which cannot always be easily traced. We processed more than 9 000 protected areas and validating the information for each protected area is impossible in the short term. It is also the purpose of the forthcoming DOPA Validator to provide the experts with means to report and correct the information from DOPA Explorer. End-users of DOPA Explorer Beta will probably notice a number of protected areas for which the Population Pressure index was not computed. This is partly due to some topological issues with a number of polygons in the WDPA. A second factor is coming from the non-negligible number of duplicated protected areas found in the WDPA. Because the processing of the pressure indicators requires the computation to run simultaneously on all protected areas, the cost distance buffer is obtained only for one of the duplicated protected areas leaving the others without results. The same problem arises with the naming of protected areas which are regularly duplicated. Last but not least, the complex issue of distinguishing terrestrial from marine protected areas when both contain coastal areas, has not found yet a solution. This can sometimes lead to absurd results for a number of protected areas which cover both types of environments.

It is also the purpose of DOPA Explorer Beta to expose all these issues that are encountered by anyone using these baseline datasets and to encourage everyone to contribute to the verification and validation of the information proposed.

The number of improvements planned for the DOPA Explorer is too long to be listed here in full and we will mention only the main ones we are currently working on.

- Version of databases: we are currently not providing in the web client any information on the versions of the databases used. This is critical when regular assessments are made and such functionality will be provided in the next versions.

- The automatic processing of our indicators can generate extravagant results when protected areas cover both marine and terrestrial ecosystems. We hope to have a more suitable approach in the future for such protected areas and to propose some useful indicators to assess pressures on marine protected areas.

- DOPA Explorer 1.0, planned for 2014, will provide an additional set of services to map ongoing project activities in the field of conservation in protected areas. This information is essential to identify the various actors on the ground as well as to identify the areas where information and actors are scarce. We will therefore include a new section providing information on current and, if possible, past projects.

- Our environmental monitoring system is currently limited mostly to Africa and we are currently exploring means to have a more global coverage. The number of products to be delivered on a 10 days basis will also include additional variables such as Land Surface Temperature (LST) and spatial and temporal distribution of surface water resources (Pekel et al., 2014).

- DOPA Explorer provides much information that is useful for reporting purposes but there is much space for improvement. We plan to significantly ease the access to the data and maps and improve the means for further use and presentation.

To improve or correct the information proposed in DOPA Explorer, a set of validation tools will be developed for experts in the DOPA Validator (Beta version planned for 2014)

- DOPA Validator will provide means to validate the generic information on the protected area shown in DOPA Explorer. Species list can be used for validation purposes and abundance data will be collected. Spatio/temporal information on species observations should further help us assessing the evolution of the species in the protected areas.
- Land cover change is a fundamental indicator for assessing pressures on protected areas, the loss of habitats and possible changes to connectivity. DOPA Validator will include a new module which will ease such assessments (see Bastin et al., 2013) and additional functionalities will be proposed to capture a more exhaustive range of threats.
- Environmental anomalies in the monitored variables can be detected by contrasting every 10 days environmental data against historical records. These anomalies can be characterized by their strength, their duration and their deviation from their expected occurrence in time, something typical of seasonal changes (Dubois et al., 2009). DOPA Explorer will provide means to flag these anomalies.
- Our pressure indicators are probably the most rudimentary ones and more efforts will be put into the mapping of threats to protected areas
- Our last but most important improvement will focus on contributing to the collection of the information that is used for assessing governance and the management effectiveness of protected areas (see e.g. Hockings, 2003).

By deploying specific tools constructed around a few reference services developed for a broad range of end-users, from park rangers to policy makers, we hope to contribute to a better communication between funding agencies and the actors on the ground, between researchers and policy-makers. It is the main purpose of the technology developed in DOPA to support communication between everyone willing to contribute to the safeguarding of biodiversity.

7. Help and Feedback

End-users of DOPA Explorer will find hereafter various ways to get more information about the DOPA Explorer.

7.1. DOPA Web site

This document is made available from the homepage of DOPA, http://dopa.jrc.ec.europa.eu/

This web site is currently the main entry point to access DOPA web sites and web services. It also provides information on latest news, major developments as well as the access to official documentation.

7.2. Distribution list

We invite interested users to subscribe to our distribution list to get automatically information about the main changes to DOPA Explorer. The mailing list is expected to be used every 2 months to circulate information on the latest changes, bugs and improvements.

To subscribe to this distribution list, visit http://irelay.jrc.it/cgi-bin/majordomo and enter the email you would like to use in "your e-mail address" field. Then click on "FIND" and enter "dopa-explorer" on the field next to it, then click on "go". After the page loads, click in the field next to the padlock symbol and click on "apply". To unsubscribe, follow the same procedure using your existing email, unclick the field next to the padlock, and then click "apply

Alternatively, you can send a message to <Majordomo@jrc.ec.europa.eu> with the following command in the body of your email message:

subscribe dopa-explorer

If you ever want to remove yourself from this mailing list, you can send mail to <Majordomo@jrc.ec.europa.eu> with the following command in the body of your email message:

unsubscribe dopa-explorer

If you ever need to get in contact with the owner of the list (e.g. if you have trouble unsubscribing, or have questions about the list itself), send an email to <owner-dopa-explorer@jrc.ec.europa.eu> .

7.3. Engaging with us through the Wiki

Should you be interested in contributing scientifically, technically or as an end-user of DOPA, we would be happy to welcome you on our Wiki to discuss our work at http://dopa.wikispaces.com/

7.4. In last resource

You can contact

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Title: An introduction to the Digital Observatory for Protected Areas (DOPA) and the DOPA Explorer (Beta)

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Abstract

The Digital Observatory for Protected Areas (DOPA) is conceived around a set of interacting Critical Biodiversity Informatics Infrastructures (databases, web modelling services, broadcasting services, ...) hosted at different institutions, including the Joint Research Centre of the European Commission, the UNEP World Conservation Monitoring Centre (UNEP-WCMC), the International Union for Conservation of Nature (IUCN), the Global Biodiversity Information Facility (GBIF) and BirdLife International. The current services of DOPA provide to a large variety of end-users, ranging from park managers, funding agencies to researchers, with means to assess, monitor and possibly forecast the state and pressure of protected areas at the local, national and global scales.

With an introduction to the DOPA, the readers will find here a user manual of the beta version of DOPA Explorer, a first web based assessment tool where information on 9 000 protected areas covering almost 90% of the global protected surface has been processed automatically to generate a set of indicators on ecosystems, climate, phenology, species, ecosystem services and pressures. DOPA Explorer can so help identify the protected areas with most unique ecosystems and species and assess the pressures they are exposed to because of human development. Ecological data derived from and near real-time earth observations are also made available for the African continent. Inversely, DOPA Explorer indirectly highlights the protected areas for which the information is incomplete. We finally invite the potential end-users of DOPA to engage with us through the proposed communication platforms to help improve our work to support the safeguarding of biodiversity.

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