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D 4.1 – Business processes and occupational profiles

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Work package / Task:

WP4 - Designing GI and EO curricula in support of Copernicus

T4.1 - Identifying business processes and occupational profiles

Short Description:

This deliverable describes the work for identifying business processes models and occupational profiles. Based on each contributor expertise, different types of workflows were collected and analyzed, in line with Business Process Model and Notation mapping language. Based on this general tasks and occupational profiles were derived for designing GI and EO curricula in support of Copernicus.

Keywords:

task, process, occupation, BPMN, diagram, collection, criteria, EO, GI, smart cities, integrated application, climate change

Dissemination Level		
PU	Public	x
RE	Restricted to other programme participants (including Commission services and project reviewers)	
CO	Confidential, only for members of the consortium (including EACEA and Commission services and project reviewers)	

Revision History:

Revision	Date	Author(s)	Status	Description
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0.2	14.11.2019	PLUS	Draft	Revision of initial version
0.3	20.11.2019	ROSA	Draft	Update the initial version
0.4	22.11.2019	ROSA	Draft	Update the initial version
1.0	29.11.2019	PLUS	Ready for QA	Revision of the updated version; inclusion of section on occupational profiles
2.0	17.01.2020	ROSA	Final version	Update with comments from QA team

Executive Summary

A business process is a set of coordinated activities, initiated in response to an event, conducted by both people and equipment in order to achieve a specific result for the customer/stakeholder of the process. The business process model creation is enabled by a notation, which is a standardized language for the description of workflows.

The report on business processes and occupational profiles presents a detailed description and inventory of identified business processes in EO*GI industry areas and required occupational profiles in the field of Copernicus and related technological and societal fields.

The methodology for identifying the major business processes uses Business Process Modelling and Notation as for documenting the details of how a process operates, as a visual representation of a work that shows is the actors involved in the process, their interactions and the data flow of business process from task to task. Based on this language, it is achieved a diagram description.

This report details and models the processes which involve Earth Observation (EO) and Geographic Information (GI) to get a better insight and understanding of common tasks in the EO*GI sector and job profiles of people working with these types of data and tools. The workflow processes were developed based on a narrative description guide. There were identified 30 BPMNs covering all the three sub-sectors (smart cities, climate change, and integrated applications) from where they were extracted more than 200 tasks and EO/GI occupational profiles.

A complex analysis of the whole range of business processes models was made by applying several criteria of similarities and differences, as duration of the event, ways of triggering the process, quantity of data needed, need for in-situ data, complexity of the processing, interaction with the user and the level of competence, business process models field of action, occupation profiles identified, type of results obtained. The spectrum of criteria builds the difference between the workflows, type of activities and occupational profiles related to them.

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Acronyms

Acronym	Description
EO	Earth Observation
GI	Geographic Information
BPMN	Business Process Model and Notation
SAR	Synthetic Aperture Radar
AI	Artificial Intelligence
GLCV	Green Leaf Cover Fraction
HR & VHR	High resolution and Very High Resolution
RS	Remote sensing
OBIA	Object Based Image Analysis
PSI	Persistent Scatterer Interferometry

Glossary

Note: some elements from the glossary have been extracted from Deliverable D1.6 (Space/Geospatial Sector Skills Strategy)

- **Task**: skills and knowledge applied in a specific application context[1]
- **Workflow**: describes the linked flow of activities with a specific start and finish that describe a process
- **Task-chain**: set of tasks being carried out immediately one after the other.
- **Job profile**: is bound to a specific work context and executed by one person[2]
- **Occupation**: is a grouping of jobs involving similar tasks and common characteristics which require a similar skill set[3]
- **Occupational profile**: show the relationships between occupations, skills, competences and qualifications[4].
- **Competence**: the proven ability to use knowledge, skills and personal, social and methodological abilities in work or study situations and in professional and/or personal development.
- **Earth Observation (EO)**: means any geo-spatial information service activity which in some way involves data coming from EO satellites i.e. any satellite with one or more sensors that measure parameters coming from the earth's surface or atmosphere. The involvement may be direct i.e. processing or distributing imagery or indirect i.e. consultancy based around knowledge of the imagery or its use. It start from the point where imagery is transmitted to the ground, so it does include reception and processing of imagery but does not include construction of ground stations or the satellites delivering the data. Note that it includes all geo-spatial information services activities where satellite EO data has been used and so extends to downstream information processing of geospatial information where data being used has been derived from EO imagery possibly in combination with other data types.
- **Geographic Information (GI)**: the data of a geographic location combined with non-spatial information (e.g. statistical data) and their representation as a map.
- **Geographic Information System (GIS)** is a computerized tool designed for storing, analysing and consulting data where geographic location is an important characteristic or critical to the analysis.

[1] Cedefop (2014). Terminology of European education and training policy: a selection of 130 terms, 2nd edn. Publications Office, Luxembourg. https://europass.cedefop.europa.eu/education-and-training-glossary/ [accessed on January 31, 2020]
[2] ESCO. Occupation and jobs. Available from: https://ec.europa.eu/esco/portal/escopedia/Occupation
[3] ESCO. Occupation and jobs. Available from: https://ec.europa.eu/esco/portal/escopedia/Occupation
[4] European Commission (2013). ESCO European Classification of Skills/Competences, Qualifications and Occupations. The first public release. Retrieved from: http://www.epea.org/esco-european-skills-competences-qualifications-and-occupations/

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Online 'live version' of the annexes is available here.

Online 'live version' of all the business processes models are available here.

1. Introduction

1.1. Introduction to EO4GEO

EO4GEO is an **Erasmus+ Sector Skills Alliance** gathering **26 partners from 13 EU countries**, most of which are part of the **Copernicus Academy Network**. Be they from academia, public or private sector, they are all active in the education and training fields of the space / geospatial sector. The project is also supported by a strong group of Associated Partners mostly consisting of associations or networks active in space/geospatial domain. The project started on January 1st, 2018, upon approval by the EU Education, Audiovisual and Culture Executive Agency (EACEA) and runs over four years.

EO4GEO **aims to help bridging the skills gap in the space/geospatial sector** by creating a strong alliance of players from the sector/community reinforcing the existing ecosystem and **fostering the uptake and integration of space/geospatial data and services**. EO4GEO works in a **multi- and interdisciplinary** way and applies innovative solutions for its education and training actions including: case-based and collaborative learning scenarios; learning-while-doing in a living lab environment; on-the-job training; co-creation of knowledge, skills and competencies; etc.

EO4GEO defines a long-term and sustainable strategy to fill the gap between supply of and demand for space/geospatial education and training taking into account the current and expected technological and non-technological developments in the space/geospatial and related sectors (e.g. ICT). The strategy will be implemented by: creating and maintaining an ontology-based Body of Knowledge for the space/geospatial sector based on previous efforts; developing and integrating a dynamic collaborative platform with associated tools; designing and developing a series of curricula and a rich portfolio of training modules directly usable in the context of Copernicus and other relevant programmes and conducting a series of training actions for a selected set of scenario's in three sub-sectors - integrated applications, smart cities and climate change to test and validate the approach. Finally, a long-term Action Plan will be developed and endorsed to roll-out and sustain the proposed solutions

For more information on the project please visit http://www.eo4geo.eu/about-eo4geo/.

1.2. Objectives of the work package

The task T4.1 is component of the WP4, which aims at designing a series of VET curricula and revise existing academic courses based on business processes and occupational profiles to be supported in the context of the Copernicus programme and related activities. The main objectives of the work package, including specific objective for the T4.1 and the other component tasks are as follows. Task 4.1 has the aim to identify business processes and link them with relevant occupational profiles. Task T4.2 will then analyse these BP's and specify required skills and group them into curricula with specified learning outcomes. Task 4.3 will improve and develop existing and new training material,

designed to motivate and inspire the next generation of scientists and technologists. Task 4.4 will develop a mobility programme to promote internships by students and young professionals.

1.3. Objectives of the task and purpose of the document

This task will identify and document the major business processes, EO industry areas and required occupational profiles in the field of Copernicus and related technological and societal fields. The identification of relevant business processes models takes into account the entire processing workflow from how data are accessed or acquired, data processing, resulting data sets and integration in new applications, stakeholder's requirements and feedback. The main idea is to detail and model the processes in order to get a better insight in the type of tasks involved in each activity, the competences needed and the occupational profiles related to them. The processes are modelled by using the BPMN (Business Process Modelling and Notation) standard, thus allowing to identify common patterns for all the processes and various occupational profiles based on tasks analysis accomplished on different competences, transversal and technical skills.

1.4. Structure of the document

This document outlines a range of preparatory measures to deliver BPMN processes as source of tasks and occupational profiles.

- Executive Summary provides a common view on Business Process Models description and which are the enablers for developing a complete Business Process Model and Notation in order to accomplish the occupational profile description.
- Chapter 1 is the introductory chapter including a section introducing EO4GEO, the objectives of the work package, the objectives of the task and of the identification and analysis of business processes and the structure of the document.
- Chapter 2 outlines the current approach to Business Process Model collection providing details on the Business Process Model and Notation flow chart method that visually determines a detailed sequence of business activities and information flows needed to complete a process, focusing on the Input-Process-Output Model. This chapter also proposes the BPMN graphical methodology.
- Chapter 3 describes the methodology used in analysing business process models, starting from defining a template for developing business process models, to be filled using BPMN for a uniform representation of a specific workflow. There are described similarities and differences between the business process models. It also presents an analysis of the BPMN occupational profiles covering EO and GI tasks.
- Chapter 4 presents the results of the analysis of business process models divided in geospatial sub-sectors, having examples and basic information for each workflow.

- Chapter 5 focuses on discussions and conclusions describing the business process modelling and notation as a useful tool for presenting business processes based on a common language allowing identification of occupational profiles covering EO and GI tasks.
- The Annexes include a description of BPMNs elements and symbols, the template for developing business process models and business process model and notation diagrams.

1.5. Objectives of the identification and analysis of Business Processes

Business processes can be defined as “A series of logically related activities or tasks (such as planning, production, or sales) performed together to produce a defined set of results” (Von Rosing, Scheer, and von Scheel, 2015). In other words, a business process consists of a series of activities, or set of inter-related tasks, that when completed accomplish a pre-defined goal. Although the subject can vary, every business process must include clear inputs and outputs to be effective. Ultimately, the output must contribute towards organisational objectives by adding value (directly or indirectly) to a product or service. Dessers (2013) define business processes as the way in which organizations create products, services or policies, as a succession of structured and interconnected activities across time and space which, starting from one or more identifiable inputs, result in one or a set of defined outputs in the form of products or services.

The basic pillars upon which business processes are meant to be developed represent an activity as something that needs to be done, then an entity as a machine, person, and customer or organization, who shall develop the activity. Inputs and outputs are tools, data … needed and/or created by processes. The input is a resource, typically consumed during the processing. An output may be a physical object (such as a report) or an overall business result such as completing a customer order. The essential modelling description of business process activity is significantly represented below.

Process design is concerned with designing the activities and data flows to ensure that they are optimized, effective, meet customer requirements, and support and sustain organizational development and growth. A well-designed process will improve efficiency and deliver greater productivity.

From any Business Process Modelling exercise, some immediate benefits can always be derived in the areas of ability to capture key "How To" process knowledge, preservation of work experience/ protection against employee knowledge loss, standardization / optimization of work activities and cost savings on training (EU, 2016).

Besides the set of activities/tasks that define a process, the concept of enablers is useful to be considered also, based on EU 2016 report on Process Management Governance and Methodology Guidelines.

In the context of EO4GEO the collection of business processes is important, because this collection describes workflows that are executed to create products or services. These workflows list the main

tasks and stakeholders, which in turn supports the identification of skills needs and occupational profiles in the domain. The identified occupational profiles thereby cover profiles of workforce directly associated with the EO*GI domain as well as profiles of workforce of neighbouring domains who interact with representatives of the EO*GI domain. The identification of occupational profiles of workforce who needs to leverage EO*GI data is of particular interest in this report as user uptake is one of the interests supported by the Copernicus programme.

The identification of skills needs and occupational profiles provides the basis for the targeted development of training programmes.

The collection of business processes needs to meet a set of criteria in order to provide a solid basis for the subsequent development of curricula and training programmes. These criteria are:

- the collection of a substantial number of different business processes (30),
- business processes covering all three sub-sectors of the project (integrated applications, smart cities, climate change),
- business processes covering not only core workflows of the EO*GI domain, but also sales, project management and administrative workflows,
- diversity of business processes in thematic, data usage, customer involvement, organisational context etc.

2. Approach to Business Model collection

Business processes can either be described in textual form or as a diagram. For the development of diagrams, the use of the Business Process Model and Notation (Annex 1) is used in this work. BPMN is a standardized notation for illustrating the flow of information between tasks. Using standardized set of symbols makes collaboration with outside analysts easier and saves you from having to dream up a visual language of your own.

Business Process Modelling Notation (BPMN) is a flow chart method that models the steps of a planned business process from end to end. A key to Business Process Management, it visually depicts a detailed sequence of business activities and information flows needed to complete a process. An example on risk mapping of earthquake events is given in Figure 1.

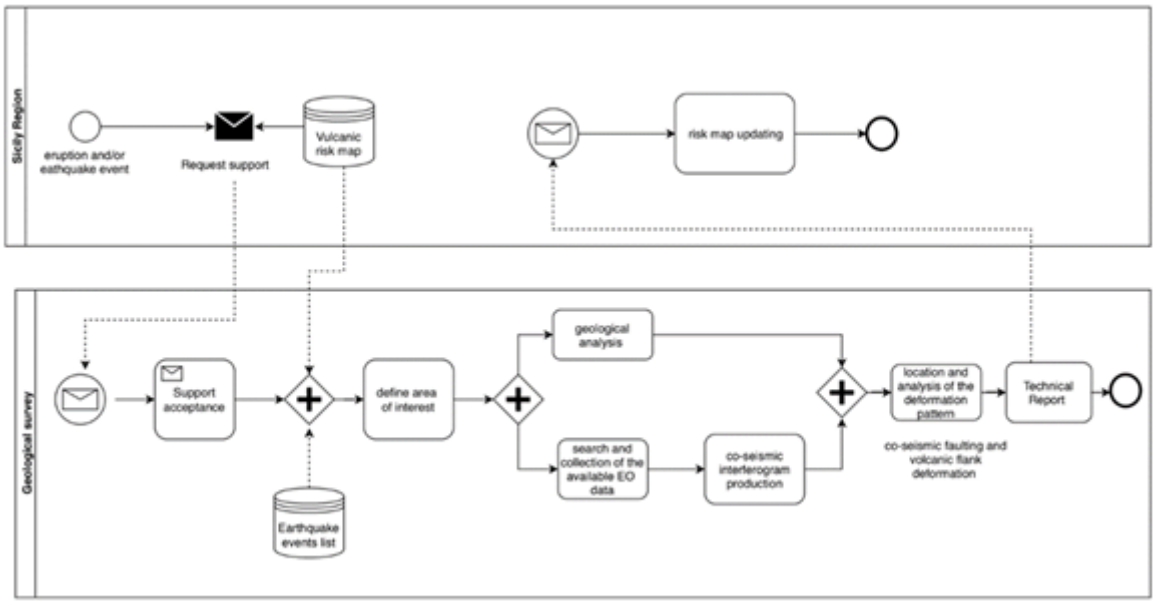

Figure 1. Etna volcano earthquake event

BPMN is targeted at participants and other stakeholders in a business process to gain understanding through an easy-to-understand visual representation of the steps. At a more involved level, it's targeted at the people who will implement the process, giving sufficient detail to enable precise implementation. It provides a standard, common language for all stakeholders, whether technical or non-technical: business analysts, process participants, managers and technical developers, as well as external teams and consultants.

Every task thereby has an input and an output (fig. 2). The Input-Process-Output Model is a functional graph that identifies the inputs, outputs, and required processing tasks required to transform inputs into outputs. The inputs represent the flow of data and materials into the process from the outside. The processing step includes all tasks required to effect a transformation of the inputs. The outputs are the data and materials flowing out of the transformation process.

Figure 2. The transformation model of a process

The activities initiated and coordinated for developing the 'Identifying business processes and occupational profiles' project task, in order to achieve different business process models coming from the EO/GI domain by numerous contributions from T4.1 participants, is represented step by step by using the BPMN language, as well, in figure 3. The workflow activities presented here are divided between two "pools", the T4.1 contributors which contributes with specific examples to the input chain part, and the T4.1 coordinator (ROSA) which create the process and analysis in order to identify occupational profiles based on the identified tasks, skills and competences. Each pool

contains chained tasks going to the availability of having final analysis results for 30 workflows covering all the three sub-sectors (smart cities, integrated applications and climate change).

The methodology approach represented in the BPMN diagram is described in next chapter.

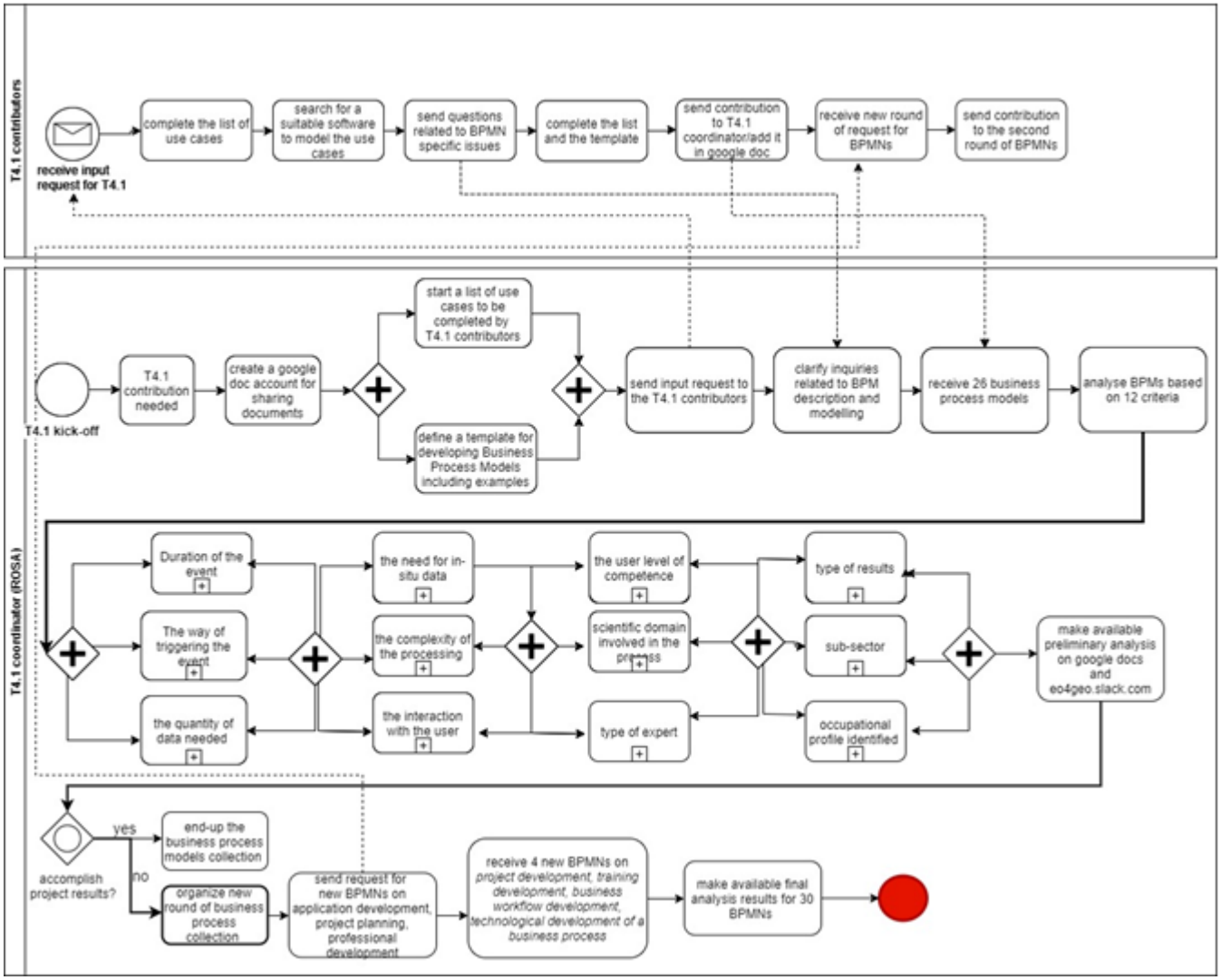

Figure 3. BPMN diagram showing the steps for the activities within T4.1

Business Process Modelled with BMPN	BPMN Source (within the Business Process Models folder on google doc)	Duration		Way of triggering the process		Quantity of data needded		Need of in-situ data		Complexity of the	
		Short-term	Long-term	New	Repeted	One type of data	ore type of da	yes	no	Low	High
1 Urban heat - input for city planning	GIB - Smart Cities	x		x			x	x		x	
2 Access to green areas	GIB - Smart Cities		x		x		x	x		x	
3 The value of trees and green infrastructure	GIB - Smart Cities		x		x	x		x		x	
4 Sustainability to storm water	GIB - Smart Cities		x		x		x	x			
5 Crowd sourcing, test case noise	GIB - Smart Cities		x		x	x		x		x	
6 Landslide affecting Cultural Heritage sites – Baia Archeolog	ISPRA - Integrated Applications		x		x		x		x		
7 Subsidence in urban area - City of Como	ISPRA - Integrated Applications	x		x			x	x		x	
8 Earthquake event – Etna volcano	ISPRA - Integrated Applications	x		x			x	x		x	
9 Landslides affecting linear infrastructures - Petacciato lanc	ISPRA - Integrated Applications		x		x		x	x		x	
10 Geospatial data and technologies applications for monitori	ROSA - Land use change monitoring		x		x		x	x			
11 Copernicus Sentinel-2 data enable timely and accurate burr	NOFFi-OBAM (NEREUS)	x		x		x		x			
12 Precision Farming for Wineyard	Planetek (NEREUS)		x		x	x			x	x	
13 Monitoring the health of water and sewerage networks	Planetek (NEREUS)		x		x	x			x	x	
14 EO for biotope-type mapping in the alpine zone in Austria	PLUS - Biotope-type meeting		x		x		x	x			
15 Change detection analysis on Walloon Brownfield sites	SAR (NEREUS)		x		x		x		x	x	
16 Automated brownfield monitoring using SAR and optical im	SAR (NEREUS)		x		x		x		x		
17 EO-based agro monitoring system to support regional decis	UJI BPMN case	x		x		x			x	x	
18 Copernicus sentinel data for mapping and monitoring of gra	Sentinel data for mapping and monitoring of grasslands		x		x		x	x			
19 Copernicus help Vessel Traffic Monitoring	SA.rar - Sentinels help vessel traffic monitori	x		x		x			x	x	
# Development of hazard zone plans for spatial planning (torr	of Hazard Zone Plans for Spatial Planning.Eva Maria (PLUS)		x		x		x		x		
21 Development of Hazard Zone Plan by Federal Waterways En	of Hazard Zone Plans for Spatial Planning.Eva Maria (PLUS)		x		x		x		x		
# Spatial Planning Model – building permit	of Hazard Zone Plans for Spatial Planning.Eva Maria (PLUS)		x		x		x		x	x	
# Landslides documentation supported with an EO-based ser	umentation with an Earth Observation-base	x		x					X	X	

Figure 4. Business Process Models analysis diagram

3.1 Template for developing business process models

The series of actions for gathering contributions in Task 4.1 started by implementing a standard template to be filled with a narrative description on each business process model. Based this, the BPMN language was applied for a uniform representation of specific workflows.

The template was outlined by a short introduction of business process models general description, the main objective of the information focusing on a description of the use case, then determining the component steps of business process description. The template itself can be found in annex 2.

3.2. Assessment of similarities and differences between the use cases

In order to have a better insight of the business process models which uses EO and GI, it was defined a spectrum of criteria including similarities and differences (fig.4), which build the difference between the workflows, type of activities, and occupational profiles related to them. The analysis can be available here. In the following lines, each criteria will be disclosed and attributed to one or more models.

3.2.1 Duration of the process

Duration is the period of time while the time event is active. The duration specifies the maximum number of minutes after the specified time has been reached that the dependency is kept in an active state. There are ***short-term*** and ***long-term*** events.

The short-term category include processes which need to be acomplished in a rapid phase as to avoid the possible extensive damages caused by phenomena as urban heat, subsidence in urban area, burned area mapping, vessel traffic monitoring, landslides.

The long-term event category define a widen period of time, when processes as the value of green infrastructure, precision farming for wineyard, biotope-type mapping in the Alpine zone, spatial planning models for building permit, solar energy forecast get accomplished for delivering a product or a service, based on a service level agreement.

3.2.2 The way of triggering the process

The events to be triggered are new/crisis event where request as well as the response have to come quickly and long-term/repeated event which request an extended period of time.

New/crisis event. The crisis event is any event that is expected to lead to an unstable and dangerous situation affecting an individual, community or whole society.

A crisis can occur as a result of an unpredictable event or as an unforeseeable consequence of some event that had been considered a potential risk. Within such an event the request for support as well as the response have to come unhesitanting. Some relevant examples corespond to the ones exposed at the category of short-term processes.

Repeated. The repeated events are guided by a plan including a frequency of completing the built tasks, having a final output which supports periodically improvement issues as in the present examples: change detection analysis on Walloon Brownfield sites , automated brownfield monitoring using SAR and optical imagery, severe weather integrated system, monitoring the health of water an sewerage networks.

3.2.3 Quantity of data needed

The quantity of data needed depends on the duration and complexity of the event.

One type of data. Usually, among the business processes models are examples which involve one type of data, specifically, satellite images, enough to extract information of interest, as in the following examples: Copernicus help Vessel Traffic Monitoring, precision farming for wineyard, burned area mapping.

More types of data. The other more complex business processes, where validation plays an important role in defining the final products, need time series, in-situ and ancillary data, VHR aerial images, as represented in the case of landslides affecting linear infrastructure or development of hazard zone plans for spatial planning.

3.2.4 Need of in-situ data

In-situ measurements are those made at the location of the instrument. There are processes which involved the use of in-situ data, air quality management, applications for monitoring land use change, sustainability to storm water, subsidence in urban area, city of Como and other processes which do not require data in the field, as in the next examples Vessel Traffic Monitoring, development of Hazard Zone Plan, biotope-type mapping in the Alpine zone.

3.2.5 Complexity of image processing

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be an image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms a core research area within engineering and computer science disciplines too.

Business Process Models analysis regarding the complexity of image processing is simply divided between **low** and **high.**

The low complexity of image processing involve classical operations as image representation, histogram manipulation (Change detection analysis on Walloon Brownfield), neighborhood operations, Fourier transformations, geometric transformations, image registration and mosaicking (Geospatial data and technologies applications for monitoring land use change), object detection (Sentinel help Vessel traffic monitoring), techniques for classifying image colors and texture (access to green areas).

The high complexity of image processing engages elaborate operations as machine learning and artificial intelligence.

Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems.

Machine learning, as represented in the workflow related to (Copernicus Sentinel data for mapping and monitoring of grasslands) is an application of artificial intelligence (AI) that provides systems the ability to learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it for themselves. Machine learning algorithms are often categorized as supervised (can apply what has been learned in the past to new data using labeled examples to predict future events) or unsupervised (used when the information used to train is neither classified nor labeled).

Machine learning enables analysis of massive quantities of data. While it generally delivers faster, more accurate results in order to identify profitable opportunities or dangerous risks, it may also require additional time and resources to train it properly. Combining machine learning with AI and cognitive technologies can make it even more effective in processing large volumes of information.

3.2.6 Interaction with the user and the level of competence

The interaction with the user is evaluated depending on the type of event, as the crisis event (short-term) need a high frequency of interaction on a short period of time, while the long-term event needs periodic interaction with user during a determined period of time.

The user quality of interaction depends on how skilled and competent, enclosed in the level of competence, in exploiting and integrating the results in everyday job activities, therefore the information delivered to the user has to be adapted according to the competency level.

3.2.7 Business process model field of action

The business process models include subjects correspondend to several scientific domains, within the project defined sub-sectors (smart cities, integrated applications, climate change), as geology, agriculture, hydrology, health, biodiversity, land use/land cover, navigation, spatial planning, meteorology.

3.2.8 Type of results realized subsequent to the work processes

Each work process delivers for each completed stage a result such as a report (EO for biotope-type mapping in the Alpine zone in Austria), web service (Water Information Management System) and operational service (Copernicus Sentinel-2 data enable timely and accurate burned area mapping).

3.2.9 Occupational profiles analysis from BPMN

According to ESCO, *"an occupation is a grouping of jobs involving similar tasks and which require a similar skill set. Occupations should not be confused with jobs or job titles. While a job is bound to a specific work context and executed by one person, occupations group jobs by common*

characteristics"[5]. The scope of ESCO occupations was determined by analysing the functions and activities which are expected to be performed as part of the occupation: „This process allows describing the occupation, identifying the boundaries of its scope, and capturing the knowledge, skills and competences that are needed to successfully perform the functions".[6] A related approach was applied to derive and identify occupational profiles from the BPMNs. Occupational profiles are *"showing the relationships between occupations, skills, competences and qualifications"*[7].

Analysis:

Analysing the 30 BMPNs swim-lanes (a swim-lanes in a BPMN groups all the activities, which a certain user has to perform; see also Annex) as well as corresponding textual Case Descriptions provided by the EO4GEO partners resulted in 105 work profiles being mentioned (see section *Profiles mentioned in BPMNs* from Figure 5: Occupational Profiles derived from BPMNs). Several of these profiles were mentioned recurrently:

- EO*GI Expert/Analyst: 10 times mentioned
- EO*GI Quality Control and Validation: 3 times mentioned
- Service Provider: 13 times mentioned
- Geologist/Geomorphologist: 6 times mentioned
- Project Manager: 4 times mentioned
- Environmentalist/Ecologist: 6 times mentioned
- City/Municipal Planer: 5 times mentioned
- Administration Officer: 3 times mentioned
- HR officer: 3 times mentioned

To assess relevant vocational fields for a qualified workforce of tomorrow in the EO*GI domain as well as reaching out to new business sectors which can be served with the manifold possibilities that EO*GI-applications offer, the identified occupational profiles are distinguished into: *EO*GI core profiles*, *EO*GI managerial profiles*, *EO*GI complementary profiles* and *EO*GI peripheral profiles*.

Subsequently, the different types of occupational profiles are introduced. The figures indicate, to what degree EO*GI related tasks are present in the profiles (with yellow symbolizing EO*GI relevance).

EO*GI core profiles are those profiles, which predominantly involve task-completion related to Earth Observation and Geoinformatics. Performing persons of core profiles either have a high level proficiency in EO*GI and a high degree of work time is dedicated to EO*GI-tasks or spend most of their

[5] ESCO. Occupation and jobs. Available from: https://ec.europa.eu/esco/portal/escopedia/Occupation
[6] ESCO. Functional Analysis. Availabe from: https://ec.europa.eu/esco/portal/escopedia/Functional_analysis
[7] European Commission (2013). ESCO European Classification of Skills/Competences, Qualifications and Occupations. The first public release. Retrieved from: http://www.epea.org/esco-european-skills-competences-qualifications-and-occupations/

worktime with EO*GI-related tasks with a medium level of required skills in EO*GI (and get supervised by a project manager, etc).

EO*GI managerial profiles can be found in different sectors of application-oriented businesses dedicated to a certain field and covering EO*GI-Tasks as one important field of their work. This involves for example the distribution of tasks in a service provider setting or tender specification in a client setting.

EO*GI peripheral profiles mainly apply to those who realise need for EO*GI support and demand a service (which is provided by one of the first two types) and then use the results of the service to proceed with their domain-related specific tasks. These applies eg. to town planners,

EO*GI complementary profiles are technical or administrative profiles, which need to have a certain idea of EO*GI-related business processes happening in their company or department while a deeper understanding is not necessary to fulfil their tasks.

To extract occupational profiles, the job profiles were listed together with their corresponding work tasks and compared to each as follows:

1. The first comparison took place regarding the job profile name: identical and similar naming of profiles provided the basis for 2.
2. Comparing work-tasks within groups of identical/similar naming: as a revision, the profiles that were grouped according to similarity of profile name were compared along similarity in workflows or task-chains and re-grouped where applicable.
3. Identifying, whether profiles can be labelled as *core EO*GI-related profiles*, *EO*GI-related managerial* or *peripheral EO*GI-related* according to the tasks available for each profile's description.
4. In addition, it turned out that some profiles could not be assigned to these three categories, as their EO*GI-related proficiency may vary dependent on the respective employer. These profiles are categorized as *Complementary Profiles.*

The following graphic provides an overview of the identified occupational profiles per category as well as fields of work, in which these profiles are found (Figure 5). At the bottom one can find the collection of all the work profiles being mentioned in the BPMNs.

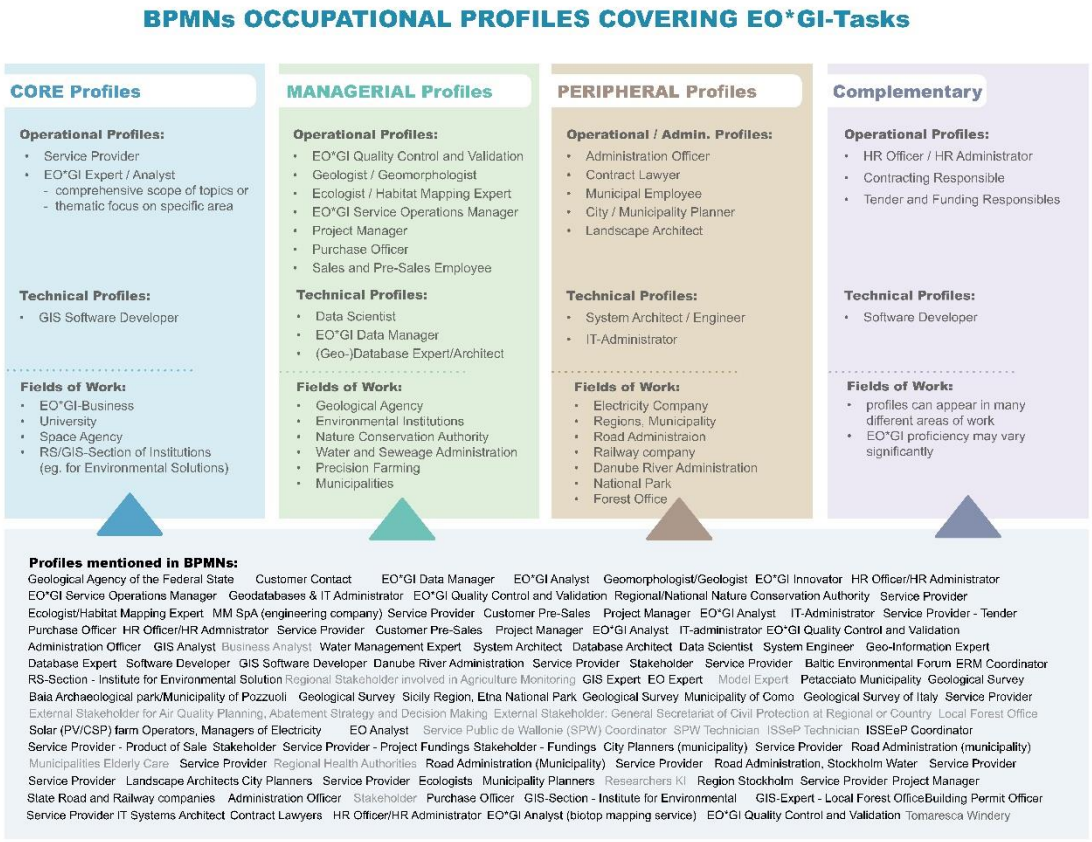

Figure 4 Occupational Profiles derived from BPMNs

For profiles marked in grey in the list of profiles included at the bottom of Figure 5, it was not possible to group them with other job profiles to derive an occupational profile based on similar tasks and skills. Reasons for greying out these profiles are: profile names do not match tasks mentioned; task description does not provide a sufficient level of detail to get clear about the tasks and responsibilities involved; non-explained abbreviations, very specialised single profiles or inconclusive profile name description.

The classification of occupational profiles into mainly, partly, remotely and complementary is based on the available profiles and related tasks listed in the BPMNs the partners provided. Occupational profiles within the classification are concerted regarding the work tasks mentioned. Nevertheless, they may vary for individual other business processes as it has to be noted that in many cases, the individual proficiencies of employees as well as particular requirements of the employer affect which tasks are performed within a profile.

Generic Workflows in the EO*GI-Domain

A comparison of the tasks between similar occupational profiles reveals similarities and differences in workflows (Figure 6). The following observations can be made:

- For **Core EO*GI related profiles**: 13 job profiles of EO*GI Analysts and EO*GI Experts were mentioned in 9 BPMNs, having similar tasks with strong focus on EO*GI. Therefore, these profiles are pooled together. EO*GI Analysts/Experts show a similar workflow as Service Provider in the BPMNs: The workflow of the EO*GI Analyst seems to exemplify/specify the middle part of the Service Provider workflow. This is due to the fact that the EO*GI Analyst is a core profile for a Service Provider in this sector. For Service Providers, the BPMNs descriptions tend to emphasize preparatory and dissemination tasks, while this is less mentioned in EO*GI Analyst/Expert descriptions. "Service Provider" was an often used term in the swim-lanes, which is not further differentiated (and includes possibly more than one person being involved).
- **EO*GI Managerial EO*GI profiles**: As already mentioned above, managerial profiles include a variety of tasks related to their specific business domain, as well as EO*GI-related tasks with a certain depth of knowledge tailored to their specific work field. Comparing the tasks of profiles like Geologists, Project Managers, Ecologists and Environmentalists showed that there is a diversity in work tasks between the profiles but also even within profiles of the same type, as far as provided in the available BPMNs. Therefore, a generalized workflow is hardly possible, also because sub-contractors (to fulfil certain tasks of the requirements) may be involved.
- **EO*GI peripheral profiles**: the workflow of tasks is similar for most operational profiles which remotely deal with EO*GI-issues. Generally spoken there is an initial event (of certain urgency) or a necessity to update/generate a certain basis for decision-making which leads to the request of support from a service provider, who is familiar with EO*GI. Remotely EO*GI related profiles often act as contracting authorities/customers. Communication with the contractor guarantees coordination of requirements and exchange of data. Profiles like City Planners, Landscape Architects, Road Administrations and Railway Company Employees receive results and reports, which are used/deal as basis for planning and decision making for future actions.

A more detailed view on core EO*GI-related profiles can also be obtained from the DACUM exercise of WP1 Preparation Strategy, which was explicitly dedicated to jobs dealing with EO and GI amongst EO4GEO partners.[8]

[8] WP1: Overview-DACUM-Profiles_exteralLinks.pdf; Available from: Slack wp1_profiles_results

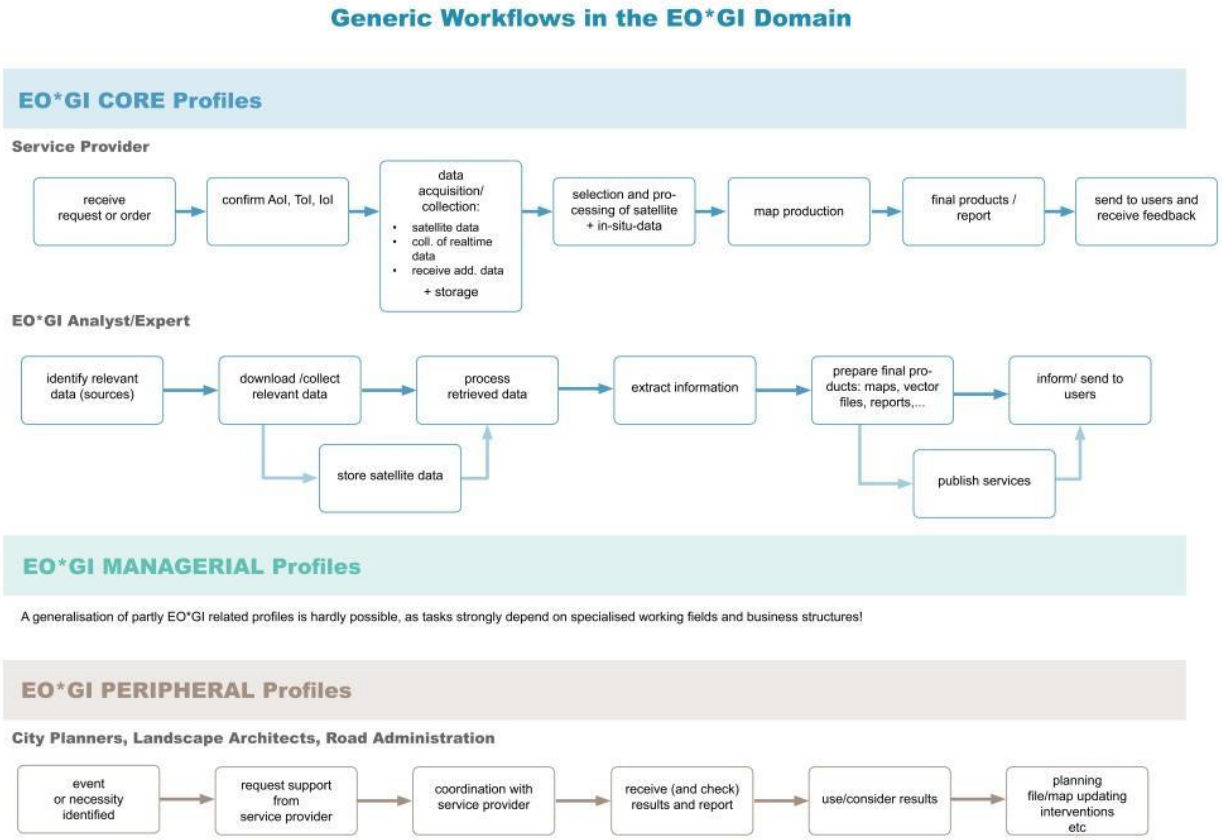

*Figure 5. Core workflows in the EO*GI domain*

Resume and Outlook regarding Occupational Profiles identified in BMPNs:

The 30 BPMNs that were available for the analysis of Task 4.1 were provided in different levels of detail: While analysing, it turned out that at many points a more detailed description regarding concrete profiles (instead of institutions) would be valuable. At some points, tasks/task-chains seemed incomplete and certain profiles are not described as complete as necessary to derive valuable insights for partially relevant profiles.

The business processes collected and analysed are established processes covering sections of the business activities of the partners providing BPMN. Certain profiles and tasks belonging to the core-activities of the partners (who are mainly active in the EO*GI-sector) are being mentioned repeatedly. Furthermore, they provide a subsection when it gets to the identification of occupational profiles relating to partner's activities – which tend to cover partly and remotely EO*GI-related profiles that are of interest for future EO4GEO training activities. The occupational profiles deriving from the BPMNs therefore cover a substantial part of relevant market-sections, but do not provide a comprehensive view on the whole potential of the market. One example is the repeated mentioning of "city planners", while "architects" do not appear in the list. Nevertheless, *thinking of the sub-sector Climate Change, architects, civil/construction engineers (as those who might engage architects) as*

well as real estate companies could be potential addressees when it gets to analysis of urban heat islands and how to contribute to a resilient built-up urban structure.

Therefore – and with regard to the orientation on market needs for the development of curricula and training material through occupational profiles and tasks - a simplified analysis of the stakeholders (potentially) interacting/being involved in commercial relationships with EO*GI-businesses is suggested.

3. Results of the analysis of business processes

4.1 Geospatial sub-sectors

In EO4GEO project three sub-sectors were defined for developing case-based scenarios: integrated applications, smart cities and climate change.

The business process models were distributed among all the three subsectors (fig.7), while the examples which build up the “other” area describe workflows of tasks related to business initiation, project, training and technological development.

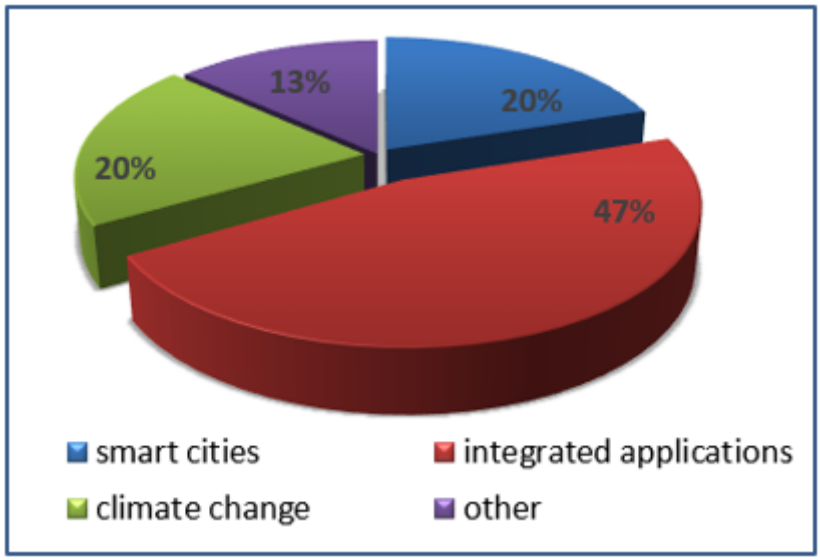

Figure 6.The distribution of business process models

4.1.1 Smart cities

A smart city can be seen as a determined geographical space able to implement solutions by sensors interconnections and mobile devices support, which can combine service production and an intelligent environment, exploits accessible information in its activities and decision making.

Basic information on business process models for smart-city are specified in table 1, having presented the name of the process, the organization which have it in a BPMN format, the stakeholder

of the products, which are the data requirements for having the process completed and the workflow category which in this section is represented by an EO/GI analysis.

Table 1. Business process models for smart city sub-sector

No.	Name	Contributing organization	Stakeholder	Data requirements	Workflow category
1	Urban heat, input for city planning	Geografiska Informationsbyran (GIB), Sweden	Stockholm municipality	Measuring stations (air temperature), Landsat data (surface temperature), Sentinel 2 data, altitude delineation of sub-areas, buildings	EO/GI analysis
2	Access to green areas	Geografiska Informationsbyran (GIB), Sweden	Stockholm municipality	Statistics, Sentinel 2, in-situ data	EO/GI analysis
3	The value of trees and green infrastructure	Geografiska Informationsbyran (GIB), Sweden	City planners, Ecologists, Landscape architects	Satellite and in-situ data	EO/GI analysis
4	Sustainability to storm water	Geografiska Informationsbyran (GIB), Sweden	Road administration of Sweden, Stockholm water administration	DEM, Sentinel 2, rain statistics	EO/GI analysis
5	Crowd sourcing, test case - noise	Geografiska Informationsbyran (GIB), Sweden	Road administration and municipality of Stockholm	Noise maps, Noise measurements (from sensors)	EO/GI analysis
6	Monitoring the health of water and sewerage networks	Planetek, Italy	Municipality of Milan	Sentinel 1	EO/GI analysis

The business process models listed here are offering smart solutions to different issues in the urban area, contributing this way to a sustainable spatial planning for citizens' quality of life.

Urban heat islands are one of the most severe problems facing today's society related to the increasing urbanization. The highly absorbent materials found in the city and the lack of vegetation in comparison with the rural areas are the main drivers behind urban heat islands. As a basis for city planning, it was decided to start identifying local heat islands, a useful initiative for the Swedish Environmental Protection Agency as well as for the Stockholm municipality. One important solution to urban heat consist in the existence and accessibility to green areas, an actual matter which represents a fundamental component of any urban ecosystem. The workflow steps for these two processes are presented in the BPMN diagrams below (fig.8 and fig.9).

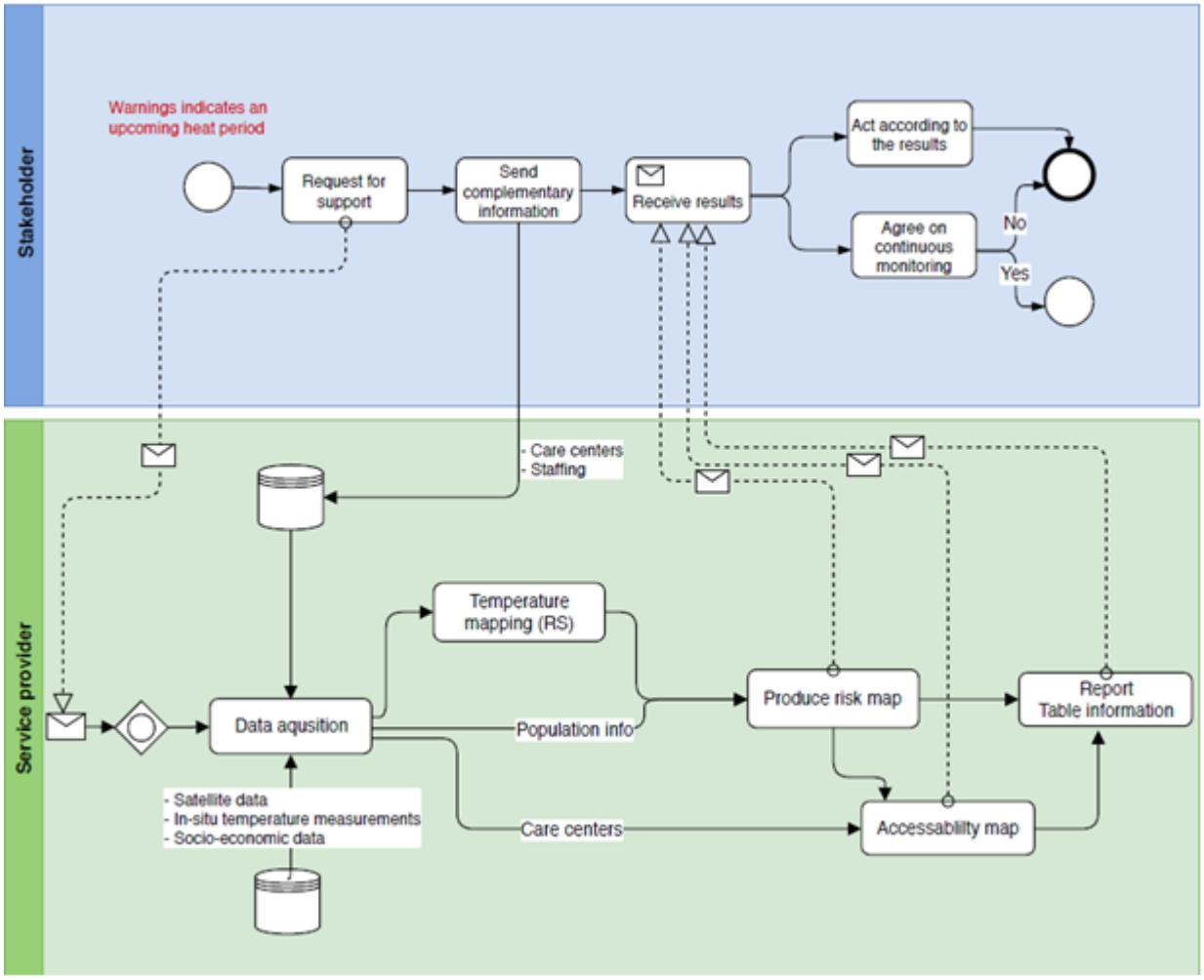

Figure 7. Urban heat, input for city planning workflow. Stockholm, Sweden

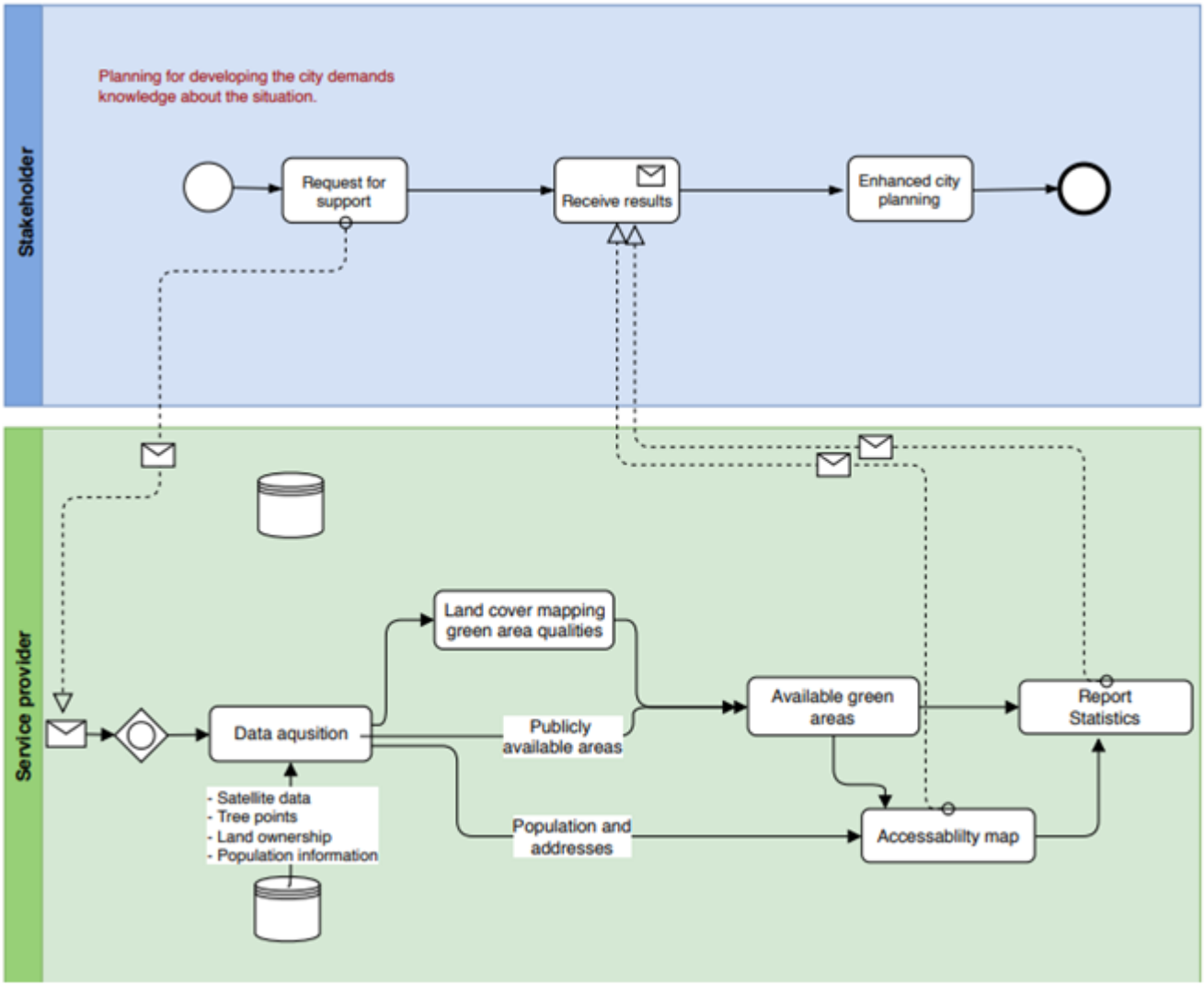

Figure 8. Access to green areas. Sweden, Stockholm

Another smart city solution is water monitoring in the municipality of Milan, the authorities searching for a method to better understand the scenario of ground surface movement caused by the structural defect of its collector that could affect the primary sewerage network, on the purpose of preventing damage to surface structures by detecting the movements underway. By using satellite radar interferometry, displacements were assessed over an area of interest by means of measurements of velocity, acceleration and coherence of Persistent Scatterers. Thematic maps, were provided, dynamic geo-analytics and reports for monitoring the heath of water and sewerage networks were prepared. The workflow of activities is described in figure 10.

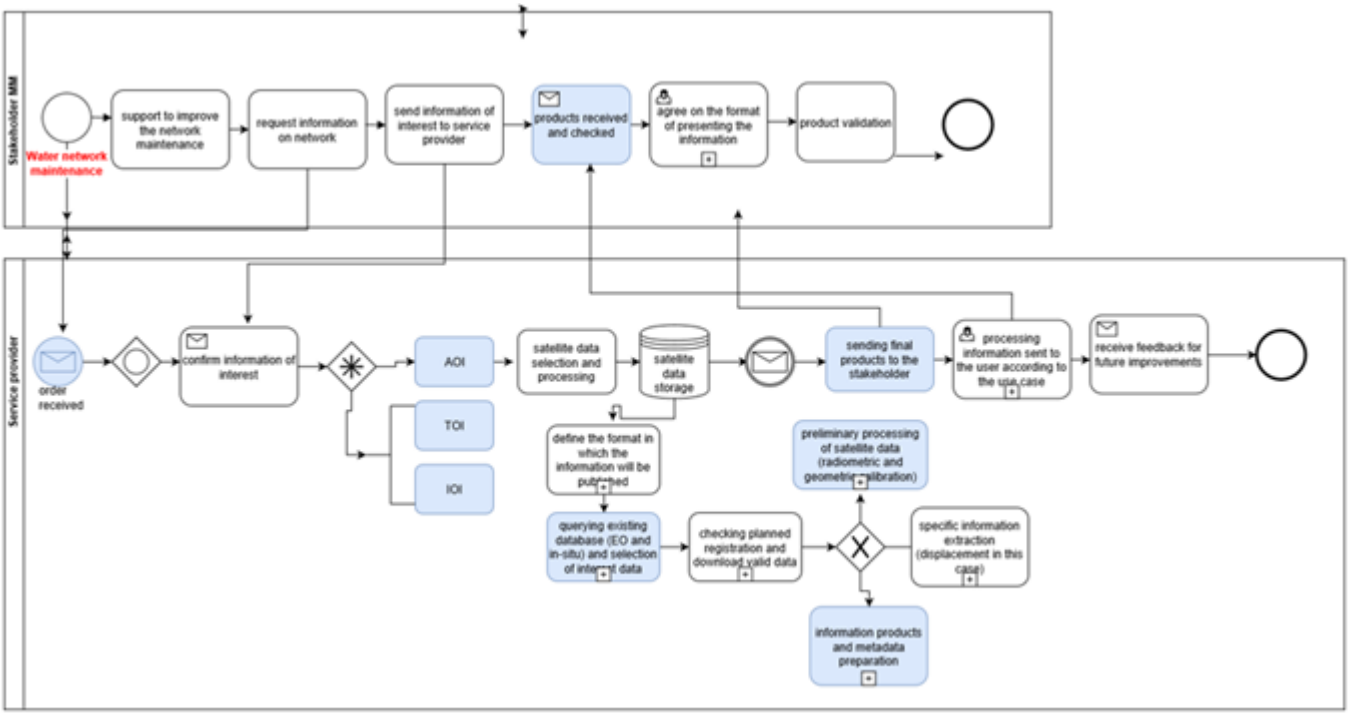

Figure 9. Monitoring the heath of water and sewerage networks, Italy, Milan

4.1.2 Climate change

Climate change is any significant long-term change in the expected patterns of average weather of a region (or the whole Earth) over a significant period of time. Climate change is about abnormal variations to the climate, and the effects of these variations on terrestrial and atmospheric surfaces.

The climate change sub-sector offers a general overview on EO/GI business processes, as presented in table 2, on two types of business process models, contributing to weather management and forecast and to land use/land cover monitoring.

Table 2. Business process models for climate change sub-sector

No.	Name	Contributing organization	Stakeholder	Data requirements	Workflow category
1	Geospatial data and technologies applications for monitoring land use change	ROSA, Romania	Ministry of Regional Development and Public Administration, Ministry of Environment, City Halls	Spot 5, Landsat, CLC	EO/GI analysis

Table 2. Business process models for climate change sub-sector

No.	Name	Contributing organization	Stakeholder	Data requirements	Workflow category
2	Precision Farming for Wineyard	Planetek, Italia	Ministry of Agriculture	Spot, Pleiades, Sentinel 2	EO/GI analysis
3	EO for biotope-type mapping in the Alpine zone in Austria	PLUS, Austria	National/Regional nature conservation authorities in Austria	VHR data HR data (Sentinel 2	EO/GI analysis
4	Air quality management	UPAT, Greece	Stakeholders for air quality planning	Copernicus Atmospheric Service, Sentinel 1, 2, 3, 5P, Meteosat Second Generation	EO/GI analysis
5	Severe weather integrated system	UPAT, Greece	General secretariat of civil protection at regional or country level	Copernicus Atmospheric Service, Sentinel 1, 2, 3, 5P, Meteosat Second Generation	EO/GI analysis
6	Solar energy forecasting	UPAT, Greece	Solar (PV/CSP) farm operators, managers of electricity grid	Copernicus Atmospheric Service, Sentinel 1, 2, 3, 5P, Meteosat Second Generation	EO/GI analysis

Land cover and climate system are closely interrelated. Land cover is defined as the observed physical cover including the vegetation and build-up areas that cover the earth's surface (FAO). The land surface interacts with the atmosphere, regulating the hydrological cycle and the earth's energy.

Monitoring and assessment of land-cover change is therefore essential to understand the impact of natural and anthropogenic changes.

The land use and land cover examples explore EO-based solutions in order to provide timely and effective services to support environmental monitoring and security, as required by the political programs. In this respect, the first business process model (tab.2) describes a prototype service for monitoring land use taking into account the requirements for integrating such services of this type of national services with similar European services. The most technically mature resources will be used to create basic services and to create conditions for the development of derived services for monitoring land use, according to the specific requirements identified at the national level and at the user or applications level.

The second example focus on biophysical parameters such as the Green leaf cover fraction (GLCV), which are extracted from multispectral images to provide information for precision farming analysis regarding vineyard crops. Zone maps were produced to define homogeneous areas on which specific agricultural practices such as fertilisation, water monitoring, punning and bunch thinning can be implemented.

Other examples of business process model support alpine habitat mapping strategy, developed based on the usage of EO techniques. Sentinel 2 time series analysis supports decision making on alpine habitat mapping (vegetation period, snow coverage) and provide rough information on areas with high degree of potential changes, as well as areas with unstable conditions. Lastly, in-field mapping is coordinated based on the HR & VHR satellite derived information, assessing biotopes, which are hard to uncover with RS techniques and is also used for validating the satellite derived information.

The workflow of events, activities and sub-processes employed in biotope-type mapping in the Alpine zone in Austria are available in annex 3.

The second group of business process models provides an assessment on climate variables as air quality management essential due to its possible implications for public health, agricultural output, visibility, and aesthetic and cultural values. Satellite-based observations reduce uncertainties in spatial distribution of air pollutants and the associated phenomena affecting them over synoptic and geospatial context. The estimation of ground-level pollutant concentration using space-based observations is one of the foremost applications of remote sensing, which has recently been used for air quality management.

The implementation of an impact based weather forecast service increase the relevance and utility of Meteorological and Hydrological Services' forecasts and warnings. Impact-based forecasting services focus on translating meteorological and hydrological hazards into sector- and location-specific impacts. By focusing on impacts, it is expected that those exposed to a hazard will have a better understanding of the risk and will more likely take appropriate action. Business Process Model description based on weather forecast for severe weather conditions is presented in figure 11.

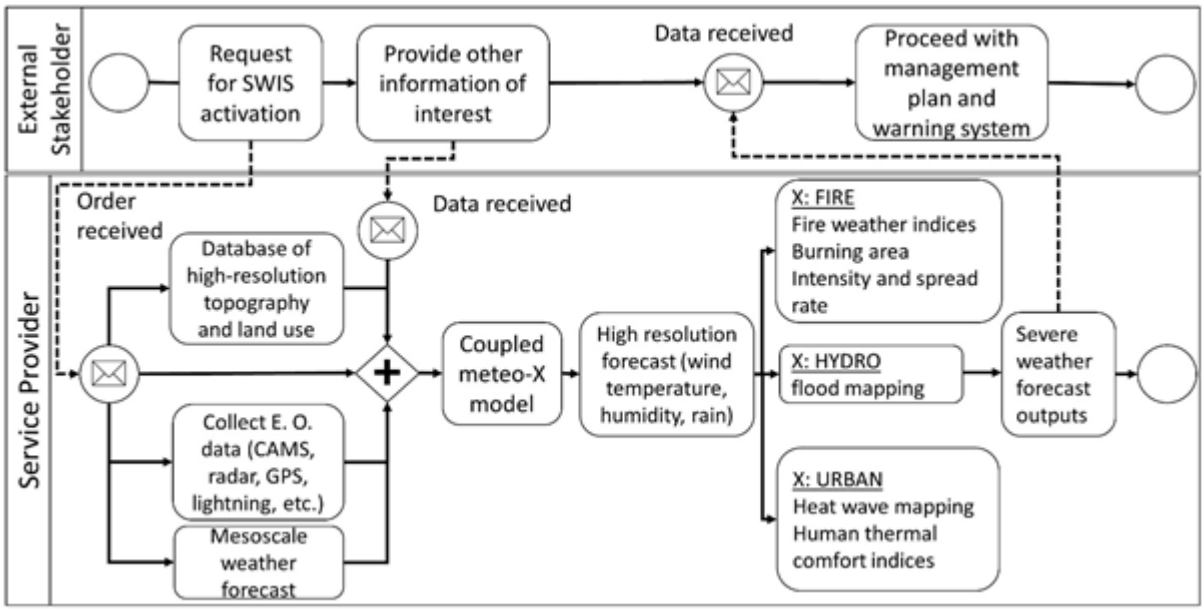

Figure 10. Severe weather integrated system, Greece

One more climate parameter modelled in this sub-sector is solar energy forecasting representing an input for efficient planning and operation of solar energy farms as wells as the electric grid economically and reliably. One of the most immediate needs is accurate forecasting for utility-scale solar facilities. Diverse resources are used to generate solar energy forecasts, ranging from measured weather and operation system data to satellite observations of clouds and weather forecasting models, as represented in the figure 12.

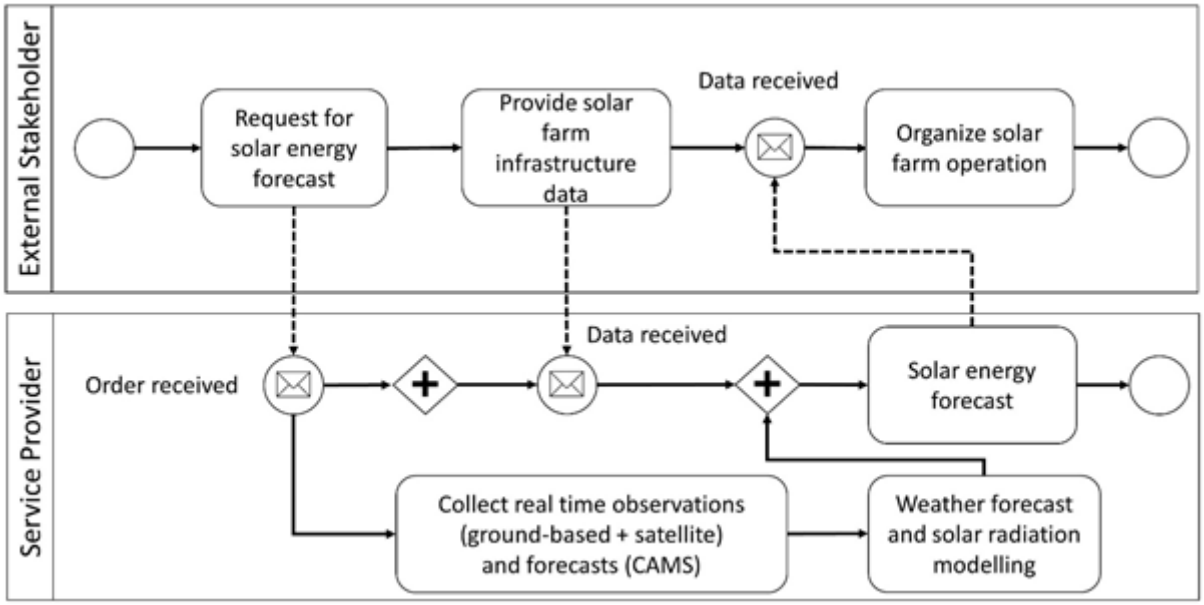

Figure 11. Solar energy forecast, Greece

4.1.3 Integrated applications

As described in EO4GEO project, integrated applications can be very diverse, but key is that they focus on multi-faceted, usually multi-sector and often on cross-border challenges. These are applications which combine different realms undergoing digitalisation such as EO and socio-economic indicators.

The most of all business process models collected for completing 4.1 task are mapped within this sub-sector and basically described below.

Table 3. Business process models for integrated applications sub-sector

No.	Name	Contributing organization	Stakeholder	Data requirements	Workflow category
1	Landslides affecting cultural heritage sites, Baia Archeological Park	Ispra, Italy	Baia Archaeological Park, Municipality of Pozzuoli (Naples)	EO data (optical, SAR interferometry) and geological data	EO/GI analysis
2	Subsidence in urban area, City of Como	Ispra, Italy	Municipality of Como, Geological Survey of Italy	EO data (optical, SAR interferometry) and geological data	EO/GI analysis
3	Earthquake event, Etna volcano	Ispra, Italy	Etna Natural Park, Sicily Region	EO data (optical, SAR interferometry) and geological data	EO/GI analysis
4	Landslide affecting linear infrastructures, Petacciato landslide	Ispra, Italy	National Road Company (ANAS), Highway Company, Railway Company, Municipality of Petacciato	EO data (optical, SAR interferometry) and geological data	EO/GI analysis
5	Copernicus Sentinel-2 data enable timely and accurate	Aristotel University of Tessaloniki, Greece	General Directorate of Forests and	Sentinel 2	EO/GI analysis

Table 3. Business process models for integrated applications sub-sector

No.	Name	Contributing organization	Stakeholder	Data requirements	Workflow category
	burned area mapping		Forest Environment		
6	Change detection analysis on Walloon Brownfield sites	NEREUS	Walloon Public Service	brownfield inventory, aerial images, Sentinel-2 data	EO/GI analysis
7	Automated brownfield monitoring using SAR and optical imagery	NEREUS	Walloon Public Service	brownfield inventory, aerial images, Sentinel-1 and Sentinel-2 data, Pleiades imagery	EO/GI analysis
8	EO-based agro monitoring system to support regional decision-making	UJI, Spain	Regional stakeholders, agriculture policy makers regional, local and municipal authorities	Sentinel 1 and Sentinel 2A, Landsat OLI, Proba-V, MODIS 250 m EVI time series , TIGGE time series	EO/GI analysis
9	Copernicus sentinel data for mapping and monitoring of grassland	Institute for Environmental Solutions, Latvia	Baltic Environmental Forum	Sentinel-1, Sentinel-2, airborne hyperspectral, airborne LiDAR	EO/GI analysis
10	Copernicus help Vessel Traffic Monitoring	ROSA, Romania	Galati Lower Danube River Administration Romanian Waters National Administration Danube Black-Sea Canal Administration	Sentinel 1 and Sentinel 2	EO/GI analysis

Table 3. Business process models for integrated applications sub-sector					
No.	**Name**	**Contributing organization**	**Stakeholder**	**Data requirements**	**Workflow category**
			Romanian Naval Authority		
11	Development of hazard zone plans for spatial planning (torrent and avalanche control)	PLUS, Austria	Torrent and Avalanche Control	Airborne Laserscanning, Orthoimagery, terrestrial surveying, further Geodata (like hydrological data), cadastre	EO/GI analysis
12	Development of Hazard Zone Plan by Federal Waterways Engineering Authority	PLUS, Austria	Federal Waterways Engineering Authority,	Airborne Laserscanning, Orthoimagery, terrestrial surveying, further Geodata (like hydrological data), cadastre	EO/GI analysis
13	Spatial Planning Model, building permit	PLUS, Austria	Province of Salzburg	Airborne Laserscanning, Orthoimagery, terrestrial surveying, further Geodata (like hydrological data), cadastre	EO/GI analysis
14	Landslides documentation supported with an EO-based service	PLUS, Austria	National and federal geological services, federal survey authorities	Sentinel-2, Landsat, Pléiades, SPOT 6/7, Worldview 3	EO/GI analysis

The business process models listed above cover different instances of using satellite remote sensing, which has reached a high degree of development, for natural hazard assessment.

The case of cultural heritage affected by landslides aims at proposing a methodology to exploit PSI (Persistent Scatterer Interferometry) data and ground displacement map in Baia Archeological Park, Italy. The PSI processing will allow to perform PS spatial and velocity analysis focused on the detection of historical and recent deformation as described in the business process model in figure 13.

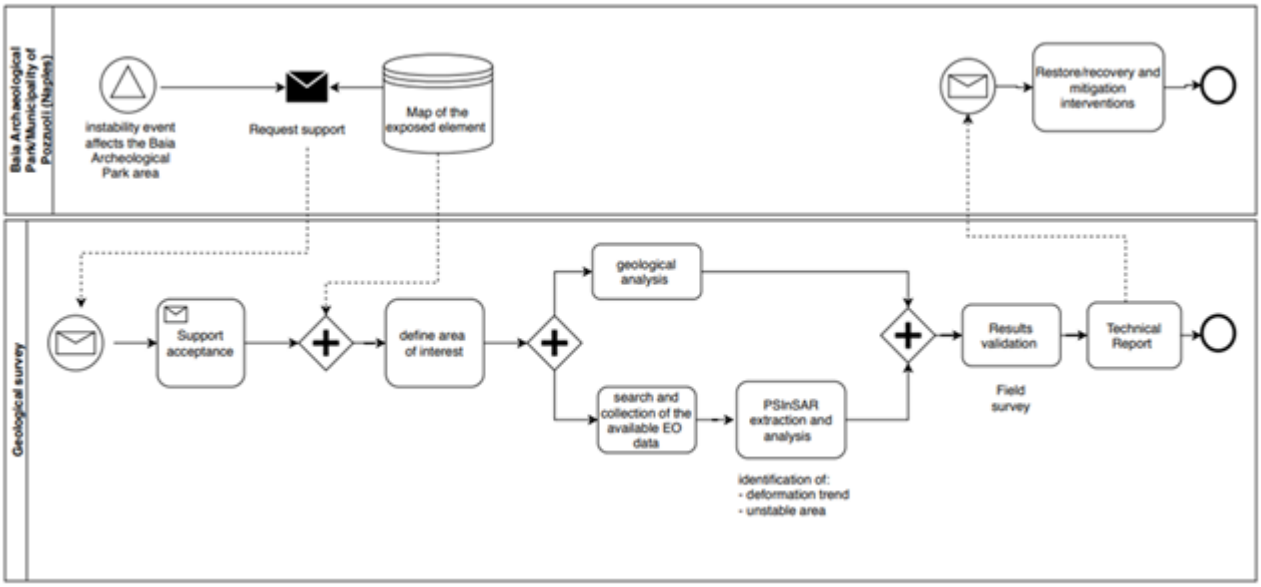

Figure 12. Landslide affecting cultural heritage sites model

As well as in the previous case, SAR interferometry is used to analyse and understand the trend of the ground deformation with respect to the subsidence phenomena starting to examine all the SAR interferometric data available and by processing the Sentinel-1 data. The detection of most affected areas leads to time series analysis of critical points, allowing to better understand the deformation pattern and its relation with the causes of their subsidence (seasonal variation, human induced activities). Another example, where processing interferometry supported co-seismic ground deformation is Etna Volcano activity, at the end of 2018. After the eruption, a SAR interferogram was obtained using images collected by Sentinel 1 –A/B, leading to the recognition of the ground deformation due to the surface faulting in the epicentre area.

Detection and mapping of existing landslides are crucial in improvement of landslide risk knowledge and consequently in assessment of landslide risk. In the case of the Petacciato landslide the data obtained from the SAR data set acquired since 1992 until now were analysed, extracting PSI data by different satellites.

The process of documentation for landslides supported with an EO-based service is relevant for tasks of landslide mitigation, preparedness, response and recovery, e.g. hazard zone planning or eligibility checking for insurance claims. Therefore, further stakeholders rely on landslide information, e.g. infrastructure providers, insurance companies, emergency response organizations, and ultimately the public. Earth observation (EO) data and innovative processing methods such as object-based image analysis (OBIA) provide the opportunity to produce landslide maps. A landslide documentation service for inventory updates - after triggering events - is described that produces

EO-derived landslide information enhanced with in-situ verification. The sequence of tasks is revealed in annex 4.

Another type of natural hazard described are the wildfires, an important environmental pressure in Greece, as in all the Mediterranean countries with significant consequent impacts in both forested ecosystems and urban areas (e.g., increased risk of floods due to loss of vegetation cover in the wildland-urban interface). Therefore, in Greece a semi-automated burned area mapping service was developed, exploiting Copernicus Sentinel-2 satellite data for mapping burned areas shortly after the fire and with the highest possible accuracy, whose workflow activity tasks are described in annex 5.

Earth Observation techniques contributed to vessel traffic monitoring, during the end of 2015 summer, navigation on the Danube river being limited by the presence of sand banks, as a consequence of severe drought. The Romanian Lower Danube River Administration (AFDJ) and the Romanian Space Agency (ROSA) were in contact and worked closely to derive a mapping product for vessel traffic monitoring at critical points, such as those close to Zimnicea, in the Romanian Danube sector. Both Sentinel 1 and Sentinel 2 data allow a clear identification of the boats sailing on the Danube without applying special detection methods, as described in the business process below (figure 14).

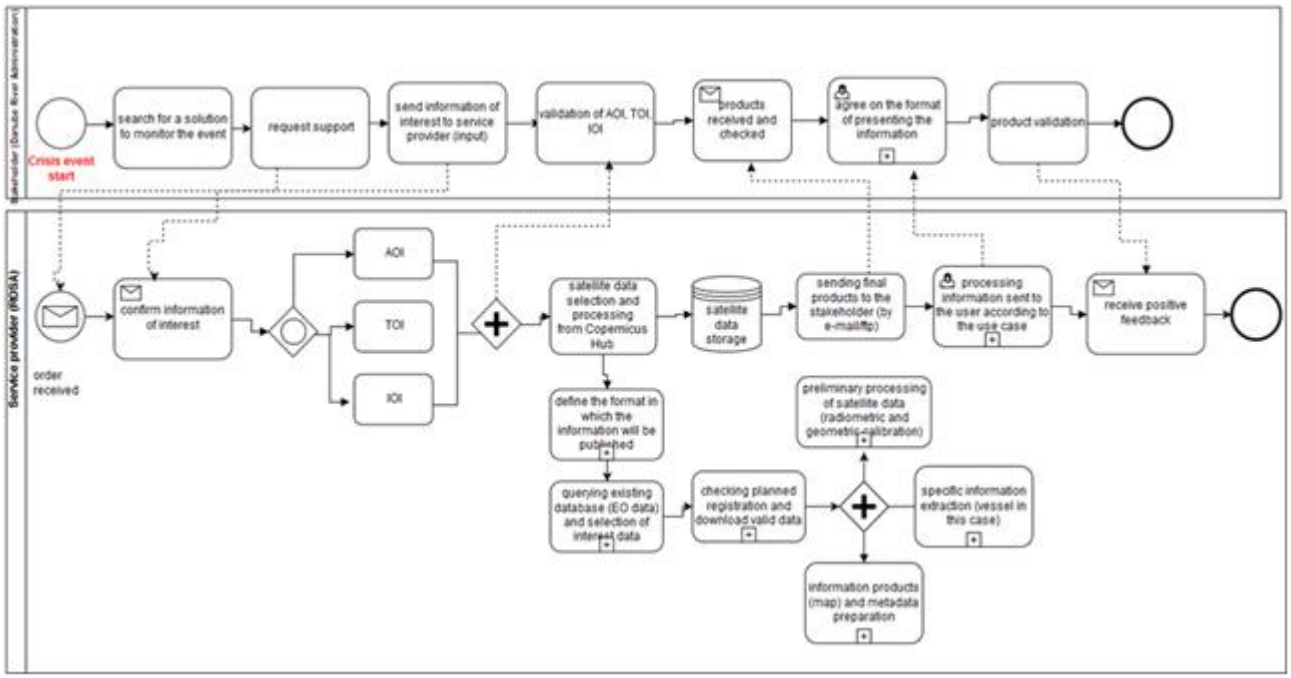

Figure 13. Copernicus Sentinels help vessel traffic monitoring

Another category of business process models using integrated applications consists in support of the regional authorities, enabling land use monitoring and planning with input on change detection analysis on Brownfield sites, and on agriculture and grasslands monitoring.

Regional authorities in Wallonia were monitoring the status and evolution of 2500 Walloon brownfields by on-site visits. In order to decrease human and environmental costs, remote

monitoring on those sites were automatically performed using Earth Observation data, as described in business process model in figure 15.

The area covered by grassland has considerably decreased in Europe throughout the last century as a result of land conversion to urban territories, arable land, and afforestation. Loss of grassland biodiversity leads to degradation or even destroying of the ecosystem functions and services, which would require enormous financial investments to maintain or provide these services artificially. The aim is to support the maintenance of biodiversity and ecosystem services provided by grasslands, through encouraging ecosystem-based planning and economically viable grassland management. Sentinel-1, Sentinel-2 and airborne hyperspectral data were used to generate various grasslands describing data products (figure 16), for large areas in Estonia, Latvia and Lithuania and additionally the temporal characteristics of satellite data were used to compare the situation in 2015 and 2018.

The already described work processes supporting regional authorities' spatial planning are strengthened by integrated applications for development of hazard zone plans for torrent and avalanche control, waterways engineering control and building permits. By representing the last application (annex 6), the Spatial Planning – building permit business process model has been integrated into the actual business planning on municipal level, which has been met wide competences in the field of spatial development in Austria. Nevertheless, it has to be noted that the procedure of building permits varies within municipalities (e.g. villages or cities).

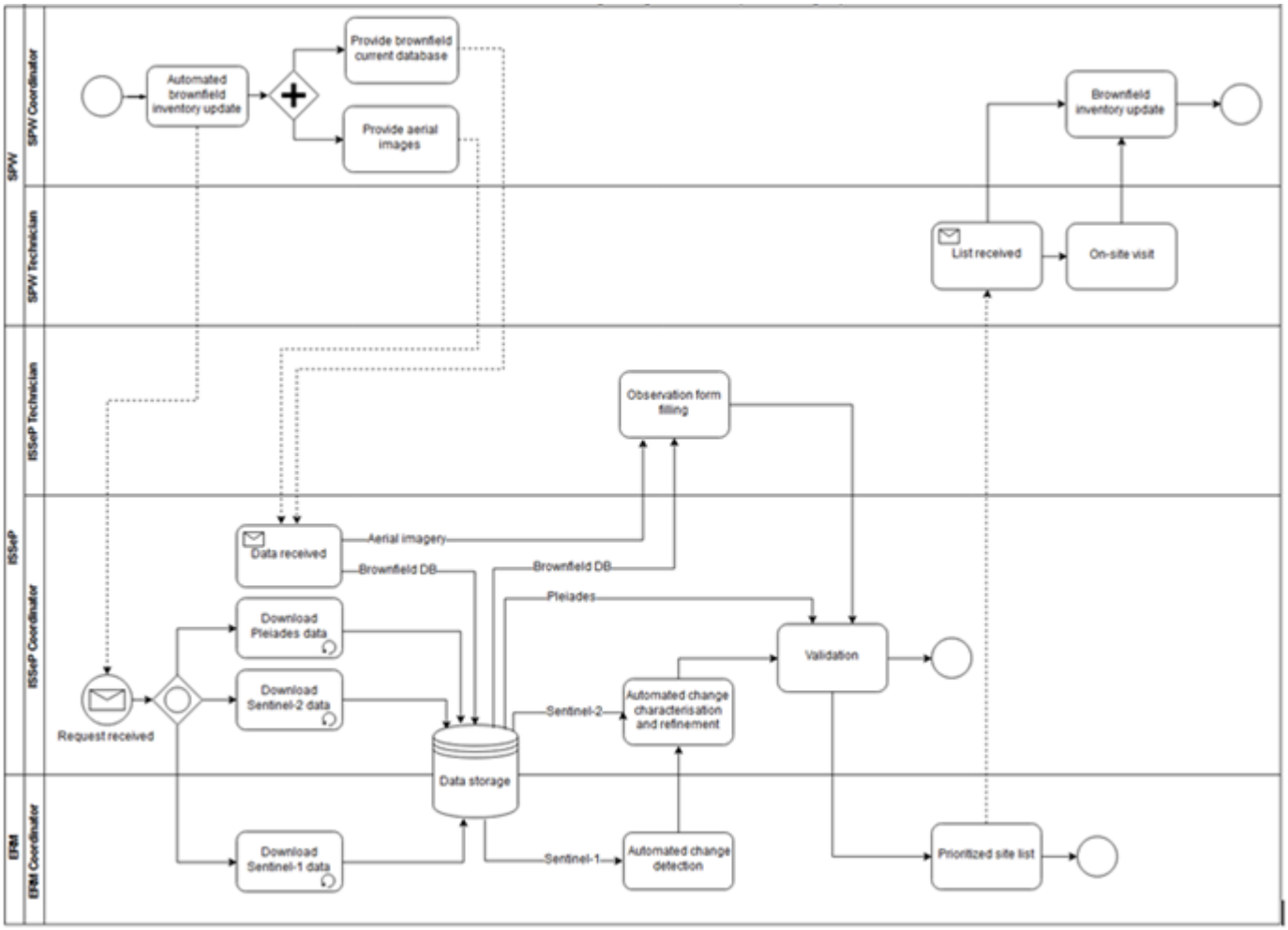

Figure 14. Automated brownfield monitoring using SAR and optical imagery

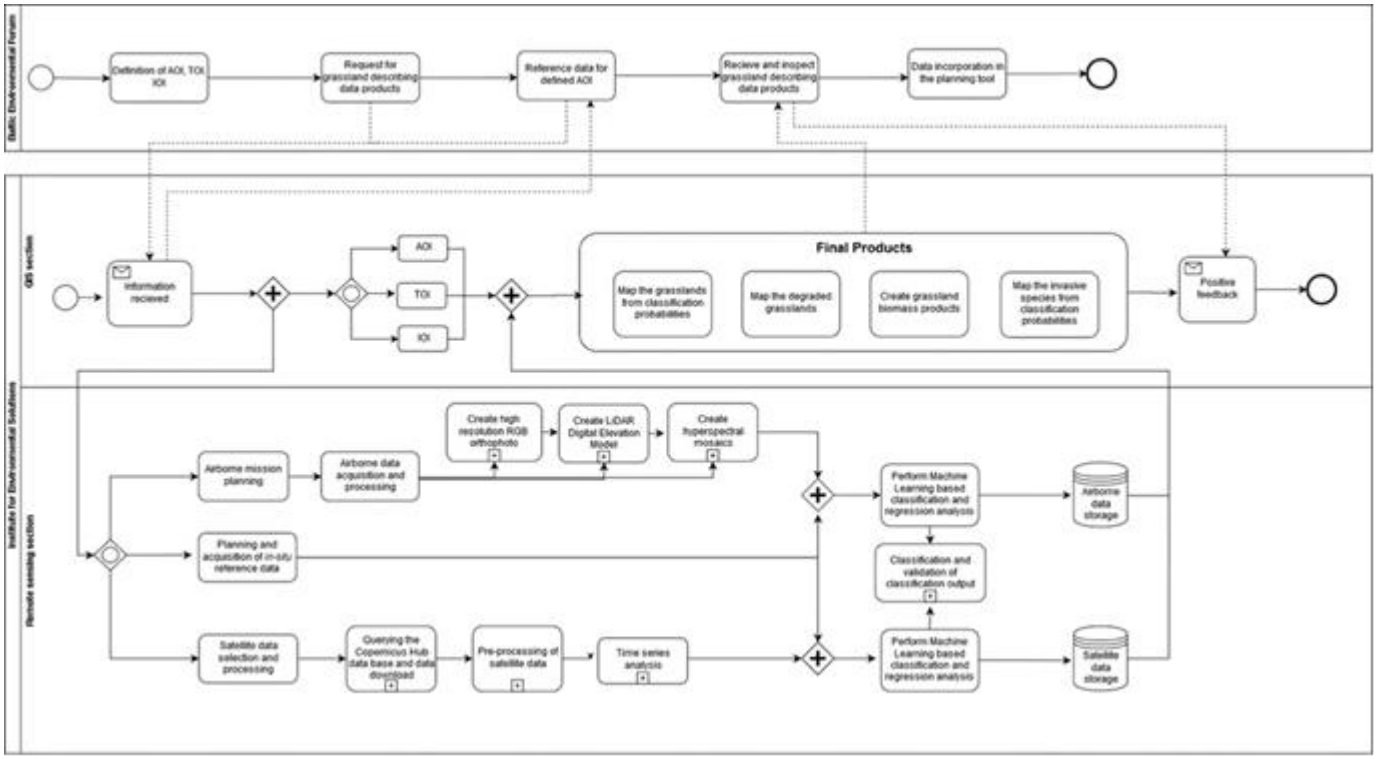

Figure 15. Copernicus Sentinel data for mapping and monitoring of grasslands business process model

4.1.4 Other business process models

This section includes workflow of tasks and occupational profiles relevant for application development, project planning and EO/GI training.

Project implementation example describe the steps needed for embody an idea into a project, passing through a series of administrative tasks.

Table 4. Business process models in other fields of activity

No.	Name	Contributing organization	Stakeholder	Data requirements	Workflow category
1	EO/GI project implementation	ROSA	The private/public authorities which use the project products	EO, GI data	Project development
2	Education and training	ROSA	Young researchers, PhD students, people involved in operational	EO, GI data	Training development

Table 4. Business process models in other fields of activity

No.	Name	Contributing organization	Stakeholder	Data requirements	Workflow category
	GEOSS Summer School		activities in which Earth Observation data is used		
3	Business Initiation	GIB	Suppliers, stakeholders	Data related to the requirements of the tender	Business workflow development
4	Water Information Management System	ROSA	Water Administration Romania	Documentation on existing system and data	Technological development of a business process

Similarities come with the business initiation and responses to tenders workflows pictured by administrative tasks like writing project proposals, calculation of pricing, promotion and customer research. The work on business initiation is based on description of the offered product or service, according to the tender specifications considering a market analysis, project idea delineation and establish collaboration with stakeholders. The succeeding steps of all the business initiation workflow is available in annex 7.

Education and training business process model describes the tasks needed for organising a teaching event with the goal of acquiring knowledge on the use of EO data and image information mining techniques contributing to prevent, monitor and assess the impact of natural and man-made disasters and crisis situations.

Water Information Management System (annex 8) describes phases and processes needed for the implementation of a water information management system for the application of the water framework directive reporting obligations. They represent the technological development steps of a business process putting together software and data allowing repetitive tasks to be performed.

5. Discussions and conclusions

This report introduces the business process modelling notation as useful tool for presenting business processes based on a common language allowing further identification of characteristics attached to different activities in which geo-spatial information is derived from EO data.

This shows the proof that, even with a reduced set of symbols, complex processes can be described and this allows further identification of occupational profiles that may be required in these processes.

The standardised representation based on symbols allow one to compare and the same time to evaluate how much a process is in line with the current trends and how much it can fulfil the needs and answer the requirements for which it need to be run.

At the same time, the potential of an analysis of business processes of a domain exceeds the specific objectives of this report. As business processes represent the status-quo of a domain, they could be used for the identification of potential improvements of workflows and additional potential for the use of new technologies or approaches.

It's well known that EO4GEO Sector Skills Alliance aims at supporting the use of Copernicus data and services, providing the programme full potential in terms of benefits for the EU economy and for its citizens, considering Copernicus user uptake strategy.

Copernicus user uptake have been designed and implemented with the aim of maximising the benefits enabled by the Programme for the different types of stakeholders in the ecosystem (e.g. industry, end-users, citizens, public service bodies). These benefits are also shown in several BPMN examples through the use of Copernicus data and Copernicus Services.

Table 5 includes all the business process models which employed in the workflow chain optical and radar Sentinel data for deriving mainly maps, then to develop scenarios and forecasting indices.

The products derived by using Copernicus data are well-known, familiar and frequently used by EO data users, supporting daily stakeholder activities, therefore, the below presented models (tab.5) do not aim to present the development of new products and they are not in an experimental stage.

During the business process models analysis, mapped in the present report, the BPMN standard met all the requirements, there were not noticed limitations in defining execution semantics and diagram interchange. As BPMN standard is quite comprehensive, consisting of over 100 graphical process elements, the workflow of deriving task and occupational profiles in EO and GI domain involved just half of the elements.

The main objective of this report is to describe relevant business models and to link them to occupational profiles, existing ones as well as new ones.

Table 5.The uptake of Copernicus data and services in the BPMNs

No.	Business process model use case	Copernicus data	Product derived
1	Urban heat, input for city planning	Sentinel 2 and Sentinel 3	Heat risk map
2	Access to green areas	Sentinel 2	Green area map
3	Sustainability to storm water	Sentinel 2	Maps for different rain intensity scenarios
4	Copernicus Sentinel – 2 data enable timely and accurate burned area mapping	Sentinel 2	Burned area map Operational service
5	Precision farming for vineyards	Sentinel 2	Zonation maps
7	Monitoring the health of water and sewerage networks	Sentinel 1	Displacement maps
8	EO for biotope-type mapping in the Alpine zone in Austria	Sentinel 2	Biotope-type maps
9	Change detection analysis on Walloon Brownfield sites	Sentinel 2	Change detection maps
10	Automated brownfield monitoring using SAR and optical imagery	Sentinel 2 and Sentinel 1	Change detection maps
11	EO-based agro monitoring system to support regional decision-making	Sentinel 1 and Sentinel 2	Rice surface maps
12	Copernicus Sentinel data for mapping and monitoring of grasslands	Sentinel-1 and Sentinel-2	Grassland map for the AOI
13	Copernicus Sentinels help Vessel Traffic Monitoring	Sentinel 1 and Sentinel 2	Vessel traffic Monitoring Map
14	Air quality management	Sentinel 1, 2, 3, 5P	Air quality forecasting at different time horizons
15	Severe weather integrated system	Sentinel 1, 2, 3, 5P	Severe weather forecast indices at different time horizons

Table 5.The uptake of Copernicus data and services in the BPMNs			
No.	**Business process model use case**	**Copernicus data**	**Product derived**
16	Solar energy forecasting	Sentinel 1, 2, 3, 5P	Solar energy forecasting at different time horizons

The business processes are described in chapter 4. In total, 9 different processes are described, based on BPMN. The processes being described are originating from real world cases and can therefore be considered to be relevant. By analysing different aspects of the processes, it was found that they show a wide variation, indicating that they are to some extent representative for the current usage of space-geospatial technologies today.

The related occupational profiles are identified in figure 5 of this report. In total 24 different occupational profiles are identified. No attempt has been made to link these profiles to the ESCO profiles.

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- Dessers, E., (2013), Spatial data infrastructures at Work. Analysing the Spatial Enablement pf Public Sector Processes, Leuven University Press, Belgium
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Annexes

ANNEX 1 – BPMN 2.0 diagram elements and symbols

BPMN depicts these four element types for business process diagrams:

1. Flow objects: events, activities, gateways
2. Connecting objects: sequence flow, message flow, association
3. Swimlanes: pool or lane
4. Artifacts: data object, group, annotation

Events

A trigger that starts, modifies or completes a process. Event types include message, timer, error, compensation, signal, cancel, escalation, link and others. They are shown by circles containing other symbols based on event type. They are classified as either “throwing” or “catching,” depending on their function.

Figure 1. BPMN event symbols

Activity

A particular activity or task performed by a person or system. It’s shown by a rectangle with rounded corners. They can become more detailed with sub-processes loops, compensations and multiple instances.

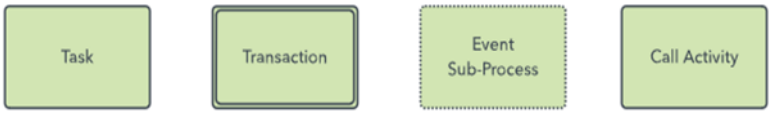


Figure 2. BPMN event activity symbols

Gateway

Decision point that can adjust the path based on conditions or events. They can be exclusive or inclusive, parallel, complex, or based on data or events.

Figure.3 BPMN gateway symbols

Sequence flow
Shows the order of activities to be performed. It is shown as a straight line with an arrow. It might show a conditional flow, or a default flow.

Figure. 4 BPMN sequence flow symbol

Message flow
Depicts messages that flow across “pools,” or organization boundaries such as departments. It shouldn’t connect events or activities within a pool. It is represented by a dashed line with a circle at the start and an arrow at the end.

Figure. 5 BPMN message flow symbol

Association
Shown with a dotted line, it associates an artifact or text to an event, activity or gateway.

Figure.6 BPMN association symbol

Pool and swim lane
A pool represents major participants in a process. A different pool may be in a different company or department but still involved in the process. Swimlanes within a pool show the activities and flow for a certain role or participant, defining who is accountable for what parts of the process.

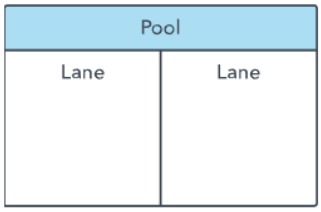


Figure.7 BPMN pool and swim lane symbol

Artifact

Additional information that developers add to bring a necessary level of detail to the diagram. There are three types of artifacts: data object, group or annotation. A data object shows what data is

necessary for an activity. A group shows a logical grouping of activities but doesn't change the diagram's flow. An annotation provides further explanation to a part of the diagram

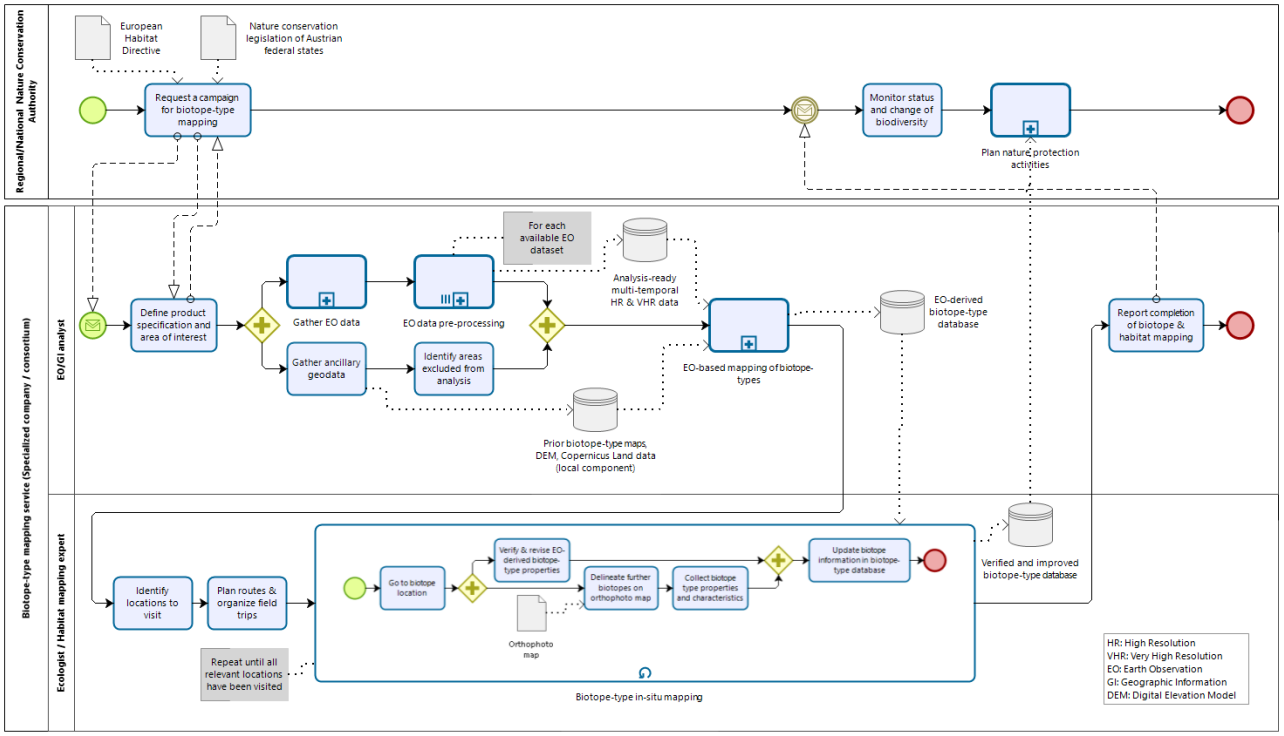
Figure. 8 BPMN artefact symbol

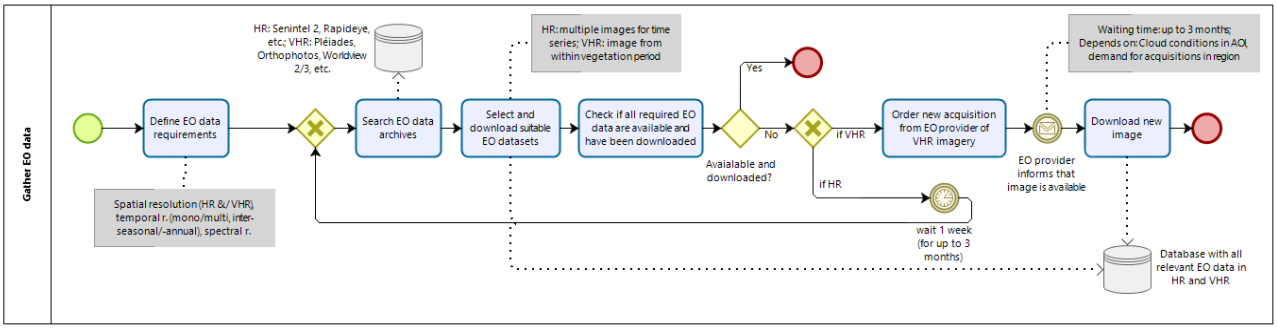
ANNEX 2 – Template for developing business process models

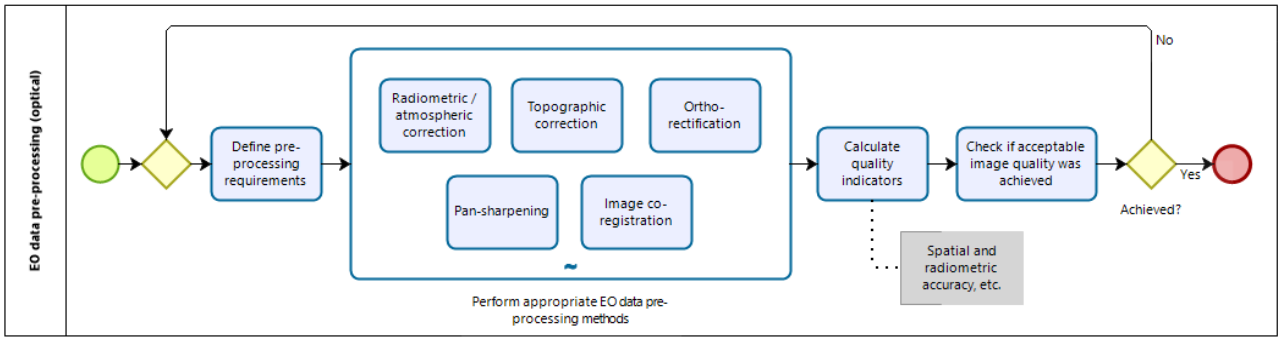
Use case title	***A short title for the use case***
EO4GEO sub-sectors (climate change, integrated applications, smart cities) integration	
Contact person	
Status	
Primary user	
Reference data provided	
Context of the use case	
Description of the use case	***A narrative description of the use case***
Business Process Description	
Documentation (suggestions)	***Include pointers to any additional documentation*** KU Leuven, Pragmatic guidelines for Business Process Modelling Von Rosing, M., von Scheel, H, 2015, The Complete Business Process Handbook Aagesen G., Krogstie, J., 2015, BPMN 2.0 for Modeling Business Process https://www.bpmnquickguide.com/ https://www.omg.org/cgi-bin/doc?dtc/10-06-02.pdf
Pre-condition	
Data used	

Post-condition	
Basic steps for developing a Business Process Model Diagram	
Step 1	Identify the process and break it down into multiple tasks (divide it into sequential events and sub processes)
Step 2	Establish the team working on the business process
Step 3	Create a business process flowchart (a draft diagram for the beginning) Workflow analysis allows business analysts to determine the current state and build toward a future state that's more efficient.
Step 4	Define the current process Current process analysis allows a work process to evaluate the current state of its processes and identify opportunities for improvement. If you don't know where you're starting from, you'll have a hard time getting to where you want to be.
Step 5	Specify improvement points
Step 6	Model the process to be by using BPMN standard *it is recommended to deepen the knowledge for description of symbols here

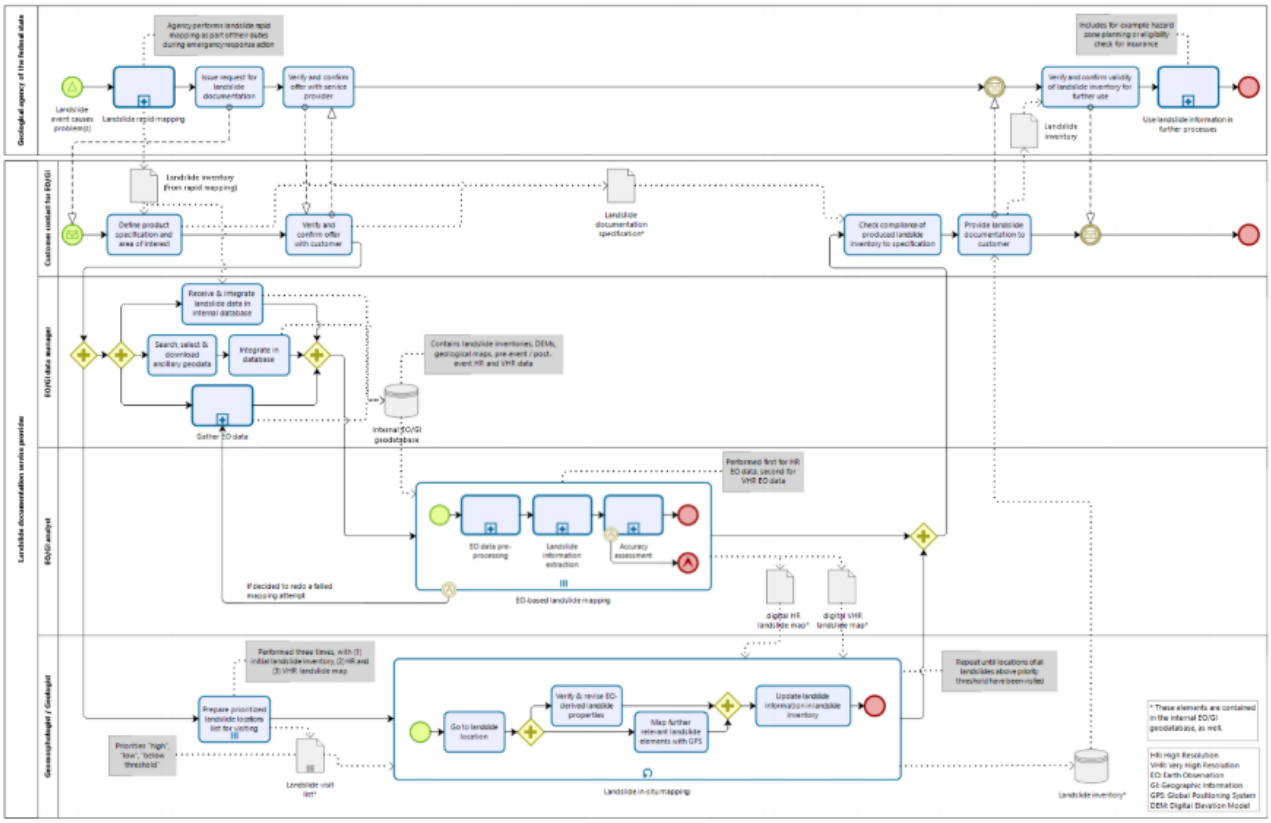
ANNEX 3 - EO for biotope-type mapping in the alpine zone in Austria



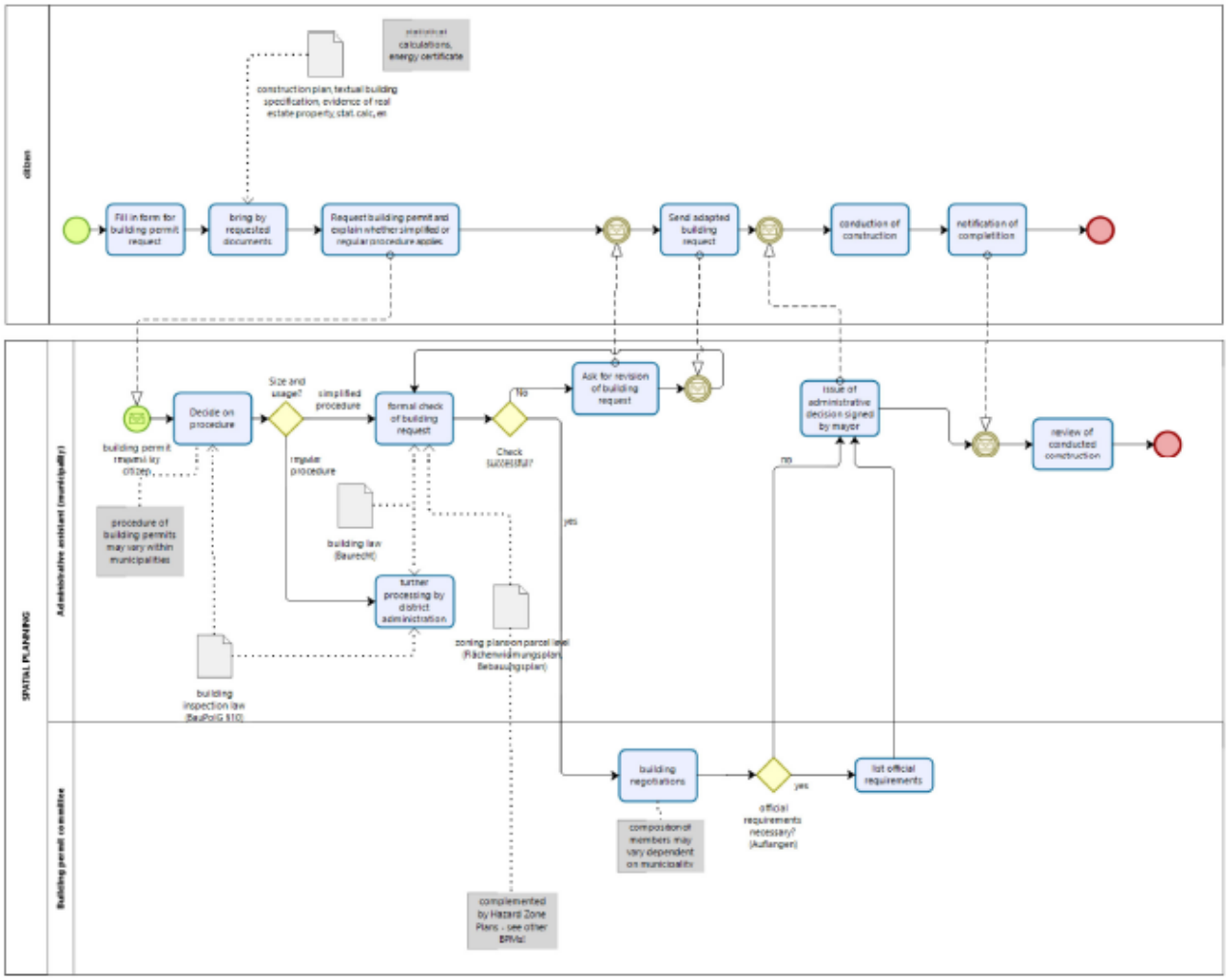




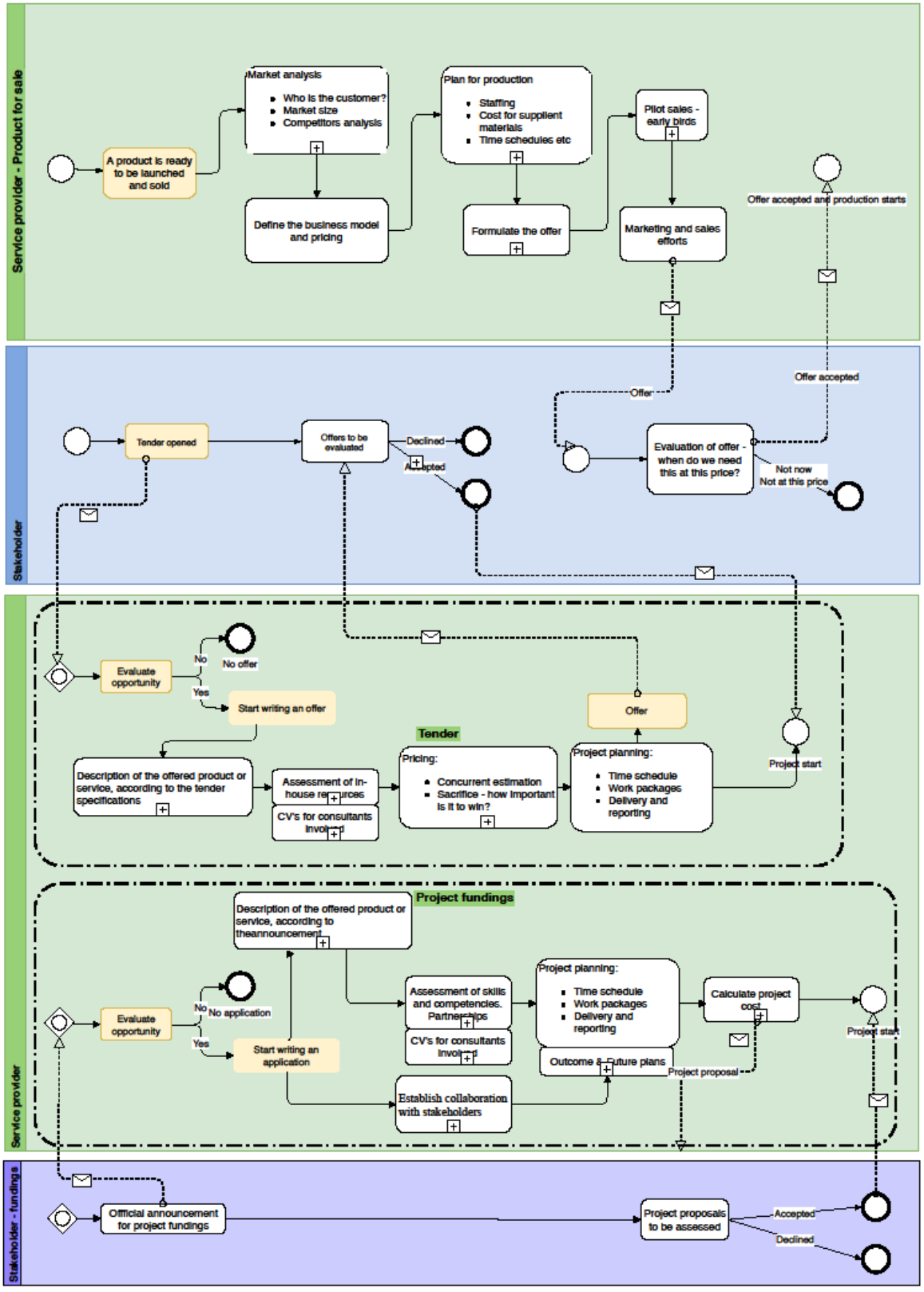
ANNEX 4 – Supporting landslide documentation with an Earth-observation based service



ANNEX 5 – Spatial Planning Model, Building Permit



ANNEX 6 – Business initiation process model



ANNEX 7 – Water Information Management System