D.3.1b: report on user requirements for the EuroGEOSS Forestry operating capacity

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These are Dublin Core metadata elements. See for more details and examples [http://www.dublincore.org/](http://www.dublincore.org/)
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<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC</td>
<td>Architecture and Data</td>
</tr>
<tr>
<td>AFOC</td>
<td>Advanced Forestry Operating Capacity</td>
</tr>
<tr>
<td>AIP-2</td>
<td>Architecture Implementation Pilot, Phase 2</td>
</tr>
<tr>
<td>AOC</td>
<td>Advanced Operating Capacity</td>
</tr>
<tr>
<td>ArcSDE</td>
<td>ArcSDE technology is a core component of ESRI ArcGIS Server. It manages spatial data in a relational database management system (RDBMS)</td>
</tr>
<tr>
<td>CIF</td>
<td>Climate Investment Funds</td>
</tr>
<tr>
<td>CSR</td>
<td>Components and Services Registry</td>
</tr>
<tr>
<td>CSW</td>
<td>Catalogue Services for the Web</td>
</tr>
<tr>
<td>DOPA</td>
<td>Digital Observatory of Protected Areas</td>
</tr>
<tr>
<td>DoW</td>
<td>Description of Work</td>
</tr>
<tr>
<td>Dublin Core</td>
<td>Dublin Core metadata standard</td>
</tr>
<tr>
<td>E2EDA ER</td>
<td>End to End Discovery and Access Engineering Report</td>
</tr>
<tr>
<td>ESA</td>
<td>European Space Agency</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>FIOC</td>
<td>Forestry Initial Operating Capacity</td>
</tr>
<tr>
<td>GCI</td>
<td>GEOSS Common Infrastructure</td>
</tr>
<tr>
<td>GEMET</td>
<td>GEneral Multilingual Environmental Thesaurus</td>
</tr>
<tr>
<td>GEOFOSS</td>
<td>Geographical Free and Open Source Software</td>
</tr>
<tr>
<td>GeoNetwork</td>
<td>GEOFOSS Metadata Catalogue</td>
</tr>
<tr>
<td>GeoServer</td>
<td>GEOFOSS Mapping Server Engine</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>IDEE</td>
<td>Spanish National Spatial Data Infrastructure</td>
</tr>
<tr>
<td>INSPIRE</td>
<td>INSPIRE Directive</td>
</tr>
<tr>
<td></td>
<td>The INSPIRE directive aims to create a European Union (EU) spatial data infrastructure.</td>
</tr>
<tr>
<td>IOC</td>
<td>Initial Operating Capacity</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>ISO 19115/19119/19139</td>
<td>Standards for spatial metadata (datasets, services, XML representation)</td>
</tr>
<tr>
<td>JRC</td>
<td>Joint Research Centre</td>
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<tr>
<td>LDAP</td>
<td>Lightweight Directory Access Protocol</td>
</tr>
<tr>
<td>OGC</td>
<td>Open Geospatial Consortium</td>
</tr>
<tr>
<td>OpenSearch</td>
<td>OpenSearch is a collection of simple formats for the sharing of search.</td>
</tr>
<tr>
<td>OpenStreetMap</td>
<td>OpenStreetMap is a free editable map of the whole world.</td>
</tr>
<tr>
<td>OWS</td>
<td>OGC Web Services</td>
</tr>
<tr>
<td>SBA</td>
<td>Societal Benefit Area</td>
</tr>
<tr>
<td>Shibboleth</td>
<td>The Shibboleth System is a standards based, open source software package for web single sign-on across or within organizational boundaries.</td>
</tr>
<tr>
<td>SIR</td>
<td>Standards Registry System</td>
</tr>
<tr>
<td>SKOS</td>
<td>Simple Knowledge Organization Systems</td>
</tr>
<tr>
<td>SWG</td>
<td>Scenario Working Group</td>
</tr>
<tr>
<td><strong>TREES-3</strong></td>
<td>Action 42003 - Global Forest Resource Monitoring</td>
</tr>
<tr>
<td><strong>UIC</strong></td>
<td>User Interface Committee</td>
</tr>
<tr>
<td><strong>UNEP</strong></td>
<td>United Nations Environment Programme.</td>
</tr>
<tr>
<td><strong>UniZar</strong></td>
<td>University of Zaragoza</td>
</tr>
<tr>
<td><strong>URL</strong></td>
<td>Unified Resource Locator</td>
</tr>
<tr>
<td><strong>WCMC</strong></td>
<td>World Conservation Monitoring Centre</td>
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<tr>
<td><strong>WCS</strong></td>
<td>Web Coverage Service</td>
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<tr>
<td><strong>WebDAV</strong></td>
<td>Web-based Distributed Authoring and Versioning</td>
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<tr>
<td><strong>WFS</strong></td>
<td>Web Feature Service</td>
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<td><strong>WFS</strong></td>
<td>Web Feature Service</td>
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<tr>
<td><strong>WFS-T</strong></td>
<td>Web Feature Service, Transactional</td>
</tr>
<tr>
<td><strong>WG</strong></td>
<td>Working Group</td>
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<tr>
<td><strong>WMS</strong></td>
<td>Web Mapping Service</td>
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<tr>
<td><strong>WMS</strong></td>
<td>Web Map Service</td>
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<td><strong>WP</strong></td>
<td>Work Package</td>
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<td><strong>WP</strong></td>
<td>Work Package</td>
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<tr>
<td><strong>WPS</strong></td>
<td>Web Processing Service</td>
</tr>
<tr>
<td><strong>XML</strong></td>
<td>eXtensible Markup Language</td>
</tr>
<tr>
<td><strong>Z39.50</strong></td>
<td>ISO standard 23950 Protocol used to retrieve (meta)data from remote databases</td>
</tr>
</tbody>
</table>
1 INTRODUCTION

The document is the deliverable D3.1b for EuroGEOSS Work Package 3 (WP3), the Report in User Requirements for the EuroGEOSS Advanced Forestry Operating Capacity (AFOC). The document will follow the same approach of the previous document D3.1 that describes the Forestry Use Scenarios for the Forestry Initial Operating Capacity.

For each Scenario, a number of processes are presented and described following a standardize processing from several OGC services available through the EuroGEOSS Forest systems. The processes will resume concrete use cases for Forest Managers and Planners analysing forest occurrences.

The integration with other thematic areas, such as Biodiversity and Droughts, is described in cross thematic processes section.

The document firsts details the Implementation of the Forest Initial Operating Capacity system, its developments and achievements, the interfaces available and the most functionality available.

The description of the AFOC follows as an evolution from FIOC in order to achieve the multidisciplinary requirements set for the EuroGEOSS project.

This document culminates in the identification and listing of macro functional requirements, derivate from the AFOC Use Scenarios (also part of this document), essential for the construction of next deliverable D3.2b where the Design Specifications and Interfaces of AFOC shall be detailed.
2 DESCRIPTION OF FORESTRY INITIAL OPERATING CAPACITY (FIOC)

The Forestry Initial Operating Capacity (FIOC) is the operating system whose main goal was to integrate all the European Forest system available through specific data interfaces, in order to gather and provide all the information in a common place.

2.1 EuroGEOSS FIOC Entry Point

![EuroGEOSS FIOC Entry Point](http://193.126.113.48/)

Figure 1: EuroGEOSS FIOC Entry Point

2.2 Metadata catalogue

2.2.1 Tools - Latest GeoNetwork

The metadata catalogue implemented is based on the open source software GeoNetwork. The implementation of the FIOC system started with the Geonetwork version 2.4.1, but now currently it is using the latest stable version 2.6.1.
Figure 2: EuroGEOSS metadata catalogue GeoNetwork

(Url: http://193.126.113.48:8083/geonetwork)

The main features present in this version are:

- INSPIRE Discovery Service and Search Panel
- Catalog interfaces (a.o. OGC CSW, INSPIRE, OpenSearch, z39.50)
- OpenLayers based OGC map viewer
- Multilingual metadata editing and viewing
- Metadata harvesting from multiple sources (OGC CSW/WMS/WFS/WCS/WPS, WebDAV, Z39.50, ArcSDE, GeoNetwork, Local filesystem)
- Metadata schema and schematron validation with error reporting
- LDAP & Shibboleth authentication support
- Runs on Windows, Linux and OSX server and desktop
- GeoServer included
2.2.2 New functionalities

Themes Functionality

The Themes functionality is mostly identical to the categories functionality already available in the software. The goal is to extend the categories into themes more related to the forest context. This allows searching metadata on the forest thematic area in a faster way.

THEMES
- Forest International
- Forest biodiversity
- Forest condition
- Forest fires
- Forest information systems
- Forest inventory
- Forest mapping
- Forest products
- Forests & Climate Change

Figure 3: EuroGEOSS Forest Themes

Mapping interaction

One of the goals of the FIOC phase of EuroGEOSS was to integrate both a catalogue and mapping viewer components for the forestry thematic area. One of the requirements of such integration was the direct and bi-directional interaction and communication between both components (please read on later sections details of this integration).

In the case of the direction Catalogue -> Map Viewer, new links were created in the Catalogue component – managed by the GeoNetwork software package – when the existence of an OWS web service was detected in the ISO 19119 metadata (services).

This approach followed the existent convention within GeoNetwork, where an OWS was identified in the ISO 19119 metadata element “Distribution Information/Transfer options/Online resource”. When the two sub-elements “URL” and “Name of the Resource” were filled in, GeoNetwork would display the Interactive map link. Using the same “detection” method we were able to modify GeoNewtork to also display the link to the FIOC Map Viewer.

The solution was still not sufficient to cover the complete integration between the FIOC Catalogue and Map Viewer components, as it was required to also display the map viewer link when, only, the
“URL” sub-element was filled in. To accommodate this new feature the GeoNetwork package was changed and extended to consider this new functionality.

![Figure 4: OWS identification within GeoNetwork](image)

Although there are elements available in ISO 19119 (and INSPIRE) metadata structure suitable to declare OWS services, there is not however a standard way to do so, i.e. the metadata creator may use many or some or just one of them, making the automatic identification within GeoNetwork difficult to implement, as many variations may occur (e.g.: above image vs. below image, show two ways – different metadata elements – to declare a OWS service).

![Figure 5: OWS identification from imported EFDAC metadata](image)

As metadata records harvested from external catalogues cannot (should not) be changed in the FIOC metadata catalogue (e.g.: on new metadata harvesting process the records would be overwritten) and most likely the institutions behind those external catalogues would not change them and the metadata records in order to “comply” with the FIOC catalogue (in terms of OWS registration), not all OWS will be recognized by the FIOC GeoNetwork Catalogue and therefore no “Interactive Map” and “EuroGEOSS Map Viewer” buttons will be displayed.

Considering the above, the forestry thematic workgroup partners will evaluate the options to implement the OWS identification within GeoNetwork Catalogue, at least for the most common
cases identified in the FIOC forestry metadata resource catalogues, e.g.: Spanish IDEE service catalogue.

**Dublin Core metadata**

The bibliographic metadata (non-spatial), in Dublin Core format, from the Forestry EFDAC catalogue was migrated successfully to the FIOC catalogue, GeoNetwork software package.

In order to maintain the same level of functionality as in the previous EFDAC metadata search GUI (at JRC), where the DC “Source” and “Relation” elements had links to resources, it was necessary to adjust the GeoNetwork catalogue to add this new functionality (since it was non-existent).

With this change, GeoNetwork is capable of recognizing URL values in those metadata elements and add a clickable link to them, allowing the user to directly access to the resources.

**Multilingual metadata**

The multilingual metadata is a new feature available in the latest version of GeoNetwork. It’s possible to declare a new language in the metadata record, after the main language has been defined. After defining the other languages, in the edition metadata mode, every metadata field has a new field for the selection of the new language to edit the metadata field in the specific language.

![Figure 6: Metadata Multilingual Example](image)
Multilingual Harvesting

Concerning the harvesting capabilities of the FIOC catalogue, GeoNetwork supports the required CSW 2.0.2 protocol for access and retrieval of metadata in external catalogues.

For this, it enables the administrator (which manages and configures the harvested catalogues) to declare (optionally, although in Forestry or other thematic areas it should be compulsory) a set of keywords to be used as search criteria during the harvesting process. This will allow the filtering of metadata records according to the supplied keywords and therefore makes it possible not to retrieve all of the metadata records from the external catalogue.

As the FIOD used the standard harvesting functionality of GeoNetwork the search criteria keywords are used as they are typed in and no internal process will translate or expand them into other languages. Although GeoNetwork has the GEMET thesaurus integration, it is only applied to the metadata and not to the harvesting process.

If the administrator wants to harvest external catalogues with multilingual keywords, it has to input them by hand, together with the English (default) keywords, in the search criteria fields of the harvesting management GUI.

In practice, if under the FIOC catalogue, a harvesting procedure is setup in the GeoNetwork management GUI, pointing to the Spanish IDEE catalogue, using English forestry related keywords, it is likely to return fewer metadata records than if using Spanish keywords. It is likely
that the metadata in the Spanish catalogue is mainly written in Spanish language and not in English (this is, of course, dependent on how the external catalogue is managed).

Considering the above, it is not presumable that every external catalogue has English as a second language describing resources on the metadata records, or even more languages than the native one (Spanish in the example given above).

If one external catalogue includes only one language (native) that is known, the harvesting configuration could include (only) keywords on that language. This will maximize the metadata return according to the search criteria. If, in other hand, the language is not known or the catalogue includes a mix of languages present on the metadata records, using English keywords, probably, will not maximize the metadata returned (that is, if English is still used at all by the external catalogue).

Possible solution to this paradigm always implies changing the GeoNetwork software package, modifying its default harvesting mechanism; in order to expand (to other languages) the English keywords present in the search criteria (considering English as the default language).

The expansion algorithm could be foreseen to use a connection to the GEMET thesaurus or eventually to the Google translator service. To be noted that the former approach could be limited, as the GEMET thesaurus may not have enough specific keywords related only to the Forestry theme (although it has the “concept list for forestry, which include 96 English keywords and their translation to approximately 30 languages); while the latter approach could be imprecise due to the possible lack of quality in the translated keyword for the forestry theme.

Taken into consideration the above, a decision cannot be made easily and additional discussion on this subject is required.

Metadata Search Service

The Metadata Search Service is a new service implementation, following the Jeeves architecture implemented in the GeoNetwork software that allows searching for metadata services, that describes OGC data services, by specifying the layers names as the search parameter. The following figure represents a search return example:


Figure 8: Results from Metadata Search Service

2.2.3 Metadata & Data

Metadata
The FIOC catalogue, based on the GeoNetwork software package, currently holds the JRC EFDAC metadata records related with spatial (ISO 19115/19119) & non-spatial (Dublin Core) resources.

In terms of integration of external catalogues, 2 catalogues with CSW harvesting capabilities were identified in the D3.1 document. These are from the Spanish Spatial Data Infrastructure and publish resource metadata related to Spanish datasets and service resources. They are:

- Spanish IDEE Service catalogue (testing infrastructure deployed at Unizar).
  
  http://idee.unizar.es/cswServicesSearch/servlet/cswservlet?request=GetCapabilities&version=2.0.2&service=CSW

- Spanish IDEE Dataset catalogue (testing infrastructure deployed at Unizar).
  
  http://idee.unizar.es/csw/servlet/cswservlet?request=GetCapabilities&version=2.0.2&service=CSW

An additional catalogue, related to another EuroGEOSS thematic area – Droughts – is being used for integration testing, as it also exposes a CSW interface publishing Droughts related resources. To some extent it proves the first step of the concept (as a simple sample) of inter-thematic connection within the EuroGEOSS scope.

- EuroGEOSS Droughts Catalogue
  
  http://EuroGEOSS.unizar.es/CatalogCube/servlet/cswservlet?request=GetCapabilities&version=2.0.2&service=CSW

As already approached in the previous section, the harvesting procedures, made against these catalogues, should be controlled using a set of keywords that represent a search criteria (i.e. Filter), aiming for the retrieval of (only) forestry related metadata records (and not the complete metadata catalogue set of resources).

To be noted that the (large) number of keywords, present in the harvesting search criteria filter, may negatively influence (slow down) the harvesting process on the target / external catalogue system. This mostly has to do with the evaluation of the Boolean condition made by the search criteria keywords that are “ORed” together and evaluated against each metadata record.

This contrasts somehow with the objective of retrieving the most number of metadata records from the external catalogue, since using more keywords in the filter will lead to obtaining more metadata.

This subject requires further discussion, in order to find a balanced solution, but as a starting point and also related to the multilingual harvesting discussed in the previous section, the first approach shall consider the usage of English keywords for the search criteria filter.

Nevertheless, for the expansion of the keywords present in the search criteria, we can identify at this stage some possible solutions that are intended to overcome the identified issues:

• Usage of the GEMET thesaurus, either internally (already within GeoNetwork) or accessing the GEMET web service (https://svn.eionet.europa.eu/projects/Zope/wiki/GEMETWebServiceAPI), in order to get the keywords (terms) under the “Concept for forestry” (http://www.eionet.europa.eu/gemet/theme_concepts?letter=0&start=0&th=14&langcode=en&ns=4). There are 96 terms in approximately 30 languages.

Figure 9: GEMET Thesaurus – Forestry Concepts list

Thesaurus Data

The GeoNetwork supports thesaurus for metadata editing, managing thesaurus and search thesaurus keywords.

The Geonetwork allows importing external thesaurus in the SKOS format. The imported thesauruses in the scope of EuroGEOSS are the GEMET thesaurus, the GEMET Theme
thesaurus and the Inspire Themes thesaurus. They are external and so no editable in the thesaurus management interface.

![Figure 10: Thesaurus imported](image)

The other functionalities for using the thesaurus are the metadata editing functionality and the advanced search interface. In the metadata editor, as showed in the following figure, the keywords metadata field allows to search for all the thesaurus terms from each thesaurus available in the Geonetwork.

![Figure 11: Thesaurus keywords search in Metadata Editor](image)

The advanced search functionality allows searching for thesaurus keywords index to the metadata records available in the catalogue.
2.2.4 Users

The current users available are, the normal user (guest) whose main function is to search for metadata according to several options, and the administrator user, that can do whatever the normal user does, and all the administrations tasks, such as harvesting other metadata catalogues, editing localization string from categories and Forest Themes, managing thesaurus, or edit metadata records.

2.3 Map Viewer

The EuroGEOSS Forest Map Viewer has been developed to provide a forest information portal that connects to a wide variety of forest and biodiversity information services. The Map Viewer enables users to access forest information from distributed sources over the internet using standard OGC services that include WMS and WFS services. In particular the Map Viewer provides discovery capabilities of spatial data layers within a spatially enabled map environment and enables users to overlay data from a variety of thematic sources.

The Map viewer consists of a number of panels, which include a WMS Layer panel, which lists all available WMS layers from a particular service. In addition, summary information pertaining to each layer is available, while the user is also given an option to access the layer's full metadata.
The Map Viewer has been developed using free, open-source programming languages, namely OpenLayers, ExtJS Framework and GeoEXT. All are Javascript technologies that can be readily integrated to develop feature rich web-mapping platforms.

The Layer tree lists all layers that have been added to the map panel as well as standard pre-defined base layers. In addition, the published WMS legends for all layers are also available.

![Figure 13: EuroGEOSS Map Viewer](http://193.126.113.48/EuroGEOSS_forest.html)

### 2.3.1 Map Viewer Components

#### WMS Layers

The WMS Layers component allows visualizing all the WMS services available within the Forest Systems that integrate the EuroGEOSS FIOC. All WMS layers are described by a name, a title and a link to the metadata available in the EuroGEOSS metadata catalogue describing the OGC service.
Layers

The Layer tree lists all layers that have been added to the map window. It consists of two folders:

1. Base Layers contains predefined such as low resolution satellite imagery and map data (e.g. OpenStreetMap);

2. Overlays contain any WMS or WFS layer that has been added to the map viewer by the user from the WMS Layer list. There is no limit to the number of layers that can be added from one or many services.

Map Panel

The map panel is the main component of the map viewer as it displays the predefined layers as well as all layers that are added by the user from different WMS Services. It also enables the user to select geographic regions and to overlay spatial data from different thematic areas. This functionality is achieved from the use of standard map navigation tools:
• Zoom to full extent;
• Zoom in / zoom out;
• Select predefined zoom;
• Pan;
• Zoom history;
• Digitise points, lines and polygons & select features;
• Print map window.

2.3.2 Data Layers

As previously described, the Map viewer is highly flexible and permits users to add WMS services and or layers from virtually any provider. However, the Map viewer has been developed with a series of predefined WMS Services for a number of thematic areas, each are subsequently listed below:

![Figure 15: OWS Services](image)

2.3.3 GeoNetwork Integration

The Map Viewer provides customised functionality to permit a user to preview & view the spatial dataset within the Map viewer, but it also allows a user to access a layer’s full metadata page in GeoNetwork.
In addition, a user that is browsing metadata in GeoNetwork can automatically load a particular layer in the Forest Map Viewer through a single click.

An overview of the interactions and data flows between the Map viewer and GeoNetwork are provided in the following Figure.

Figure 16: Forestry Catalogue and Map Viewer bi-directional integration

2.4 TREES Application

2.4.1 Background information on the TREES-3 project


Action 42003 - Global Forest Resource Monitoring (TREES-3)

The TREES-3 Action provides quantitative measurements and mapping of changes in forest resources for EU policies related to global environmental and forestry issues, with a focus on Eurasian boreal forests and tropical forests, including the Caribbean and Pacific regions. It also addresses forest cover and cover change issues related to EU commitments to Multilateral Environmental Agreements, especially to UN conventions such as the UNFCCC, UNCCD, UNCBD, and the UN Forest Forum, as well as Action Plans such as on Forest Law Enforcement Governance and Trade (FLEGT).
The Action generates regional forest maps, tracks areas of rapid forest change and produces statistically valid estimates of cover change for the current and previous decades (from the mid 1970’s to 2005-10). It identifies the regional drivers of deforestation, with a focus on tropical and Eurasian boreal forests. The TREES-3 products are used as inputs for future climate change impact scenarios and, through close cooperation with DG Environment, provide a basis for developing non-annex-1 countries’ input into the Kyoto Protocol process. The regional forest maps and estimates of cover change are shared with Commission services, EU Delegations, International Organisations (in particular the Food and Agricultural Organization - FAO), and partner countries. Biomass maps and carbon emission/storage estimates are produced for selected forest ecosystems. Due to persistent cloud in the tropics and poor illumination in winter months in the boreal ecosystems, the TREES-3 Action develops forest monitoring techniques which include radar technologies, as these have good cloud penetration properties and operate without sunlight.

2.4.1.1 Specific objectives of the TREES-3 Action

a) To document changes in forest cover between the years 1975, 1990, 2000 and 2005/2006 from high spatial resolution satellite imagery through an internationally endorsed global sampling scheme.

b) To update our knowledge on deforestation hotspots in the tropics and their current drivers.

c) To map forest cover and other land cover for the year 2005 from medium resolution (300m) optical remote sensing satellite data through collaboration with the ESA and a network of partners.

d) To map forest characteristics (forest cover, biomass indicators) for the period 2006/2007 in the tropics and boreal Eurasia from radar satellite data at circa 100m resolution.

e) To support EU Development and Environment policies in the framework of multilateral environmental agreements by providing options for monitoring changes in forest resources.

The Action collaborates with the European Space Agency (ESA) in the framework of the GLOBCOVER project (global land cover map at 300m resolution for the year 2005) in order to use MERIS-sensor data from the ENVISAT satellite and with the Japanese space agency JAXA in the framework of their Kyoto and Carbon programme to ensure access to radar imagery from the ALOS satellite launched in 2006.

The Action has set up a collaborative partnership with the Food and Agricultural Organization of the UN in the framework of their Global Forest Resources Assessment programme (remote sensing survey component).
The Action also has a number of scientific collaborators or local partners, in particular in the tropics (e.g. ACTO in South America) and Eurasia (e.g. the European Environment Agency).

2.4.1.2 Objectives from 2.4.1.1 specifically addressed in EuroGEOSS

In order to document forest cover change, (a) the TREES-3 project gathers landcover information for 20 km-square sample sites at over 4000 lat-long degree confluence points in the tropical zones of Africa, Asia, and South America. Multi-spectral imagery for each confluence point is processed and classified using object-based techniques to generate homogeneous landcover segments whose geometry is consistent between the sample years (e.g., 1990 / 2000). The classified segments are then subjected to a series of validation steps which combine specialist knowledge at JRC and expert knowledge from the countries concerned. Designated national experts verify the content of each landcover segment using high-quality ‘imagettes’ (currently derived from Landsat imagery) as contextual information.

The analysis of change in these segments allows the identification of deforestation hotspots (b) and provides options for monitoring changes in forest resources, (e) both through the summary change statistics for the sample sites and the simplified land use maps which are generated by FAO from those samples.

2.4.1.3 Main customers

- DG Environment
- DG RELEX family: RELEX, DEV, AIDCO
- EC Delegations in tropical countries
- Members States' AFOLU experts
- European Environmental Agency (EEA)
- Food and Agricultural Organization of the United Nations (FAO)
- Regional organisations in Developing Countries, e.g. the Amazon Co-operation Treaty Organisation (ACTO)
- United Nations Framework Convention on Climate Change (UNFCCC)

2.4.1.4 EU Legislation and Documents supported by the TREES-3 Action

- Commission Communication “Winning the Battle against Global Climate Change” COM(2005) 35
- Council Conclusions “ Forest Law Enforcement, Governance and Trade (FLEGT)” (2003/C 268/01)

Contact Info: Frédéric Achard - Tel.: +39-0332-785545 E-mail: frederic.achard(at)jrc.ec.europa.eu
2.4.2 Tools

The sample validation process described in section 2.4.1.2 has been historically carried out using an application developed at the Joint Research Centre in ENVI’s IDL programming language (the JRC Land Cover Change Validation Tool, see figure below). This application works from a dbf metadata file which references a set of pre-prepared ESRI shapefiles and geotiffs. The application and country-specific dataset can be supplied to national experts from a participating country on a CD, or, more commonly, used at a regional workshop where many experts are gathered for training in using the tool. The tool has been well evaluated and adapted for internal and external use.

![Figure 17: The IDL-based Landcover Change Validation tool.](image)

Two Web-based prototype versions of the IDL tool have been developed within the EuroGEOSS project, using OGC standards for data formats and geospatial Web services. Both prototypes allow users to view and query the status of their allocated sites (completed or in progress), and to select segments where particular types of change have occurred for overlay on ancillary contextual data. They differ in the level of editing functionality offered. The first (prototype A) is based on a
shapefile repository to which users can upload their edited dbf files online, and sign them off as completed – relabeling of segments is still performed using the IDL tool. The second (prototype B) allows the editing and validation process to be carried out entirely online, using a PostGIS database which is exposed via a Web Feature Service.

Evaluation of the alternative prototypes is currently underway, with user feedback being gathered as to which best suits the needs of a wide community of users. There is potential for both to be used in combination, allowing some users (for example, those with poor internet connectivity) to carry out editing with a local version of the existing IDL tool but still upload their changes via the internet to a PostGIS database, while others edit the same data directly via a Web interface.

2.4.3 Functionality

2.4.3.1 Site viewing functionality

The user logs in with a username and password which is used to identify the sample sites allocated to them, and the current status of those sites (completed or in progress). User information and site metadata (e.g., local geographic projection, bounding box of the sample site, names of available imagery files) is stored in a Postgres or PostGIS database (for prototype A, no spatial database storage is required, so a Postgres database may be used if required).

The location and status of the user’s sample sites is displayed on a zoomable, draggable map. Various backdrops based on publicly available global mapping can be selected.

Figure 18: Site Viewing Map I
2.4.3.2 **Upload functionality (Prototype A only)**

Users who have edited one of their allocated shapefiles using the existing IDL tool can select the ‘Upload Changes’ tab to upload the altered .dbf file which contains the new updated labels to the server. At this point, checks are carried out to verify that the user has permission to edit this sample site. When the file has been successfully uploaded, the user has the option of signing the site off immediately as ‘Completed’ or viewing their changes in a separate tab.

![Prototype A Upload Functionality](image)

2.4.3.3 **Viewing functionality**

When a site is selected for viewing, data from two different years can be displayed at once. The landcover segments are shown on the right, and the available satellite ‘imagette’ is shown on the left. In the example below, the user can see the original classification (at centre) along with any
changes that they may have made (at right). The changes may be approved and the site signed off as ‘completed’ from this page. The layout of this viewing window, and its content, is highly configurable.

2.4.3.4 Selection and Contextual viewing functionalty

The user may select specific landcover segments which fulfil specific conditions (for example, those where a specific type of landcover change has occurred, or those with a status of 'Unclassified'. These options are again configurable.
The geometries of the selected segments are retrieved as GML or GeoJSON from the underlying Web Feature Service. This means that they can be overlaid on selected contextual data.

In the example below, the Map Viewer (section 2.3) is integrated as an extra tab allowing various WMS layers to be selected as the backdrop for these segment outlines.

Figure 22: Selection and Contextual Viewing Functionality

Figure 23: Contextual Viewing Functionality in FIOC/AFOC Map Viewer
2.4.3.5 Editing functionality (Prototype B only)

The user may select segments by clicking or dragging a box on the map. These segments may then be re-labelled as belonging to a different landcover, using drop-down menus. When the changes are committed, they are written directly to the underlying PostGIS database, and the view is refreshed accordingly.

2.4.4 Users

The current users are:

- The **editing user (registered guest)** who has password-protected access to view and edit specific geographic sites, and to designate the validation process as being complete for those sites.

- the **administrator user**, who has the same privileges as the editing user, plus the rights to add a site and its metadata to the collection, to create a user and assign sites to them, and to query the historical changes in classification for use in analysis (for example, generating confusion matrices or identifying deforestation hotspots)
When the 2010 data is completely validated and documented, it will be made available to the general public, and a third type of user will be created: the viewing user, who has the rights to view maps and statistical summaries of change.

2.4.5 Available data

The TREES-3 project currently makes available to internal users high quality 'imagettes' which cover the 20km x 20km confluence point samples. These are derived from Landsat imagery, partly sourced from the South Dakota State University's global database of sample tiles, extracted from the USGS GLS archives. For sites where this data is of insufficient quality, or is contaminated by cloud, other Landsat images, or alternative sources of satellite data, are used within JRC to obtain the best possible view.

This multi-temporal, multi-spectral data is classified using an object-based approach with a minimum mapping unit of 5 ha, to generate the polygonal landcover 'segments' whose location and shape are consistent between the study years. In addition to the processed satellite data and the resulting vector maps of landcover, the processing workflow generates several ancillary datasets which could be of value for future re-use within GEOSS: for example:

- Polygons representing training areas for specific landcovers,
- Spectral signatures for those landcovers,
- Summary statistics on overall change and rates of confusion between classes.

In addition to the Landsat data, which is currently used, new sources of multispectral data will came on-stream and be evaluated for possible use in the next classification/validation exercise. These could include:

- For Africa, the 22m-resolution product from DMCii, acquired for GMES.
- For South America and SouthEast Asia, the harmonised dataset generated from ALOS AVNIR-2, DMC DEIMOS-1 and KOMPSAT-2 MSC by the European Space Agency's TropForest project.

However, Landsat will continue to be the most important source of imagery for the immediate future.
3 FAOC INTEGRATION WITH OTHER THEMATIC AREAS

The integration of the Forestry thematic with the other EuroGEOSS thematic areas started with the implementation of the IOC systems, for every theme present in this project (Biodiversity and Droughts and Forestry). Each one of them, have built their own IOC clients that implemented a set of interoperability protocols and data models, allowing the support of the multi-disciplinary thematic environments (which characterises the EuroGEOSS capacity).

With the objective of providing a harmonized access service (for every protocol used), a new middleware service was implemented and named ‘brokering system’, aka EuroGEOSS Broker.

Having this harmonized access service implemented with interoperable protocols, among different thematic areas, allows identifying and implementing new processes of analysis between different contexts and different types of data.

3.1 EuroGEOSS Broker


The EuroGEOSS Broker is a common “place” (i.e. entry point address) to join and harmonize different access services, from different thematic areas, and made all of them available according to standards and interoperable interfaces. In technical terms, it implements a framework to federate well-accepted catalogue, inventory and access standard services.

Using this new common place, i.e. EuroGEOSS Broker, new services available from the framework of each thematic area can easily be exposed to each other (or even to systems outside of EuroGEOSS) by simply publishing them in the thematic area’s specific catalogue (of course that...
the thematic area catalogue must be already declared in the EuroGEOSS Broker according to the desired protocol, i.e. the Biodiversity can right away use a WMS service published in the Forest catalogue, by simply issuing a catalogue request (e.g.: CSW request for finding WMS services) to the Broker service.

The EuroGEOSS Broker is based on the software Gi-Cat which implements the entire framework and services available to the users and systems (federated services).
3.1.1 Gi-Cat

The implementation software

http://zeus.pin.unifi.it/cgi-bin/twiki/view/GiCat/WebHome

Gi-Cat is an open source software that implements a framework for distributed federated catalogue services providing several standard interfaces and extensions. As example the Gi-Cat can publish different interfaces: CSW/ISO, CSW/ebRIM (CIM extension package), CSW/ebRIM (EO extension package) and an extended Gi-cat SOAP interface. Following are descriptive accepted profilers and data sources.

Profilers:
- OGC CSW 2.0.2 AP core
- OGC CSW 2.0.2 AP ISO 1.0 (with CSW-T support)
- OGC CSW 2.0.2 ebRIM EO
- OGC CSW 2.0.2 ebRIM CIM
- OpenSearch
- GENESI DR
- Gi-cat extended interface
- OAI-PMH 2.0

Data Sources:
- OGC WCS 1.0, 1.1
- OGC WMS 1.3.0, 1.1.1
- OGC WFS 1.0.0
- OGC WPS 1.0.0
- OGC CSW 2.0.2 Core, AP ISO 1.0, ebRIM/CIM, ebRIM/EO
- THREDDS 1.0.1, 1.0.2
- CDI 1.04, 1.3
- Gi-cat 7.x
- GBIF
- GeoNetwork (versions 2.2.0 and 2.4.1) catalog service
- deegree (tested with version 2.2) catalog service
- OpenSearch accessor
- OAI-PMH 2.0
- NetCDF CF 1.4
GDACS

RSS and GeoRSS 2.0

The software is based in a modular architecture divided by several components that are part of distributed search and access capabilities. The Common Data Model component is responsible for modelling the metadata supported by Gi-Cat for cataloguing, discovery and access of data. The Profilers component is responsible for receiving requests in specific profile and delegates the request by interpret it to Query Manager Component. This component, matches the profile request against the common data model. The Accessors component interacts with heterogeneous services to access and discover data. The following figure presents the interaction between the components within the Gi-Cat architecture.

![Gi-Cat architecture](http://zeus.pin.unifi.it/twiki/pub/GIcat/GIcatDocumentation/Gi-cat-block.png)

**Figure 27: Gi-Cat architecture**

(Source: http://zeus.pin.unifi.it/twiki/pub/GIcat/GIcatDocumentation/GI-cat-block.png)

### 3.2 Processes and the combination of data from different thematic area

The processes that will be implemented in the AFOC system use most of data collected and joined in the FIOC system. This data identifies the relevant information of the Forest thematic area available among several Forestry systems.

The same approach was introduced and implemented in the other thematic areas, biodiversity and droughts, involved in the EuroGEOSS context.
The convergence of having data of different thematic areas using same interoperable interfaces, will allow creating and extending different processes for analysis of data from different thematics and to make the results of the processes available for inspection and analysis.

The proposed processes follow the Forest Use Scenarios: Forest Change Scenario and Forest Fires Scenario and the Cross Thematic scenarios. (Please check next chapter for details).

For the Forest Change Scenario the following processes were identified: Forest loss and gain in protected areas over certain period; Updating the global forest cover – South America or other area related to the TREES project (TREES project application). (Please check next chapter for details).

For the Forest Fires Scenario the following processes were identified: Calculation of burnt area in protected areas; Calculation of burnt area by forest type in selected area; Calculation of burnt area by tree species (pilot) in selected area. (Please check next chapter for details).

For the Cross Thematic Scenario the following processes were identified: Calculation of correlation between droughts and forest weather indexes and their tendency over the certain period in selected areas or in protected areas). (Please check next chapter for details).

The above description is the first identification of the main processes for the EuroGEOSS Forest thematic area. For every Forest Use Scenario, the layers from other thematic areas (Biodiversity and Droughts) could be used in combination with the ones from forestry, in order to accomplish several types of analysis and research. This methodology allows promoting new (multi-disciplinary) processes for the EuroGEOSS AOC systems.
4 USE SCENARIOS

4.1 Forest Change Mapping Scenario

**Goal.** The main goal of this scenario is to improve present knowledge of the extent of and change in tropical and boreal forest cover on continental / European / national scale and reduce uncertainties in global estimates of forest cover change. The improvement and establishment of inter-connection among the systems and data structures at the local, regional and global levels through the developed specific applications (Forestry Map Viewer and TREES application) give the possibility to have the forest cover and forest cover change data and combine them with existing forest maps, layers and forest data on local, regional and global levels using them for various models, analysis and research. In addition the layers from other thematic areas as biodiversity and droughts could be used in combination with the forestry layers for various analysis and research.

The forest change mapping scenario is based on the use of the developed Forestry Map Viewer and TREES application, which are described in the previous sections and which interact and communicate with other information and data on forests available on local, national, regional and global level. The use of the Forestry Map Viewer, TREES application and available tools combining different sources improves the quality of the analysis and provides the opportunity for the user to perform different validation (see above under the section "TREES application"). The advanced validation and the use of the TREES application is described in the previous section while the example of the advanced calculation (Forest loss and gain in protected areas over certain period) using Forestry Map Viewer is described below. The advanced calculation of this scenario will be implemented trough WPS.

**Users:**

1. The Joint Research Centre. The Land Management and Natural Hazard (LMNH) Unit in particular its action related to monitoring the state of European forests (FOREST) and responsible for European Forest Fire Information System (EFFIS).

2. Centro National de Información Geográfica (CNIG) - Spain. Assigned to Ministry of Public Works and Transports through National Geographic Institute of Spain, which coordinates the Spatial Data Infrastructure of Spain (IDEE), a collective project with more than 80 nodes publishing and integrating more than 500 Web services and 6,000 layers of data and metadata covering all themes in INSPIRE Annexes I and II, following OGC specifications, ISO standards and INSPIRE principles. This initiative allows users to locate, identify and access geospatial information produced in Spain on the Internet.

3. Users of EFDAC (European Forest Data Centre).

4. End – users. Forest experts, forest managers, forest and environmental researchers and modellers, educational users, individual personal users.

5. Users of TREES application: editing user (registered guest), administrator user, viewing user.
**Background for WPS to perform advanced calculations.** The calculations of FAOC will be implemented through WPS. The implementation of Web Processing Service (WPS) in Forest change mapping scenario will follow this line: the user searches (CSW/WMS/WFS) the forest data from different systems (EFDAC, E-forest, Spanish forest data, TREES project data) and selects the preferred forest thematic layers. Later the user searches (CSW/WMS/WFS) data from other thematic area available in the Forestry Map Viewer (EuroParc, biodiversity, droughts data) and selects the preferred layers. Within the common Map Viewer through the developed WPS the user overlays those in combination with the layers from other thematic areas or other data on forest in order to perform various analyses, for instance: calculation of forest loss and gain in protected areas over certain period.

4.1.1 *Forest loss and gain in protected areas over certain period*

The Web Processing Service technology that will be developed as part of the Advanced Operating Capacity will be based on PyWPS, a python WPS environment. PyWPS is light weight, but it enables processes to access underlying geo-spatial and analytical software, such as GDAL/OGR, GRASS-GIS and R statistics.

Based on these technologies, the EuroGEOSS will focus on the development of standard WPS services that can be used to analyse forest data primarily from the JRC EFDAc service, but also in conjunction with other thematic data, such as drought and biodiversity information. Initially the WPS services will consist of standard spatial analytical tools, such as:

- Buffer;
- Vector Union, Intersect, Dissolve, Point in Polygon;
- Reproject vector or raster data.

These standard tools will subsequently be combined in a processing chain to provide more sophisticated and focussed WPS tools. With respect to the analysis of spatial pattern according to the 3 classes (forest gain, forest loss and stable forests within the period 1990-2000) within protected areas, the pseudo-code for such a WPS will broadly consists of the following stages:

1. Load forest change (1990-2000) raster layer from EFDAC;
2. Load WMS Layer of Spanish protected areas (EUROPARC WMS);
3. Allow user to select individual Protected area polygon or delineate area using digitising tool;
4. Based on these inputs, run the WPS to produce a range of outputs pertaining to the extent of forest gain, forest loss and stable forests during period 1990-2000 within the protected area or a selected polygon;
5. The output from this process will consist of a web page including univariate statistics of the forests in tabular format according to the mentioned classes, map of affected areas as a PNG/JPEG file and spatial data outputs in Shapefile or GML.
6. It is also foreseeable that further spatial analysis could be carried out using the capabilities of R statistics.
The above mentioned pseudo-code is a preliminary outline of the functionality that can potentially be achieved through the use of PyWPS in conjunction with OpenLayers, GRASS GIS, GDAL/OGR and R statistics.

4.1.2 Updating the global forest cover – South America or other area related to the TREES project (TREES project application)

The validation of forest cover by experts will be implemented through two Web-based prototype versions of the IDL tool developed within the EuroGEOSS project, using OGC standards for data formats and geospatial Web services. The description of the process, tools and validation options are described in the previous section “TREES application”. Both prototypes allow users to view and query the status of their allocated sites (completed or in progress), and to select segments where particular types of change have occurred for overlay on ancillary contextual data. They differ in the level of editing functionality offered.

When the 2010 data is completely validated and documented, it will be made available to the general public (viewing users) to view maps and statistical summaries of change. These layers will be made available in the developed common Forestry Map Viewer where it will be possible to combine them with other forest layers as well as layers from other thematic areas for various advanced calculations and analysis. The calculations will broadly follow the mentioned steps (under “Forest loss and gain in protected areas over certain period”) but will include other WFS data input.

4.2 Forest Fires Scenario

**Goal.** The forest fire scenario is based on the use of the developed Forestry Map Viewer, which is described in the previous section and which interacts and communicates with other information and data on forest fires available on local, national, regional and global level. The use of this application and available tools combining different sources improves the quality of the analysis and provides the opportunity for the user to perform different calculations. The several applications of these new opportunities are described below as the options targeted to perform various calculations in relation to forest fire using the local and regional European data. The FAOC allows to use the various forest fires and other related information systems which exist at European (European Forest Fire Information Systems) and national – local (pilot data from Spain) scale.

The main purpose of the forest fire scenarios and corresponding advanced calculations is the improvement and establishment of inter-connection among the systems and data structure about forest fires as well as identification of options and interfaces in order to take benefit from data and products available at global, regional and national levels.
Users:

6. The Joint Research Centre. The Land Management and Natural Hazard (LMNH) Unit in particular its action related to monitoring the state of European forests (FOREST) and responsible for European Forest Fire Information System (EFFIS).

7. Centro National de Información Geográfica (CNIG) - Spain. Assigned to Ministry of Public Works and Transports through National Geographic Institute of Spain, which coordinates the Spatial Data Infrastructure of Spain (IDEE), a collective project with more than 80 nodes publishing and integrating more than 500 Web services and 6,000 layers of data and metadata covering all themes in INSPIRE Annexes I and II, following OGC specifications, ISO standards and INSPIRE principles. This initiative allows users to locate, identify and access geospatial information produced in Spain on the Internet.

8. Users of EFFIS (European Forest Fire Information System).

9. End – users. Forest fires experts, forest managers, forest and environmental researchers and modellers, educational users, individual personal users.

Background for WPS to perform advanced calculations. The advanced calculations of FAOC will be implemented through WPS. The implementation of all WPS in forest fire scenario will follow this line: the user searches (CSW/WMS/WFS) the forest fires and other forest data from different systems (EFDAC, Eforest, EFFIS, Spanish forest data) and selects the preferred forest fire thematic layers. Later the user searches (CSW/WMS/WFS) data from other thematic area available in the Forestry Map Viewer (EuroParc, biodiversity, droughts data) and selects the preferred layers. Within the common Map Viewer trough the developed WPS the user overlays them in combination with the layers from other thematic areas or other data on forest fires in order to perform various analysis, for instance: a) calculation of burnt area in protected areas, b) calculation of burnt area by forest type in selected area, c) calculation of burnt area by tree species (pilot) in selected area.

4.2.1 Calculation of burnt area in protected areas

The Web Processing Service technology that will be developed as part of the Advanced Operating Capacity will be based on PyWPS, a python WPS environment. PyWPS is light weight, but it enables processes to access underlying geo-spatial and analytical software, such as GDAL/ OGR, GRASS-GIS and R statistics.

Based on these technologies, EuroGEOSS will focus on the development of standard WPS services that can be used to analyse forest fire data primarily from the JRC EFFIS service, but also in conjunction with other thematic data, such as drought and biodiversity information. Initially the WPS services will consist of standard spatial analytical tools, such as:

- Buffer;
- Vector Union, Intersect, Dissolve, Point in Polygon;
- Reproject vector or raster data.
These standard tools will subsequently be combined in a processing chain to provide more sophisticated and focussed WPS tools.

With respect to the analysis of burnt areas within protected areas, the pseudo-code for such a WPS will broadly consists of the following stages:

1. Load Burnt Areas from EFFIS;
2. Load WMS Layer of Spanish protected areas (EUROPARC WMS);
3. Allow user to select individual Protected area polygon or delineate area using digitising tool;
4. Based on these inputs, run the WPS to produce a range of outputs pertaining to the extent of burnt area within the protected area or selected polygon;
5. The output from this process will consist of a web page including univariate statistics of the forest fires in tabular format, map of affected areas as a PNG/JPEG file and spatial data outputs in Shapefile or GML.
6. It is also foreseeable that further spatial analysis could be carried out using the capabilities of R statistics.

The above mentioned pseudo-code is a preliminary outline of the functionality that can potentially be achieved through the use of PyWPS in conjunction with OpenLayers, GRASS GIS, GDAL/OGR and R statistics.

4.2.2 Calculation of burnt area by forest type in selected area

The calculation of burnt areas by forest type within a selected area will broadly follow the steps mentioned above, but will include an additional WFS data input of forest types from the eFOREST or EFDAC services. The output from this process will consist of a web page including univariate statistics of the forest fires in tabular format (burnt area by forest type: broadleaved and coniferous), map of affected areas as a PNG/JPEG file and spatial data outputs in Shapefile or GML. The WPS will use WFS input layers from Eforest platform, for instance Tree Stand Global Composition in Europe on 1x1km INSPIRE grid (majority of coniferous and broadleaves), etc.

4.2.3 Calculation of burnt area by tree species (pilot) in selected area

The calculation of burnt areas by forest tree species within a selected area will also follow the steps above, but will include an additional WFS data input of forest tree species from the eFOREST services. The output from this process will consist of a web page including univariate statistics of the forest fires by selected – pilot tree species in tabular format (burnt area of forest stand according to the selected tree species, for instance pine.), map of affected areas as a PNG/JPEG file and spatial data outputs in Shapefile or GML. The WPS will use WFS input layers from Eforest platform, for instance: species richness in Europe on 1x1km INSPIRE grid (number of different tree species per grid), etc.
4.3 Cross-Thematic

4.3.1 Calculation of correlation between droughts and forest weather indexes and their tendency over the certain period in selected areas or in protected areas

Goal. The cross-thematic scenario is based on the use of the developed Forestry Map Viewer, which is described in the previous section and which interacts and communicates with other information and data on forests available on local, national, regional and global level. The use of this application and available tools combining different sources improves the quality of the analysis and provides the opportunity for the user to perform different calculations. This cross-thematic option targeted to perform the correlation analysis between Fire Weather Index (FWI) and Droughts Index. This analysis will be performed through WPS which will use forest fires layers available from EFFIS service and droughts thematic layers available from European Droughts Observatory (EDO). This will be implemented through the developed common Forestry Map Viewer.

Users:

1. The Joint Research Centre. The Land Management and Natural Hazard (LMNH) Unit in particular its action related to monitoring the state of European forests (FOREST) and responsible for European Forest Fire Information System (EFFIS).
2. Users of EFFIS (European Forest Fire Information System).
3. End – users. Forest fires experts, droughts experts, forest managers, forest, droughts and environmental researchers and modellers, educational users, individual personal users.

Background for WPS to perform the analysis. The implementation of WPS in the cross-thematic scenario will follow this line: the user searches (CSW/WMS/WFS) the forest fires data from different systems (EFDAC, EFFIS, Spanish forest data) and selects the preferred forest fire thematic layers. The FWI layers of a certain period or FWI anomalies and absolute ranking, which are based on the comparison of the daily fire danger level with the last 50 years of daily FWI values, will be used within Forestry Map Viewer. Later the user searches (CSW/WMS/WFS) data from droughts thematic area available in the Forestry Map Viewer and selects the preferred layers. Finally the user selects the protected area layer from biodiversity thematic area where he wants to perform the advanced calculation. Within the common Map Viewer through the developed WPS the user overlays the selected layers and performs the correlation statistical analysis and the tendency between Fire Weather Index (FWI) and Droughts Index over the certain period in selected areas or in protected areas.

The calculation of correlation between droughts and forest weather indexes and their tendency over the certain period in selected areas or in protected areas will broadly follow the steps mentioned in other scenarios, but will include an additional WFS data input of forest fire and droughts from the EFFIS and EDO services. The output from this process will consist of a web page including univariate statistics of the analysis of correlation between two indexes, map of affected areas as a PNG/JPEG file and spatial data outputs in Shapefile or GML.
5 REQUIREMENTS OF DIFFERENT USER CATEGORIES

All identified forestry users (different types and categories) shall be able to access the functionalities described in the Use Scenarios section above, mainly the WPS services intended for the AFOC project phase.

The users of the TREES applications have different user types and categories, other than the identified forestry users (TREES users are themselves a type of forestry users for the FIOC and AFOC), but they are specifically attached to and deal independently to specific TREES applications and will not influence the functionalities described in the Use Scenarios.

6 FUNCTIONAL REQUIREMENTS

The Functional Requirements resumes the general functions whose derivation comes from the description and the steps available for the proposed processes to be available in the FAOC system, in the Use Scenarios described in the previous Section.

<table>
<thead>
<tr>
<th>UFR</th>
<th>Description</th>
<th>Related Scenario &amp; Use Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Users will be able to select combination of data from different thematic areas.</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Users will be able to select different types of analysis, like calculation of forest loss and gain in protected areas over certain period.</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Users will be able to select different kind of processes for further analysis.</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Users will be able to get the description of the processes available in order to interpret the inputs and outputs of the processes.</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Users will be able to communicate with the IOC system clients through the interoperable interfaces available and implemented in the IOC phase.</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Users will be able to select forest layers within a period time.</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Users will be able to select geometrical inputs for the analysis of the processes.</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Users will be able to see the results from the processes in several formats, depending on the process. The formats could be: tabular, map, univariate statistics, shapefile or GML.</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 1: User and Functional Requirements (Macro) for AFOC

<table>
<thead>
<tr>
<th>UFR</th>
<th>Description</th>
<th>Related Scenario &amp; Use Case</th>
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</thead>
<tbody>
<tr>
<td>9</td>
<td>Users will be able to perform different calculations in the fire forest context, like calculation of burnt area in protected areas, calculation of burnt area by forest type in selected area and calculation of burnt area by tree species in selected area.</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Users will be able to get forest fires data from the specific Forest systems for further analysis.</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Users will be able to select different type of data from different systems, through different OGC protocols, like WMS or WFS.</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Users will be able to correlate different indexes available from different thematic areas.</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Users will be able to compare different thematic area indexes available and their tendency over a certain period.</td>
<td>-</td>
</tr>
</tbody>
</table>

The macro functional requirements detailed above will be turned into design specifications and interfaces for the Advanced Forestry Operating Capacity and will be described in deliverable D3.2b.
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