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These are Dublin Core metadata elements. See for more details and examples http://www.dublincore.org/

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ACRONYMS AND ABBREVIATIONS

Abbreviation	Name
ADC	Architecture and Data
AIP-2	Architecture Implementation Pilot, Phase 2
AOC	Advanced Operating Capacity
BPMN	Business Process Modelling Notation
CIF	Climate Investment Funds
CSR	Components and Services Registry
DOPA	Digital Observatory of Protected Areas
DoW	Description of Work
E2EDA ER	End to End Discovery and Access Engineering Report
GCI	GEOSS Common Infrastructure
GUI	Graphical User Interface
FAOC	Forest Advanced Operating Capacity
FIOC	Forest Initial Operating Capacity
IOC	Initial Operating Capacity
GDAL	Geospatial Data Abstraction Library
GRASS	Geographic Resources Analysis Support System
JRC	Joint Research Centre
OGR	OGR Simple Feature Library
OWS	OGC Web Services
SBA	Societal Benefit Area
SIR	Standards Registry System
SWG	Scenario Working Group
UIC	User Interface Committee
UNEP	United Nations Environment Programme.
WCMC	World Conservation Monitoring Centre
WCS	Web Coverage Service
WFS	Web Feature Service
WG / WP	Working Group / work package
WMS	Web Mapping Service
WPS	Web Processing Service
XPDL	XML Process Definition Language

1 INTRODUCTION

The overarching aim of EuroGEOSS is demonstrating the added scientific value of making existing systems and applications interoperable. The project contributes to improving scientific understanding of the complex interrelations governing forestry, drought and biodiversity processes. EuroGEOSS is also contributing to answer scientific questions providing increased access to new forms of data and services through empirical experiments implemented in WPS tools.

The activities of the forest thematic area within EuroGEOSS focus on the implementation of two main phases. First, the Forest Initial Operating Capacity (FIOC), and second the Forest Advanced Operating Capacity (FAOC). The FIOC (EuroGEOSS, 2009, 2010a) addresses the first implementation component of the Forestry Operating Capacity and integrates tools, services, datasets and scenarios that serve as test-beds for the implementation of the FAOC (EuroGEOSS, 2010b, 2011a).

The models and workflows described in this report focus (EuroGEOSS, 2010b) on two analytical models developed within the FAOC. These relate specifically to the estimation of the impact of forest fires on protected areas and the calculation of forest change over specific time periods. A detailed description of the two models content and use scenario within the forestry systems (European Forest Fire Information System -EFFIS- and European Forest Data Center -EFDAC-) are described in the D.3.1b (Report on user requirements for the EuroGEOSS Forestry Operating Capacity) (EuroGEOSS, 2010b) and D.3.2b (Report on the design specifications for EuroGEOSS forestry components and interfaces) (EuroGEOSS, 2011a).

The purpose of this report is to describe these two models as workflows in Business Process Modelling Notation (BPMN). These workflows are not fully executable in an automatic way, but require user input to spatially define the area of interest and parameter selection.

This document provides a summary of the two use case scenarios that have been discussed in detail in D.3.2b (EuroGEOSS, 2011a), while the technical implementation and detailed methodologies relating to the implementation of these scenarios are part of the on-going Task 3.7 (Deployment of an advanced operational capacity for forestry). This report is important to provide background and to identify how the use case scenarios can be integrated into more complex multidisciplinary modelling tasks.

This report is structured in six chapters. Chapter 2 briefly describes the use case scenarios for forest fires and forest change. Chapter 3 shows the protocols corresponding to the FIOC and FAOC. Chapters 4 and 5 describe the step-by-step and BPMN workflows of the forest fires and forest change models respectively. The summary chapter includes the main outcomes of this deliverable and the multi-disciplinary interoperability aspects of the presented models and the further activities within the FAOC.

2 USE CASE SCENARIOS FOR FOREST FIRES AND FOREST CHANGE

The use case scenarios for forest fires and forest change are thoroughly described in D.3.2b (EuroGEOSS, 2011a). In this chapter we include a short overview of their basic description through flow steps. Table 1 and Table 2 present the use case scenarios for the forest fire and forest change respectively.

At the moment of drafting this report the models are in development and will soon be available in the FAOC as two WPS', that can be used for example using the client provided in FAOC or calling the OGC WPS interface. The purpose of the workflow description in Table 1 and Table 2 is useful as a "recipe" description but also for potential reuse if the components are accessible individually, this in order for example to refine the model.

Table 1: Forest fire use case for calculation of burnt area for protected areas (for details see D.3.2b)

Overview	
Title	Forest fire: Calculation of burnt areas within a Protected Area.
Description	The end-user, through WMS services (CSW/WMS/WFS) searches, accesses and visualizes forest fire maps and layers available in (EFFIS) according to scenario option. The end-user selects the burnt area map from EFFIS.
Basic Flow	
Step 1: *Selection of Area of Interest:* As a first input to the WPS, the user identifies the area of interest (AOI) for the analysis. The user can also select a polygon from a published WFS layer of protected areas (e.g. Natura 2000 areas or national parks). **Input: Polygon boundaries. It is also possible for the user to select multiple polygons.** **Step 2:** *Processing of Selected Area:* The AOI is converted to GML using OGR Simple Feature Library (OGR) functions. If necessary, a buffer can be applied to the selected area in order to overcome any issue of spatial scale between different input data layers (this spatial analysis facility is optional). **Step 3:** *Vector spatial analysis:* The inputs will be processed using standard vector spatial analytical tools, e.g. polygon overlay and intersection to calculate the extent of burnt areas within the AOI of interest (designated protected area or digitised polygon). This process can be achieved in two ways: Use of the OGR Simple Features Library Python bindings and in particular, the Geometry Methods (e.g. OGR.Geometry.Intersect). Where necessary, it will be possible to use the GRASS–GIS vector tools for spatial analysis, the most important ones would be v.overlay that provides the facility to overlay, intersect and buffer vector polygon layers. **Output: polygon extent of burnt area located within AOI**. **Step 4:** *Output summary:* Once the extent of burnt areas within the AOI have been calculated, summary information will be produced for the user that will include: *Tabular data of percentage of land cover with attribute information from both layers in XML format, but also output as comma delimited text file (csv); Map outputs displayed directly within OpenLayers map client, but also generated as PDFs.*	

Table 2: Forest change use case for forest loss and gain in protected areas over certain period (for details see D.3.2b)

Overview	
Title	Forest change: Calculation of forest loss and gain in protected areas over certain period.
Description	The end-user through WMS services (CSW/WMS/WFS/WCS) searches, accesses and visualizes forest cover maps and layers available in the European Forest Data Center (EFDAC) according to scenario option.
Basic Flow	
Step 1: *Selection of Area of Interest:* The User selects the Area of Interest (AOI) or Protected Area polygon. **Step 2:** *Selection of Time of Interest:* The User selects the two time periods for the analysis: T0 and T1. T0 can be either 1990 or 2000, T1 can be either 2000 or 2006 (but can only be 2006 if 2000 has been chosen for T0). **Step 3:** *Forest Change maps production:* Once inputs have been selected. The WCS' are retrieved based on bounding box of AOI and processed using Geospatial Data Abstraction Library (GDAL). Summary statistics are derived from the WCS (i.e. total forest area). Forest change maps are also produced using map algebra to show areas of loss, gain and no-change, which is displayed as a WMS within the map viewer. **Step 4:** *Output summary:* Summary statistics are displayed as graphs showing the extent of change (total forest area, percentage loss, percentage gain). The related map is available to download as a TIFF.	

3 ACCESSING DATA AND PROCESSES

The datasets and processes are accessible via the OGC CSW part of the FIOC (EuroGEOSS, 2009) or using the EuroGEOSS broker service for discovering resources via their services. WFS and WCS are currently accessed directly from EFDAC and EFFIS, but in time the WPS will provide the functionality to access data from the EuroGEOSS broker. The following list outlines the key data services that are used with the FIOC:

1. EFDAC[1]: The European Forest Data Centre hosted by the JRC publishes a range of WMS, WFS and WCS layers relating to forest cover, forest pattern analysis (fragmentation/core area) and forest health and condition (EuroGEOSS, 2010a, 2011a).
2. EFFIS[2]: European Forest Fire Information System hosted by the JRC publishes fire danger information, extent of burnt area and hot spot locations that are updated on a daily basis (EuroGEOSS, 2010a, 2011a).
3. E-FOREST[3]: this service hosted by the JRC provides harmonised forest information from 21 European national forest inventories.
4. Spanish Datasets: A range of national and regional data services are accessed by the FIOC viewer to access data related to national parks, protected areas and NATURA 2000 locations.

[1] http://efdac-catalog.jrc.ec.europa.eu/
[2] http://effis.jrc.ec.europa.eu/
[3] http://efdac.ifn.fr/

3.1 Forest Initial Operating Capacity and Forest Advanced Operating Capacity

The development of the Forestry Work Package has been developed under two strands. The Initial Operating Capacity (FIOC) consisted of the development of an interoperable map client and metadata catalogue using open-source tools. The Metadata Catalogue was developed using GeoNetworks, while a range of JavaScript libraries were used for the development of the map client. The Advanced Operating Capacity (FAOC) consists in the implementation of WPS services enabling processes to access geo-spatial data and analytical software (e.g. GDAL/OGR, GRASS GIS, R statistics). Based on these technologies the FAOC will focus on the development of standard WPS services that will be used to analyse forest thematic data from different sources in conjunction with other thematic data such as drought and biodiversity.

Although the two applications within the FIOC have been developed independently, there was a strong emphasis on the integration and interoperability. In particular, both systems were customised to facilitate the interaction of both applications. For example, it is possible to view map layers within the Map Viewer and to retrieve some summary metadata information as well as providing a dynamic link to the layer's full metadata page stored within GeoNetworks. The inverse is also true, a user can browse a Metadata page within GeoNetworks and add the WMS/WFS layer or entire service to the Map Viewer in an automatic way.

Figure 1 and Figure 2 provides an overview of the Forestry Map Viewer and Metadata Catalogue respectively.

Figure 1: EuroGEOSS Forestry Map Viewer (entry point: http://193.126.113.48/)

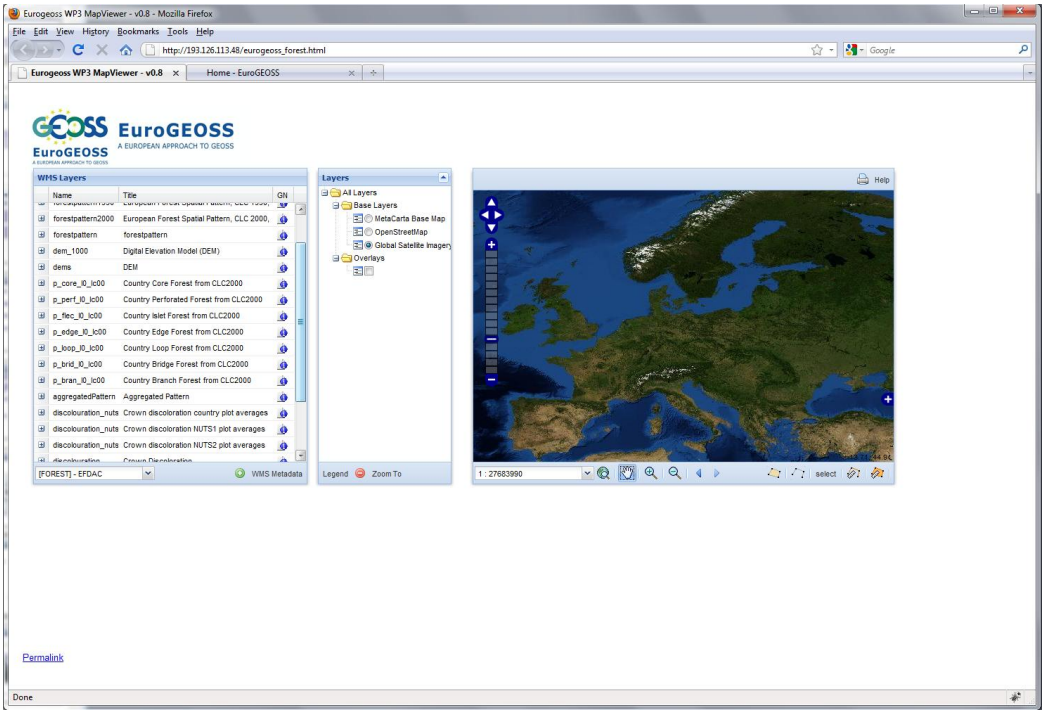

Figure 2: EuroGEOSS Forestry Metadata Catalogue (entry point: http://193.126.113.48/)

4 FOREST FIRE MODEL

The forest fire model considered aims at calculating of the burnt area within protected areas. Some variant of a core model of calculation of burnt area are expressed in the D.3.2b (EuroGEOSS, 2011a): "*Calculation of burnt area by forest type in selected area*" and *"Calculation of burnt area by tree species (pilot) in selected area".*

Figure 3 shows the workflow of the illustrative forest fire model in its BPMN format. For a description of the BPMN see D.2.3.1 (EuroGEOSS, 2011b) and D.2.4.1 (EuroGEOSS, 2010c). BPMN is an on-going standard allowing sharing a conceptual model within a multidisciplinary context including with Information Technology engineers who then will be able to translate the BPMN or its XPDL format encoding into an executable sequence using a workflow engine.

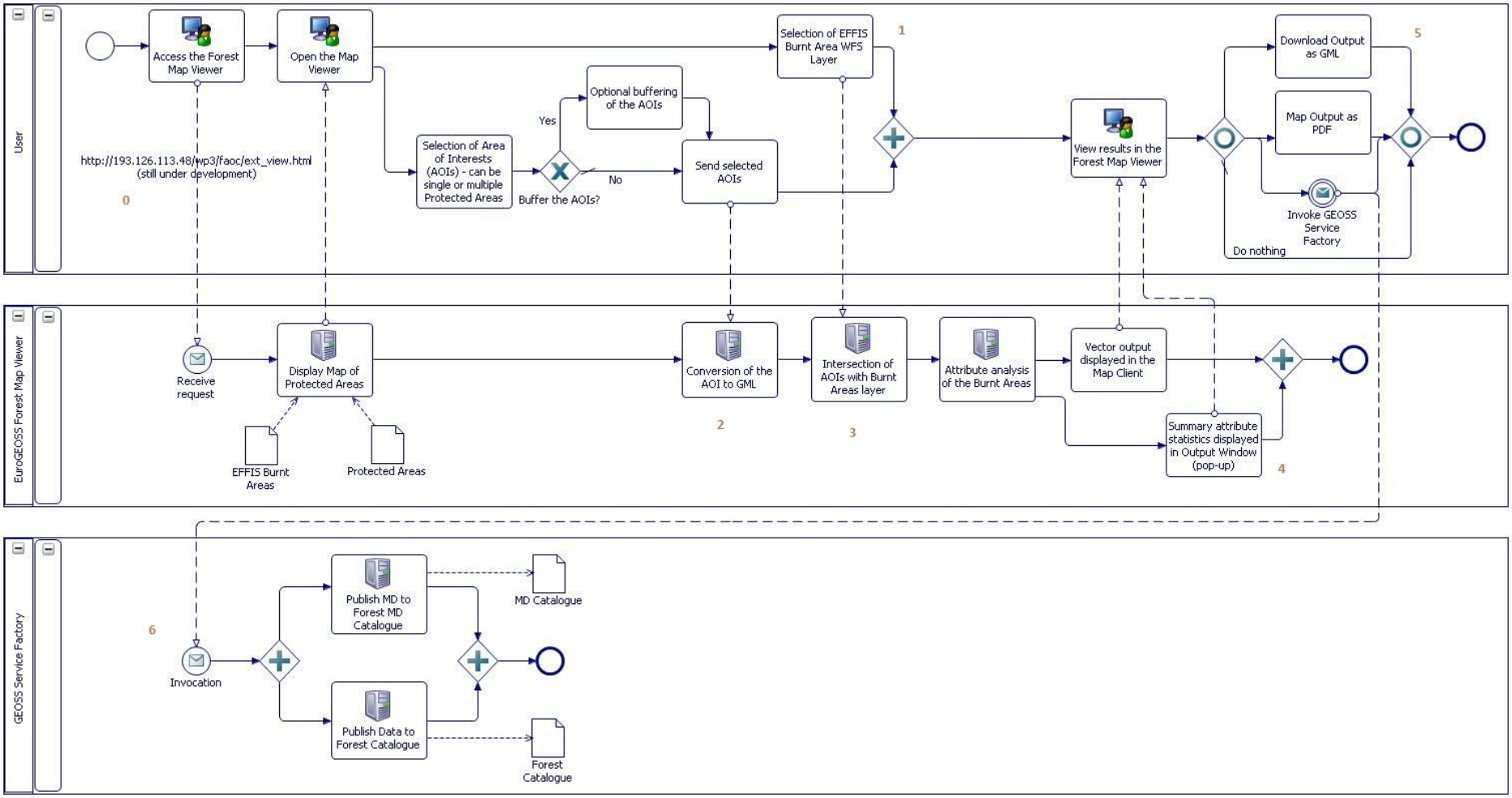

Figure 3: BPMN workflow of the forest fire model (calculation the bunt area within protected areas)

4.1 Forest fire burnt area within a protected area model components

Beside the general description given in Table 1, Table 3 allows the workflow to be "executed" by pointing out the components URL.

Table 3: Forest fire workflow steps description (see Figure 3)

Step/Task	Description	[Protocol] involved and details
0 Start	- User goes to the EFFIS/EuroGEOSS website	**[WWW/WMS]** website with querying section and mapping section
1 Query	- User selects/loads a AOI e.g. from Natura 2000 areas or national parks	**[CSW/WFS]** server hosted within EFFIS system or discoverable using EuroGEOSS broker service
1' Query	- User/system selection of the available burnt areas maps burnt within the EFFIS	**[WFS]** server hosted within EFFIS system or discoverable using EuroGEOSS broker service
2' Buffering	- Spatial analysis operation buffering the AOI or PA	**[WFS-T and WMS]** transformation and display of the buffered area
2 Conversion	- Format transformation	**[GML]** WFS-T / WFS transformation into GML
3 Intersection	- Spatial analysis performing the intersection with burnt areas from 1'	**[WFS-T/GML]**
4 Geoprocessing and 5' and 5"	- Burnt areas statistics, output as a map (online client and as printed as pdf)	**[WPS or trigger within the WFS DBMS]** **[WMS]**
5 Processing	- A processing is activated to deliver a report as a XML file and CSV	**[WPS or trigger within the WFS DBMS]**
6-Publish using GSF	At the end of the WPS, the outputs are published using the GSF to GeoNetworks and GeoServer and in turn appear in the EuroGEOSS broker	**WPS trigger within the WPS**

5 FOREST CHANGE MODEL

The forest change model is aiming at accounting quantitatively and qualitatively the forest loss and gain in protected areas over a certain period. Figure 4 shows the workflow of the illustrative forest change model in its BPMN format.

The implementation of the FAOC is integrated in the EuroGEOSS broker. For example, within the implementation of FAOC the GSF WPS (EuroGEOSS, 2010d) will be integrated in the WPS workflows described in figures 3 and 4. This integration will enable the forest WPS to publish their outputs to the Map Viewer (running on GeoServer) and associated Metadata to our metadata catalogue (running on GeoNetworks). Therefore, the outputs from the forest WPS should also be visible in the EuroGEOSS broker. In addition, FAOC implementation foresees to search the EuroGEOSS broker for inputs to the forest WPS.

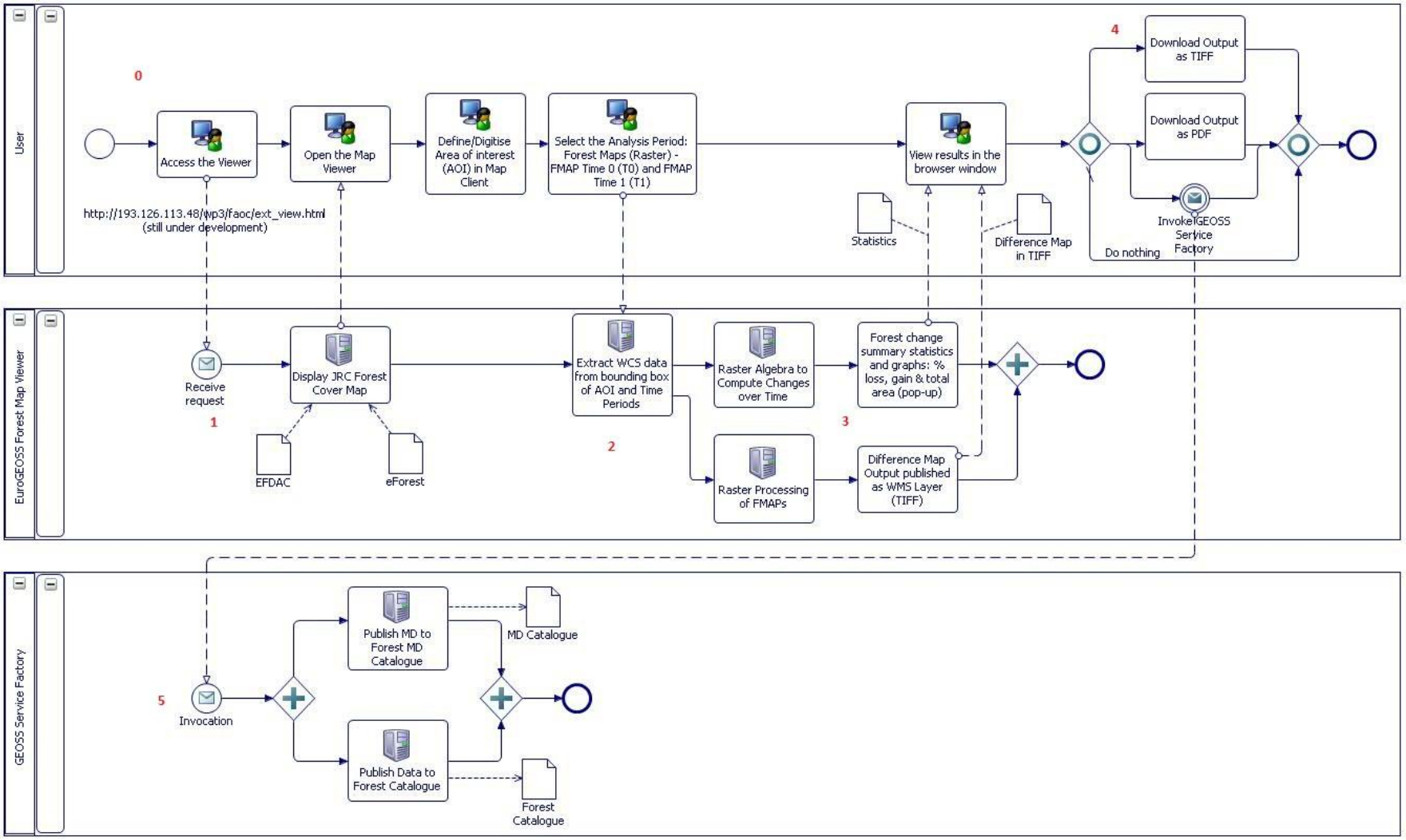

Figure 4: BPMN workflow of the forest change model (calculation of forest change i.e. loss/gain over a certain period)

5.1 Forest change model components

Beside the general description given in Table 2, Table 4 allows the workflow to be "executed" by pointing out the components URL.

Table 4: Forest Change workflow steps description (see Figure 4)

Step/Task	Description	[Protocol] involved and details
0 Start	- User goes to the EFFIS/EuroGEOSS website - Querying the EuroGEOSS broker	**[WWW/WMS/CSW]** website with querying section and mapping section
1 Query	- User selects/loads a AOI e.g. from Natura 2000 areas or national parks or protected area (PA)	**[CSW/WFS]** server hosted within EFFIS system or discoverable using EuroGEOSS broker service
1' Query	- User/system selection of the available periods within the EFFIS	**[WWW WFS]** server hosted within EFFIS system or discoverable using EuroGEOSS broker service
2 Retrieving rasters	- System query for WCS data	**[WCS CSW]** query to the EFFIS system
3 Raster analysis	- Statistics of the pixels within the AOI or PA	**[WCS or WFS-T]**
3' Map algebra	- Spatio-temporal analysis within AOI	**[WCS and WPS]**
4 and 4' Results report	- Map displayed and summary reported	**[WPS or trigger within the WFS DBMS] [WMS]**
5 Invoke GSF	At the end of the WPS, the outputs are published using the GSF to GeoNetworks and GeoServer and in turn appear in the EuroGEOSS broker	**WPS Trigger within WPS**

6 SUMMARY AND FURTHER ACTIVITIES

This report summarises the formal workflows of two selected models of the EuroGEOSS Forestry component. The workflows have been described from a computing interoperability point of view but it is worth mention that these workflows are not fully executable in an automatic manner. Thus user intervention is needed, for example the input to define the area of interest and/or parameter selection, but also some computational components need further development to be used in this interoperable context. The workflows provided in this report were developed in the BPMN notation. When the requirements are fully met, this notation provides the information necessary for the translation of the BPMN models/workflows into an executable sequence using a workflow engine or orchestration software.

A more robust interoperability component is envisaged within the FAOC through the further implementation of new tools. Two examples give some insights into these new tools. First, within the FAOC we will develop a WPS that analyses the EFFIS fire danger data with respect to the European Drought Observatory (EDO) composite drought indicator. This would be of interest since the Fire Danger dataset contains a Drought Code dataset, which in theory, should correlate quite closely with the EDO drought indicator. This analysis would provide a deeper insight into the variations of the Drought Indices and potentially allow them to be refined.

The second application example uses the concept of "voluntary geographic information" (VGI) (Goodchild, 2007) as a tool contributing to forest fire monitoring. In the report D.2.6.1 (EuroGEOSS, 2010d) several Web 2.0 services are described and will become new data sources of the EuroGEOSS Discovery Broker component. Some of these web 2.0 services will be integrated in the FAOC WPS. The new components will provide the capacity to connect and integrate Web 2.0 resources into the user workflows. In addition, this open the possibility of comparing official information with Web 2.0 VGI sources with the aim of help in the decision making process.

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