MS.MONINA

Multi-scale Service for Monitoring NATURA 2000 Habitats of European Community Interest

Deliverables

Deliverable 5.8

Service implementation report

WP 5 MS.MONINA Site

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1.0	20/11/2013	32	Final approval (PLUS)

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1 EXECUTIVE SUMMARY

Within WP 5 MS.MONINA Site, several subservices were further developed and their applicability tested and improved through new implementations.

This deliverable provides a factual overview of the status of these site services at the end of the project, in terms of accomplished implementations of site pilots, method developments, user feedback and challenges for further operationalization. Furthermore, boundary requirements for a successful implementation are listed, and a rough cost estimate is given.

The document concludes with a conceptual design of the site level service, and names further aspects to be tackled for a successful realisation.

2 INTRODUCTION

2.1 OBJECTIVES OF THIS DOCUMENT

As a follow-up to the Deliverables 5.2 (service definition), 5.3 (service development) and 5.5 (performance report), this document presents the status of the WP 5 Site subservices at the end of the MS.MONINA project. This overview is deliberately kept factual. For illustrations of the outputs, we refer to Deliverable 5.7 (service prototypes) and to the MS.MONINA geoportal (www.ms-monina.eu/geoportal).

2.2 STRUCTURE OF THIS DOCUMENT

Chapter 3 contains fact sheets of the status of all MS.MONINA Site subservices, containing:

- Aim and synopsis of the subservice,
- Status and realized implementations, including links to the MS.MONINA SDI,
- Method developments,
- User feedback,
- Challenges and experiences,
- Boundary conditions and requirements for a successful implementation,
- Approximate cost level for a 10 by 10 km site.

Chapter 4 presents a conceptual design of the site level service, and names further aspects to be tackled for a successful realisation.

3 IMPLEMENTATION FACT SHEETS

This chapter presents a status-quo of each subservice in WP 5 (MS.MONINA Site), using the following fact sheet:

Site service *<subservice name>*
Subservice aim and synopsis
Status of service implementation Original implementation: <site pilot name> Link to SDI: <insert site-specific link> - <Product name> - … Additional implementation: <site pilot name> Link to SDI: <insert site-specific link> - <Product name> - …
Method developments <describe main developments of the method if any. Bullet points preferred>
User feedback <describe user feedback, to be distilled from user validation reports (WP2) where applicable. Bullet points preferred>
Challenges and experiences <describe relevant experiences and challenges in further operationalization. Bullet points preferred>
Boundary conditions and requirements <describe required input (image type and amount, timing, reference data), contexts, habitat types and other relevant boundary conditions that may limit the successful application of the method>
Costs <roughly estimate costs of application for a site of 100 km² (10 by 10 km), including images, reference data, software, personnel,…>

3.1 PARIS-LODRON UNIVERSITY SALZBURG (PLUS), INTERFACULTY DEPARTMENT OF GEOINFORMATICS – Z_GIS, AUSTRIA

Site service *Riparian forest mapping and quality assessment*
Subservice aim and synopsis
The riparian forest mapping and quality assessment service provides Natura 2000 patch maps as well as some key structural characteristics. The service focuses on providing vector data for riparian forest habitats (Alluvial forests 91E0*, Riparian mixed forest 91F0), which were visually delineated, as well as semi-automatically derived from

very high resolution satellite imagery using object based image analysis. Visual delineation uses EUNIS-3 classification scheme, whereas semi-automated object based image analysis uses the Natura 2000 habitat categories as well as EUNIS-3 classification scheme. In a second stage, the service delivers information on habitat conditions, which are calculated using landscape metrics. Quantitative measures on habitat form, structural richness, fragmentation, diversity and the configuration of undisturbed core areas are provided. The derived habitat quality indicators in combination with classification results can be used for informed decisions on the location and type of management activities on the site level.

Status of service implementation

Original implementation: Salzachauen, Austria

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=salza

- EUNIS-3 classification
- Core area of riparian forests
- Edge density - a structure parameter
- Loss of woody habitat
- Fractal dimension - a form parameter
- Proportion of riparian forest
- Shape index - a form parameter
- Semiautomatic EUNIS-3 Classification
- Semiautomatic N2000 habitat mapping
- Forest stands
- Tree stands
- Tree species dominance

Additional implementations: Danube river national park, Austria

- Tree stands
- Forest stands

Method developments

- Tree species classification
- Semiautomated habitat modelling (Annex I, EUNIS-3) using object based image analysis
- Species dominance calculation
- Forest management activity indicators
- Forest structure indicators
- Habitat quality indicators

User feedback

- Metadata is complete.
- Geographic coverage, thematic content, geometric accuracy: good to very good.
- Thematic accuracy needs to be improved to match the user requirements.
- Nice input but needs improvement for best usage (see challenges).
- Products in their actual state are not mature enough to replace the practiced methods for management conservation plans.
- In general the product has the potential to improve the temporal resolution, envisage update frequency, improved accuracy, improved metadata information, development and support of standards and processes, improved evaluation for reporting procedure, more efficient resource management, monitoring of management plans, and reduced detection costs, compared to the products which are currently in use.

- High interest in the products at reasonable price.

Challenges and experiences

- Improvement of tree species classification, as a critical baseline layer for the semiautomatic mapping of habitats.
- Postprocessing of habitat maps for generalized, scale-specific boundaries.
- Providing cadastre-constraint boundaries for habitat maps.
- Testing additional remote sensing derived habitat quality indicators to arrive at a more complete picture on habitat quality.
- Rule set and thresholds adaption needed due to differences in tree species coverage and composition.
- Spatial and time consistent reference data is essential. Reference data acquisition period needs to be coincident with satellite image acquisition.
- Object-specific change assessment to integrate and compare semi-automated product with current manual mapping activities.

Boundary conditions and requirements

- VHR1 satellite imagery (minimum 4 bands, 8 bands or more advantageous)
- Time series analysis: Time step 5 – 10 years, minimum one summer scene (June – July) per time step, two scenes (summer, autumn: End October / November) advantageous. Optional additional windows begin of April – mid of May and end October / November (for enhancing tree species extraction, neophytes / undergrowth detection, phenology studies).
- Reference data: georeferenced point data with high spatial accuracy (0.5 to 1 m), ground validated habitat field map for verification. Coregistrated reference data to tree crowns (optional).
- Optional data: cadastre data, LiDAR DEM and DSM (> 10 pt/m^2)
- Habitat types: 91E0, 91F0, (9170), (9180), (other forest habitat types)
- Biogeographical zone: Continental tested; Mediterranean, Alpine, Atlantic possible

Costs

Image = 2800 Euro

Reference data / field work = 5000

Software = 2000

Product processing = 6000

Sum estimated = 14000 - 18000 Euro

Site service *Forest disturbance service*

Subservice aim and synopsis

The aim of the forest disturbance service is to identify and monitor forest disturbances triggered by abiotic (storm events) and biotic (insect pests, mainly infestations of spruce bark beetles [*Ips typographus*]) factors that result in a patchy distribution of deadwood. Thus, the service allows assessing and visualizing the spatial variability and dynamics of a forest ecosystem at regional scale. The service mainly provides information based on remote sensing data of different time slots that also enable to detect forest change even in areas that are difficult to access. High resolution satellite imagery and reproducible methods for semi-automated feature extraction support traditional techniques of large scale forest inventory through field surveys and aerial photo interpretation. Data integration, data analyses and change detection are performed by an object-based image analysis (OBIA) approach.

Status of service implementation

Original implementation: Bavarian forest National Park (DE) and Kalkalpen National Park (AT)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=kalk:

- Forest disturbance

Method developments

- Semi-automated forest disturbance assessment using object-based image analysis approach
- Fuzzy classification
- Forest disturbance indication on patch level

User feedback

- Metadata is complete.
- Geographic coverage, thematic content, geometric accuracy: very good.
- Thematic accuracy: good to very good.
- Input matches the requirements to report dead wood coverage (forest structure).
- Products are best used as additional information and support the assessment of dead wood (forest structure).
- Valid to replace or valid as a complementary method to the practiced methods for management conservation plans.
- The product has the potential to: improve accuracy, improve metadata information, development and support of standards and processes, improve evaluation for reporting procedure, more efficient resource management, monitoring of management plans, and reduced detection costs, compared to the products which are currently in use.
- High interest in the products at reasonable price.

Challenges and experiences

- Rule set and thresholds adaption needed, due to differences in vegetation coverage and ground spatial resolution of other sensor type.
- Improvement of the seasonal aspects. Forest disturbance analysis in spring required, to represent the biomass calculation annually.

Boundary conditions and requirements

- Existence of a forest mask
- Reference data: georeferenced point data with high spatial accuracy (0.5 to 1 m). Coregistrated reference data to tree crowns (optional).
- Optional data: LiDAR CHM > 10 pt/m^2

Costs

Image = 600 Euro

Reference data / field work = 1600

Software = 2000

Product processing = 4500

Sum estimated = 8000 - 10000 Euro

3.2 NATIONAL RESEARCH INSTITUTE OF SCIENCE AND TECHNOLOGY FOR ENVIRONMENT AND AGRICULTURE (IRSTEA), FRANCE & REGIONAL CONSERVATORY FOR NATURAL AREAS LANGUEDOC-ROUSSILLON (CEN-LR), FRANCE

Site service *Habitat mapping using sparse partial least squares discriminant analysis*

Subservice aim and synopsis

This subservice aims at mapping the spatial distribution of complex natural habitats at the site level. Very high resolution satellite imagery and aerial photos (and when available a digital elevation model) are recommended for implementing the service. A limited number of reference data (e.g. field data tailored to the classification of remote-sensing imagery or photointerpretation of homogeneous image objects using aerial photos) is required for training the classifier. Due to both limited data input requirements and the computational efficiency of the developed automatic classification method, the service can be easily transferred to different protected sites independently of the biogeographical region.

The following habitats are under special consideration:

- Corine biotope: 15.1133 Upper shore Mediterranean glasswort swards
- Corine biotope: 15.51 Mediterranean tall rush saltmarshes
- Corine biotope: 44.62 Mediterranean riparian elm forests
- Corine biotope: 53.12 Common reed beds
- Corine biotope: 81.1 Dry improved grasslands

Status of service implementation

Original implementation: Larzac foothills

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=larza: Larzac foothills

- Mapping grassland and riparian ash woods

Additional implementation: Lagoons of Palavas

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=palav: Lagoons of Palavas

- Classification of natural habitats over “Les Etangs Palavasiens”

Additional implementation: Lower Aude valley

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=lav: Lower Aude Valley

- Predicted natural habitats over Lower Aude Valley Natura 2000 site

Method developments

- Segmentation of the aerial imagery into homogeneous objects
- Computation of radiometric and textural variables (e.g. NDVI, textural features, etc.) from the satellite and aerial data and topographic variables from the LIDAR DEM (e.g. Topographic Position Index)
- Selection and statistical analysis of the training set (e.g. outlier analysis)
- Grouping or separation of habitat classes based on a stepwise model selection and analysis of the error rate
- Dimension reduction and selection of the final model and the final number of classes of habitats to be classified using sparse partial least square discriminant analysis
- Classification of all the image objects using the selected explanatory variables

- Cross validation
- Final validation using in-situ data

User feedback (by CEN-LR)

- **Assessment of service quality and procedures:**
  - Very good user-service provider communication
  - Very good attention to requirements after service delivery
  - Moderately fluent user-service provider relationship
- **Usability and benefits of the service:**
  - Very useful for visualization of vegetation/habitat and/or its characteristics in maps
  - Less useful for local management plans
- **Improvements and benefits**
  - Improved spatial coverage
  - Improved resolution
  - Envisaged update frequency
  - Improved evaluation of reporting procedure
  - Reduced detection cost
  - Good cost saving
  - Good monitoring capability
  - Good objectivity/reliability

General comment: the MS.MONINA product's level of efficiency, in terms of time saved, accuracy etc., is higher than the systems, products that were/are used before. The main impact is the way the CEN-LR will be able to gain time in the future to map every habitat patch. The CEN-LR will «only» have to precise/confirm the habitat type. A lot of boring work saved and a standardized method to repeat.

Challenges and experiences

For achieving better results in terms of discrimination of a larger number of habitat classes, it is necessary to improve the learning stage of the classifier. This can be attained through the use of more adequate reference data (e.g. field data tailored to the classification of remote-sensing imagery or photointerpretation of homogeneous image objects resulting from an automated segmentation of the remote-sensing data). Despite the beneficial effect of outlier detection and removal thanks to the multivariate outlier analysis, the reference data still include heterogeneous areas and ill-defined habitats. In addition to the enhancement of the learning set, special efforts should be made to redefine the typologies of habitats and to establish a relationship between habitat classes in the field and biophysical parameters that are accessible through remote sensing.

Other data sources could also be tested and included in the classifier for discriminating a larger number of habitat classes. If available, thematic information on soil properties can be beneficial as well as multiseasonal remote-sensing data can be also very useful for detecting trends in NDVI that may help in distinguishing between combinations of vegetation types (e.g. improved and semi-improved grasslands) and mainly between coniferous other evergreen and deciduous forest species.

The wider application of the method requires

(1) access to suitable reference data on existing habitats, ideally based on photointerpretation and ground-truthing by an experienced ecologist;

(2) the availability of very high-resolution imagery with the NIR band as a primary source for segmenting the landscape into homogenous image objects that reflect the habitat patterns; and

(3) the availability of ancillary data (e.g. DEM) that would lead to further enhancement of the classification of the

habitats.

Boundary conditions and requirements

Image type:

- Very High Resolution satellite imagery (desirable WorldView 2 type data; in case not available RapidEye data can be used)
- Colour infrared aerial photos for image segmentation
- Timing: At least two images acquired during early spring before leaf flush and an image in the post-spring period
- Access to digital elevation model (at least 25 m grid cells) and if available to LIDAR DEM.
- Habitat types: no constraints on habitat types. However the habitats must be contrasted (in terms of radiometry and structural characteristics) and not subject to frequent environmental changes (e.g. variability in the temporality of flooding levels, sensitivity to soil moisture, etc.).

Costs

Data/Operator/Software	Cost (for 100 km²)	Task	Duration (in days)
Aerial photos CIR	30 €	Mosaicking and Segmentation	1
Experienced ecologists	300 €	Photointerpretation (selection of training sets)	1
		Field surveys	1
Digital Elevation Model (25 m)	Free	Computation of topographic variables	0.25
WorldView-2	2 600€ (archive) 3 200€ (tasking)	- Preprocessing - Computation of textural and spectral features	0.5
		-Running the SPLSDA model	1
Operator	320€/day	-Data preparation -Image analysis -Validation	5 * 320 = 1600
Software: • Ecognition	Approximately 15 000€		
- Orfeo ToolBox	Free	- As an alternative to Ecognition for image segmentation - Image processing	
• R	Free	- SPLSDA variable selection and classification model - Computation of topographic variables	

		- Spectral indices	

3.3 EFTAS FERNERKUNDUNG TECHNOLOGIETRANSFER, GERMANY

Site service *Habitat mapping and structure monitoring*

Subservice aim and synopsis

The aim of this subservice is to monitor extent and quality aspects of lowland habitats in the Western-European plains. The subservice was developed for a large study area in Schleswig-Holstein, Germany. Indicators for grassland, wetland and heath site developments were developed. They addressed the following habitats and their conservation status:

- 6410 *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils
- 6510 Lowland hay meadows
- 7120 Degraded raised bogs still capable of natural regeneration
- 7140 Transition mires and quaking bogs

The following habitats were **only addressed in** the **transfer exercise Kalmthoutse Heide, Belgium:**

- 2310 Dry sand heaths with *Calluna* and *Genista*
- 2330 Inland dunes with open *Corynephorus* and *Agrostis* grasslands
- 4010 Northern Atlantic wet heaths with *Erica tetralix*
- 4030 European dry heaths

Measured indicators of conservation status are:

- Vegetation cover and land use intensity changes: 6410, 6510, 7120
- Bush/shrub encroachment: 7120, 7140

Only addressed in transfer exercise Kalmthoutse Heide, Belgium:

- Bush/shrub encroachment: 2310, 2330, 4010, 4030
- Horizontal structural diversity (cover and distribution of open soil, lichens/moss, typical species): 2310, 4010, 4030
- Cover of species indicative of recent (abiotic) changes or invasive species (e.g. *Molinia caerulea* or *Campylopus introflexus*): 2310, 2330, 4010, 4030

Status of service implementation

Heath and grassland indicator map

Original implementation: This approach was originally developed within the German R&D project DeCOVER (www.decover.info) over a Natura 2000 site in North-Rhine-Westphalia, Germany.

Implementation in MS.MONINA: Kalmthoutse Heide (Belgium)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=kalm

- Heath and grassland indicator map

Tree/Shrub percentage layer

Original implementation: This approach was originally developed within the German R&D project DeCOVER (www.decover.info) for heath and grassland habitats in North-Rhine-Westphalia, Germany. It was adapted to a wetland site covering a part of the Natura 2000 site "Moore der Eider-Treene-Sorge-Niederung (FFH DE 1622-391)" in Schleswig-Holstein, Germany.

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=eider

- Tree shrub percentage layer ETS wetland

Grassland information layers (relevant for 6210, 6410, 6510) (WP4)

These information products were generated as part of the WP4 state service developments. However, they could also be applied within existing Natura 2000 sites and thus act as site services. To support the classification and discrimination of different grassland types in Schleswig-Holstein several information layers were calculated. They can be used as indicator of land cover change and land use intensification over existing sites.
Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=mede

- Biomass information layer (IL): providing a indicator of vegetation vitality at a given (image acquisition) time
- Homogeneity IL: providing an indicator of spectral variability
- Linear structure IL: as an indicator of human activities (e.g. mowing, fertilizing, peat extraction)
- Mowing intensity IL: as an indicator of the number of mowing events detected (only partly tested, due to limited image time series)
- Slope IL: to indicate exposure
- Soil information ILs: extracted from existing soil maps, preferred soil types and qualities were converted into classifiable raster images

Method developments

Heath and grassland indicator map

- Adaptation from multi-temporal (combining Worldview-2 and RapidEye satellite images) to monotemporal approach (Worldview-2 only)

Tree/Shrub percentage layer

- Adaptation of classification rules and thresholds from heath/grassland site to wetland site
- Adaptation from multi-temporal (combining Worldview-2 and RapidEye satellite images) to monotemporal approach (Worldview-2 only)

User feedback

It was acknowledged that the site services could be complementary to existing (mostly field-based) routines and that they will improve the task performance and improve the efficiency of work processes.

Challenges and experiences

- The application and transfer of site services requires a close interaction with site managers to ensure the uptake and integration of site-specific environmental conditions.
- A limiting factor for an operational application is still the existence of adequate sensor data and timely field and ancillary data
- The developed services could not address the very specific criteria needed to distinguish single habitat types and conditions. They are mostly based on floristic components and changes, which cannot be

addressed operationally, yet. The example products provide (only) additional information to site managers. This is still a limiting factor from the user point of view.
- Very high resolution satellite images are still seen as too costly.

Boundary conditions and requirements

- Availability of very high spatial resolution images during vegetation period (0.5-2m)
- Field knowledge and reference samples to calibrate indicator classification, ideally from identical vegetation period

Costs

Image costs: WV-2 data (Standard Orthoproduct 1:12.000) = 41 US$ per km²

The site specific processing costs are highly site specific and influenced by

- the quality and quantity of reference data available,
- the size of the site for site specific adaptations needed to calibrate the image classifications are similar for smaller or larger areas, thus reducing the costs per square km for larger sites.

3.4 FLEMISH INSTITUTE FOR TECHNOLOGICAL RESEARCH (VITO) & RESEARCH INSTITUTE FOR NATURE AND FOREST (INBO), BELGIUM

Site service *Habitat mapping and status evaluation*

Subservice aim and synopsis

The aim of the habitat mapping and status evaluation subservice is to map single patches of Natura 2000 habitats and to evaluate their local conservation status. The subservice is applicable to:

Heathland and inland dunes (4010, 4030, 2310, 2330)
Coastal dune habitats (2110, 2120, 2130, 2150, 2160, 2170, 2180, 2190)

Measured indicators of habitat quality ('structures & functions') are:

Grass encroachment (2310, 2330, 4010, 4030),
Bush / tree encroachment (2310, 2330, 4010, 4030),
Vertical structure (2310, 4030) through differentiation of heathland age classes (young – aged – mixed),
Horizontal structure (2310, 2330) through presence of bare sand, mosses, lichens and *Corynephorus* grasses,
Sand dune fixation (2310, 2330) by grasses and mosses,
Encroachment by invasive alien species, i.e. *Campylopus introflexus* (2310, 2330, 4030).

Status of service implementation

Original implementation: Kalmthoutse Heide (Belgium)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=kalm

- Land cover and vegetation map of Kalmthoutse Heide, 2007
- Natura 2000 habitat map of Kalmthoutse Heide, 2007

Additional implementation: (1) Grenspark De Zoom-Kalmthoutse Heide (Belgium & the Netherlands)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=kalm

- Land cover and vegetation map of Grenspark DZ-KH: 2010, 2011 (June and Sept) and 2012

- Natura 2000 habitat map of Grenspark DZ-KH: 2010, 2011 (June and Sept) and 2012

Additional implementation: (2) Flemish Nature Reserve De Westhoek (Belgium)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=west

- Land cover and vegetation map of De Westhoek, 2011
- Natura 2000 habitat map of De Westhoek, 2011

Method developments

- Adaptations to cope with different types (esp. polygons instead of points) and lower numbers of field reference data
- Adapt remote sensing oriented classification scheme to site context
- Extension of BIOHAB-based segmentation rules from heathland specific to habitat generic rules
- Adapt habitat reclassification rules to site context

User feedback

- Potentially very useful output products for heathlands in frame of conservation status reporting
- Opens up possibilities for change detection (still to be done)
- Coastal dune outputs so far unfulfilling, further research needed

Challenges and experiences

- Design of a site-proper classification scheme is crucial and requires substantial input from user
- Dependency on high amount of very recent field data needs to be brought down
- More extensive testing for reliability needed (esp. in light of change detection)
- Applications in coastal dunes still in R&D-phase, not ready for operationalization yet

Boundary conditions and requirements

- Image requirements: hyperspectral, taken in vegetation growing season (May-Oct), spatial resolution approx 2-5 m
- Reference data requirements: fair amount of field reference data needed, representing all classes to be mapped, coinciding as much as possible with image acquisition date
- Habitats: heathland habitats in Atlantic (and probably also Continental) biogeographical region

Costs

- Rough estimate of costs of application for a site of 100 km² (10 by 10 km): 50 kEUR
  - Airborne (manned) flight operations (stand by not included): 15 kEUR
  - Level 2 processing: 5 kEUR
  - Field work (approximately 200 plots visited and processed): 20 kEUR
  - Level 3 processing (based on existing development, new requirements not included): 10 kEUR

3.5 NATIONAL OBSERVATORY OF ATHENS (NOA) & GREEK BIOTOPE/WETLAND CENTRE (EKBY), GREECE

Site service *Habitat mapping*

Subservice aim and synopsis

The habitat mapping subservice of NOA was originally designed to map habitats of a wetland area according to a

nomenclature required by the user. In particular for the following habitats that are of user's interest.

- 1310: *Salicornia* and other annuals colonizing mud and sand
- 1410: Mediterranean salt meadows
- 1420: Mediterranean and thermo-Atlantic halophilous scrubs
- 6420: Mediterranean tall humid grasslands of the *Molinio-Holoschoenion*
- 92D0: Southern riparian galleries and thickets
- 92A0: *Salix alba* and *Populus alba* galleries

The ANAX tool (Advanced classification methods for inventorying and mapping protected areas using satellite imagery), developed at the National Observatory of Athens, is used for the classification of habitat types. The output of ANAX is a raster image file, in which each pixel is characterized by its class (mostly Annex-I habitat types).

Status of service implementation

Original implementation: Axios Delta, Greece

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=axios

- Axios delta habitat mapping with Kernel-based Reclassification algorithm

Additional implementations: Aliakmonas Delta, Greece

Link to SDI (same as Axios): http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=axios

- Aliakmonas delta habitat mapping with Kernel-based Reclassification algorithm

Method developments

- ANAX Kernel Re-classification (KRC) runs in a user friendly environment (compared to command line).
- The training sets can be any polygon shape (not necessarily rectangles).
- Validation polygons can also be selected for automatic evaluation of the result.

For Axios test site, the most representing habitat type is 1420. Its coverage percentage is quite high at national as well as at European level. The recommended strategic plan for Axios Delta considers its surface, one of the indicators for monitoring and assessing the coastal ecosystem structure and its conservation status. It is strongly affected by the management measures applied in the area (i.e. resource management as it is grazing, water management). As a result, its spatial structure creates a very complex pattern both because of its big coverage that naturally creates various patterns (i.e. water patches or patches of unvegetated substrates in between the vegetated area) and because of the human interventions, mainly along the riverbed where access is possible. Therefore, three subclasses had to be distinguished; (i) the vegetated part on the seasonally flooded area (upwards from the sea and along the riverbed) the most degraded part, (ii) the vegetated part on the low reaches of the delta, the less degraded part, and (iii) the big spaces of unvegetated salty crust substrate. This subanalysis increases the processing time, but it allows further spatial analysis in a GIS system which would be very useful in monitoring conservation status by measuring certain spatial indicators that help to translate the ratios of depredated and non depredated areas, density of vegetated areas, density of unvegetated areas etc.

User feedback

- General evaluation is 'Very Good'.
- High resolution habitat mapping of Axios Delta is considered as a valuable tool for monitoring habitat area as well as habitat spatial configuration.
- The product should cover the full NATURA 2000 site.
- Communication flow and integration into user's work process was seamless.

Challenges and experiences

- Wetland habitat types are mixed and each one may appear with various spectral signatures.
- To address these specificities the user had to be trained to photo-interpret the image and had to collect additional ground truth data and decide, together with the image analyst, on the appropriate subclasses that each habitat type should be further analyzed.
- KRC algorithm incorporates spectral and textural information analysis and is a robust classifier when applied to very high spatial resolution imagery for complex problems as in this wetland.
- Key information for wetland mapping is provided by the seasonal changes of the habitats, which can be identified from images acquired at the low and high water levels.
- ANAX is user-friendly software platform able to perform training, classification and accuracy assessment in the form of an error matrix.

Boundary conditions and requirements

Required input:

- WorldView-2 multispectral images of two dates: one before and one after the summer
- Field observations
- Existing reference data

Results suggest that the KRC algorithm applied to dual date WV-2 satellite imagery covering seasonal flooding, can support monitoring of Mediterranean wetlands to an extend depending on the environment complexity. This doubles the cost of EO data necessary for this kind of mapping.

Costs

Cost is mostly associated with time consumed to plan, perform and validate the classification. The time and cost are dependent on the experience of the user. Clearly, the selection of the training set is by far the most time consuming step of the process yet very important for the success of the validation. This is due to the involvement of different experts (ecologists, remote sensing scientists), the level of their knowledge on the area to be mapped, the availability of external sources of data (previous maps). A dedicated field trip can be considered necessary. In the case of wetlands, accessibility is limited in the majority of the area making in-situ inspections a complicated mission. Cost has to be evaluated on a case-by-case basis.

3.6 EURAC, ITALY

Site service *Alpine habitat mapping*

Subservice aim and synopsis

The aim of this subservice was to map alpine habitats. The following habitat types were considered:

Temperate heath and scrub (4060)
Natural and semi-natural grassland formations (6150, 6230, 6520)
Raised bogs and mires and fens (7140)
Rocky habitats and caves (8110, 8120)
Forests (9410, 9420)

For assessing the conservation status, a remote sensing-based disturbance indicator of shrub and tree encroachment was calculated. Specifically, the percentage of shrub and tree coverage in grassland habitats (6150, 6230, and 6520) is calculated based on the land-cover and habitat maps that are produced during the mapping procedure of the alpine habitats.

Status of service implementation

Original implementation: Rieserferner Ahrn Nature Park, Italy

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=rfa

- Spatial distribution of different habitats in the Rieserferner Ahrn Nature Park

Method developments

- The classification scheme was modified to include different types of habitats.
- The Support Vector Machine classifier was included in the method. In the original method two classification approaches were used, namely maximum likelihood and decision tree.
- The post-processing procedure was modified according to site characteristics.

User feedback

- The product is useful as a basis for preparing maps for new management plans and to gain an overview of the distribution of very extensive NATURA 2000 habitats.
- In the future it would be useful to map every two years NATURA 2000 habitats on the entire territory of the Autonomous Province of Bolzano to allow change detection analysis.

Challenges and experiences

- Reliable information is needed to modify the classification scheme according to site characteristics.
- Very good reference data as well as field surveys are necessary for collecting samples.
- Cloud free images are difficult to acquire in the alpine regions of South Tyrol. Topographic shadows are also prominent.

Boundary conditions and requirements

- Image requirements: multi-temporal RapidEye images (level 1B) acquired from May to October
- Reference data: For each habitat to be mapped, approximately 150 samples are required. Samples should ideally be collected during the time window in which the images are acquired.
- Habitats: habitats in Alpine biogeographical regions

Costs

3.7 UNIVERSITY OF BONN (UBO), GERMANY

Site service *Ordination-based habitat monitoring*

Subservice aim and synopsis

The aim of this subservice is the analysis of remotely sensed (hyperspectral) imagery to allow the mapping of compositional variation in (semi-)natural plant assemblages that are characteristic for a number of Natura 2000 habitat types. In contrast to techniques aiming at categorization by means of thematic classification, the implemented scheme makes use of ordination methods to extract major floristic gradients describing the prevailing composition of the considered observation area as metric variables. After linkage to the geometrically corrected hyperspectral imagery by partial least-squares regression, this results in a raster data map of the observation area representing model-based predictions of the vegetation's species composition.

The presented method was applied to areas in the Atlantic and Continental biogeographical regions and both

homogeneous and heterogeneous landscapes comprising Natura 2000 habitat types of a number of categories, including:

Inland dunes (2xxx)
Heath and scrub (4xxx)
Grassland formations (6xxx)
Raised bogs (7xxx)

The retrieved information can be utilized to evaluate the local conservation status of the considered area, including assessment of habitat quality and – by means of repeated observation – its trend of development.

Status of service implementation

Original implementation: Wahner Heide (Germany)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=wahne

- Species Composition Map 2011

Additional implementation 1: Kalmthoutse Heide (Belgium)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=kalm

- Species Composition Map 2007

Additional implementation 2: Döberitzer Heide (Germany)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=dober

- Species Composition Map 2008

Method developments

- Improved operability of map production
- Enhanced visualization of algorithm results

User feedback

- Not applicable

Challenges and experiences

- processing overhead for expected amount of data (high resolution hyperspectral imagery) not to be underestimated
- no operational identification of unwanted image features, i.e. residual cloud cover or image artifacts, visual quality control necessary
- streamlining of vegetation reference data challenging due to different sampling conditions, data collection criteria and varying quality standards
- operational identification of areas not applicable to service approach (i.e. forests) under research, yet not fully developed resulting in additional manual work

Boundary conditions and requirements

- Image requirements: hyperspectral imagery, spatial resolution approx. 2-5 m, acquired during vegetation growing season between May and September
- Reference data: field reference data collected during image acquisition period necessary
- Habitat constraints: only applicable to open land habitat types, especially heathland and grassland types as well as bogs in Atlantic and Continental biogeographical regions

Costs

The costs are currently high due to

- the necessity to acquire airborne hyperspectral imagery
- the necessity to collect field reference data

With the upcoming hyperspectral satellite data from satellites such as EnMAP costs will be less of an issue. Field data collection was about 3000,- EUR for 100 km². The costs for image pre-processing and analysis will depend on the data at hand. The final analysis steps (NMDS, PLSR, visualization) can be finished in few hours.

3.8 INSTITUTE OF GEODESY AND CARTOGRAPHY (IGIK), POLAND

Site service *Wetland monitoring*

Subservice aim and synopsis

The aim of the Wetland Monitoring subservice of IGiK is to identify, classify and map Natura 2000 habitats within lowland alluvial plains of the Continental biogeographical region. In the initial study site, the Biebrza National Park in Poland, the focus was on the following habitat types:

Xeric sand calcareous grasslands (6120*)

Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (6410)

Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) (6510)

Transition mires and quaking bogs (7140)

Alkaline fens (7230)

Central European lichen Scots pine forests (91T0)

Measured indicators of habitat quality ('structures & functions') are:

Bush / tree encroachment

Change of land cover / land use

Characteristics of vegetation through vegetation and backscattering indices

Status of service implementation

Original implementation: Biebrza National Park (Poland)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=bnp

- Map of wetland habitats 2011
- Map of wetland habitats based on radar data 2012
- Changes in vegetation structure 2012 (1)
- Changes in vegetation structure 2012 (2)
- Changes in vegetation structure 2012 (3)

Additional implementation: Döberitzer Heide & Ferbritzer Bruch (Germany)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=dober

- Map of wetland habitats

Method developments

- Adaptation of remote sensing based classification scheme to species composition existing within wetland area
- Refinement of classification algorithm due to changeable environmental conditions within wetlands

- Incorporation of information derived from radar satellite data for studying changes in vegetation structure

User feedback

- Potentially useful output product for mapping wetland habitats
- Very-high-resolution satellite data give possibilities to monitor vegetation changes within wetland areas
- Careful timing of satellite data acquisition must be secured in order to monitor wetlands effectively

Challenges and experiences

- Application of site-proper classification scheme matched with user needs is essential for operational use
- Highly reliable classification method based on satellite images requires large amount of recent field data for validation purposes
- More extensive verification of the prepared method, due to vegetation seasonality, is needed

Boundary conditions and requirements

- Image requirements: multispectral, very high-resolution data (1 – 4 meter ground resolution), collected within vegetation growing season (May – September)
- Reference data requirements: suitable amount of reference field data representing vegetation classes is needed, collected close to image acquisition date
- Method dedicated to wetland habitats located in the geographical zone with temperate climate

Costs

Costs of application – production of map of wetland habitats - for a site of 100 km² (10 by 10 km), including VHR satellite images, reference data, software and personnel costs is ca. 6500 EUR.

3.9 EOVISION, AUSTRIA

Site service *Alpine habitat assessment*

Subservice aim and synopsis

The aim of the subservice is to provide Earth Observation based information on habitats within Alpine regions of interest, with a specific focus on forest habitats. The approach used for this service was based on the work done previously within the EC FP5 project EON2000+, and has been applied already to habitat analyses in the National Park Hohe Tauern (9410 *Picea* forests, 9420 Alpine *Pinus cembra* forests) and in the Hochkönig region (9410 *Picea* forests, 6170 Alpine calcareous grassland), both in Austria.

A major challenge for the application of EO data classification methods in Alpine regions is the fact that illumination by the sun varies strongly, depending on the angle between the solar irradiation and the normal vector of the slope. This makes the application of specific topographic normalization procedures inevitable. Additionally, in some cases, where habitats were found in specific elevation ranges or expositions, it proved useful to integrate the elevation as provided in the digital elevation model (DEM) as an additional information layer for the classification procedure.

Status of service implementation

Original implementation: Kalkalpen

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=kalk

- Land cover map Kalkalpen, 2011
- Land cover map Kalkalpen, 2012

Method developments

- Adaptations to integrate DEM in classification procedure
- Integration of open source segmentation tool
- Adaptation of classification rules to specific site

User feedback

- Potential usefulness of product for actual forest habitats acknowledged
- Detailed analysis to be done

Challenges and experiences

- Rough terrain causes difficulties in orthorectification (quality of DEM important)
- Very challenging situation with respect to shadowing by terrain and by boundaries of forest stands
- Classification difficult in transition areas from vegetation to rocks at higher altitudes
- Challenges due to different phenology at different altitudes
- Vegetation period at higher altitudes very short – short acquisition window

Boundary conditions and requirements

- DEM
- Multispectral, multitemporal VHR data (resolution 2m)
- Reference data: sufficient ground truth, from field assessment (preferably) or very recent biotope inventory

Costs

- Costs calculated per year and for 100 km² (no linear scaling with area, as staff cost increases slower)
- GMES context: approx. € 3,300 (no VHR data cost; DEM cost: € 300; field trip for ground truth, distance to office 200 km: € 180; personnel, 5 person days: € 2,800)
- Normal business case: approx. € 12,600 (as above, plus tasking for 2 WV-2 scenes: € 7,600)

Site service *Alpine habitat change assessment*

Subservice aim and synopsis

The aim of the service is to provide Earth Observation based information on the dynamics within habitats in Alpine regions of interest, with a specific focus on forest habitats. The approach used for this service was closely related to the one described above (Alpine habitat assessment), and as such based on the work done previously within the EC FP5 project EON2000+. The method was applied already to habitat analyses in the National Park Hohe Tauern (9410 *Picea* forests, 9420 Alpine *Pinus cembra* forests) and in the Hochkönig region (9410 *Picea* forests, 6170 Alpine calcareous grassland), both in Austria.

For habitat change analyses two methods are applied: first, change classification based on classified satellite scenes from two different acquisition dates, and second, classification of the combined image stack. Both approaches have their specific advantages and disadvantages and their application depends on the specific situation.

The information provided as a result comprises change maps indicating which habitat patches have changed in

which way, statistical information on the changes and, if required and possible, information on the reason of changes.

Status of service implementation

Original implementation: Nationalpark Kalkalpen

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=kalk

- Land cover change map Kalkalpen 2011-2012

Method developments

- No specific development; special treatment of shadow areas

User feedback

- Potential usefulness of product for quick assessment of changes of/within habitats acknowledged, considered useful to be better able to focus awareness to relevant areas within the site
- Detailed analysis yet to be done

Challenges and experiences

- As above

Boundary conditions and requirements

- As above

Costs

- Work is based on assessment for the land cover in the two years to be compared
- Additional cost for change analysis: € 800 (essentially 1.5 person days)

3.10SPECTO NATURA (SN), UNITED KINGDOM

Site service *Land cover mapping*

Subservice aim and synopsis

This service represents an approach to the extraction of information from aerial photography and very high spatial resolution (VHR) satellite data in support of mapping and characterization across a broad range of habitats. The approach was an extension on other work using VHR data in combination with object-based data structures and has been used for wetland restoration monitoring as its test case.

Due to the limited spectral information content and the extremely high level of spatial detail within VHR datasets this approach employs a simple scene component analysis to extract the maximum amount of spectral information from the data and an object-based contextual spatial framework to extract the spectral information within a realistic landscape structure.

Status of service implementation

Original implementation: Wicken Fen, UK

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=wicke

- wicken-DUAL - Scene component map using SPOT-5 and AP from 2012

- wicken-SC2007 - Scene component map using AP from 2007
- wicken-SC2012 - Scene component map using AP from 2012
- wicken-PHENO - Phenological indicator map using multi-date DMC from 2010
- wicken-RAO - Rich attributed objects summarising raster data

Additional implementations: (1) Salzachauen Reserve, Austria

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=salza

- salz-SC2011 - Scene component map using WV-2 from 2011
- salz-RAO - Rich attributed objects summarising raster data

Additional implementations: (2) Sierra Nevada, Spain

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=mesp

- Juniper2003-11 - Object grid (20 m) with proportions of Juniper and Shrub scene components from 2003 and 2011 and their changes
- Juniper2003 - Juniper and Shrub scene components from 2003
- Juniper2011 - Juniper and Shrub scene components from 2011

Method developments

- Adaptations to cope with different sensor types, moving from aerial photograph to satellite VHR data.
- Adaptations to new habitat types, moving from wetlands to wet forest to dry scrub.
- The outputs were expanded from simple proportions of scene components to indicators that summarise habitat characteristics (wetness, heterogeneity and shade fraction).
- Incorporating change detection, dealing seasonality and data quality.

User feedback

- The original user was happy with the approach, but identified areas for improvement.
- The scene component approach did not always align with the perceptions of some users who expected the product to contain "clean boundaries and finite classes" regardless of the true nature of the landscape.
- This subservice required close integration between the service provider and the user to maximise its potential, and thus requires a certain amount of training / familiarisation.
- The indicators were seen to be potentially useful, but again they required explanation as they do not fit with the standard habitat mapping approach.

Challenges and experiences

- The key challenge is to make sure that the end users are fully integrated in the process. The time and effort involved is well rewarded by the outcomes of the final product.
- As always the acquisition of suitable EO data remains a challenge.
- As the approach is used for monitoring purposes the issues of change detection continue to be challenging particularly when dealing with seasonality and interannual variations.
- The approach relies on management objects to summarise the results, but when dealing with dynamic habitat patches it is necessary to also include image segmentation into the overall object structure.

Boundary conditions and requirements

- Preferably multi-date (winter or spring and summer) VHR (< 5 m).
- Management objects to provide a context for the analysis.
- Close engagement with the end users prior to and during the production.

Costs

- Assume a site of 100 km² (10 by 10 km), excluding end user staff costs.
- Images – €2000, 2 VHR images at ~€1000.
- Software – €3000 for a commercial system, could be open source, one-off cost, not included in total.
- EO expert staff costs – €2000, 6 days at €400 / day, includes 1 whole day and 1 half day meeting with user.
- Total cost ~ €4400 or €44 / km^2

3.11 LUFTBILD UMWELT PLANUNG (LUP), GERMANY

Site service *Habitat monitoring with hyperspectral data*

Subservice aim and synopsis

The aim of this subservice is to map Natura 2000 habitats and plant associations. In the initial study site, the Döberitzer Heide in Germany, the focus was on the following habitat types:

Dry sand heaths with *Calluna* and *Genista (2310)*
Inland dunes with open *Corynephorus* and *Agrostis* grasslands (2330)
European dry heaths (4030)
Molinia meadows on calcareous, peaty or clayey-silt-laden soils (6410)
Lowland hay meadows (6510)
Hydrophilous tall herbfringe communities (6430)

Measured indicators of conservation status were:

Bush/tree encroachment
Change of land cover / land use
Grass encroachment
Plant associations (indicating species composition)

Status of service implementation

Original implementation: Döberitzer Heide (Germany)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=dober

- Habitat Types Distribution 2008

Method developments

- No new method developments were possible since no actual hyperspectral data were available during the project

User feedback

- Products regarded as very useful for the Natura2000 monitoring
- Unfortunately data costs are much too high at the moment

Challenges and experiences

- Extensive pre-processing requirements need to be simplified and standardized

Boundary conditions and requirements

- Image requirements: hyperspectral data with high to medium spatial resolution (e.g. AISA or APEX)
- Reference data requirements: spectral field measurements
- Habitats: applicable to all habitats

Costs

- Image costs: approx. 20.000 to 30.000 €
- Reference data: approx. 4 field days (32 hours * 49 €) = 1568 €
- Image pre-processing and analysis: approx. 10 days (80 hours * 49 €) = 3920 €
- Extra costs: a field spectrometer is needed, special software is needed

Site service *Knowledge-based heathland monitoring*

Subservice aim and synopsis

The aim of this subservice is to evaluate heathland habitat types and to assess indicators of their conservation status as well as to derive change maps (habitat type change, conservation status change). The service works with a knowledge-based classification.

Studied habitats are:

Dry sand heaths with *Calluna* and *Genista* (2310)
Inland dunes with open *Corynephorus* and *Agrostis* grasslands (2330)
European dry heaths (4030)

Used indicators for deriving habitat quality are:

Bush / tree encroachment
Grass encroachment
Percentage of open soil
Area dominated by cryptogams
Area covered by *Calluna*-heath
Area covered by *Cytisus*-heath
Area covered by dry grassland

Status of service implementation

Original implementation: Döberitzer Heide (Germany)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=dober

- Conservation Status Assessment Indicators 2011
- Wood cover change from 2004 to 2011 in percent
- Conservation Status 2011

Additional implementation: (1) Kleine Schorfheide (Germany)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=schor

- Habitat Types Distribution 2011
- Conservation Status Assessment Indicators 2011
- Conservation Status 2011

Additional implementation: (2) Kalmthoutse Heide (Belgium)

Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=kalm

- Conservation Status Assessment Indicators 2012

Method developments

- Adaptations to integrate new indicator classes (e.g. wet heath)
- Adaptations were also necessary transferring the landuse-code of the a-priori data to our coding system

User feedback

- Products regarded as very useful for the heathland monitoring and already operationally in use
- Especially useful for change detection purposes

Challenges and experiences

- Good satellite image quality is needed (low viewing angle)
- Recent field data are necessary for a reliable accuracy assessment

Boundary conditions and requirements

- Image requirements: multispectral, very high spatial resolution satellite images (e.g. QuickBird, GeoEye, WorldView 2, Pleiades), at least 0.8 m spatial resolution of the panchromatic sensor needed
- Reference data requirements: at least 20 sites for every class needed for accuracy assessment and/or knowledge base adaptations
- Habitats: heathland habitats in Continental and Atlantic biogeographical region

Costs

- Image costs: approx. 20 € per km² = 2000 €
- Reference data: approx. 2 field days (16 hours * 49 €) = 784 €
- Image analysis: approx. 4 days (32 hours * 49 €) = 1568 €

Site service *Habitat monitoring with multi-temporal data*

Subservice aim and synopsis

The aim of this subservice is to map Natura 2000 habitats and plant associations with multi-temporal satellite data (medium spatial resolution) on the basis of phenological signatures.

Studied habitats are:

Dry sand heaths with *Calluna* and *Genista* (2310)
Inland dunes with open *Corynephorus* and *Agrostis* grasslands (2330)
European dry heaths (4030)
Molinia meadows on calcareous, peaty or clayey-silt-laden soils (6410)
Lowland hay meadows (6510)
Hydrophilous tall herbfringe communities (6430)

Used indicators for deriving habitat quality are:

Bush/tree encroachment
Grass encroachment
Plant associations (indicating species composition)

Land use intensity
Status of service implementation Original implementation: Döberitzer Heide (Germany) Link to SDI: http://msmonina.vgt.vito.be/geonetwork/srv/en/main.home?category=dober - Habitat Types Distribution 2011/2012
Method developments • Implementation of phenological signatures into classification procedures
User feedback • Products regarded as very useful for the Natura2000 monitoring • Unfortunately data costs and amount of work to establish the libraries are much too high at the moment
Challenges and experiences • Extensive library with spectral field measurements of every plant association and its phenology is necessary • Habitats with strong human use (e.g. repeated mowing) cannot be classified with phenological signatures at the moment, more R&D needed
Boundary conditions and requirements • Image requirements: multispectral and multitemporal data with medium spatial resolution (e.g. RapidEye), at least 5 images throughout the phenological cycle needed • Reference data requirements: a spectral field library with at least 5 measurements throughout the phenological cycle for every plant association • Habitats: useful for all habitats with low human interaction and strong phenological aspects
Costs This is hard to estimate since the field work required to build up the spectral library is very intense. Later on, not that much field work is needed once the library is established.

4 FURTHER STEPS TOWARDS AN OPERATIONAL SITE LEVEL SERVICE

From the developments within WP5 (MS.MONINA Site), it is clear that it is technically feasible to apply most subservices to a (much) wider range of habitats and regions than those in which they were initially tested. This opens opportunities to develop (and commercialize) an operational system that offers biodiversity-related map products to users throughout Europe. How exactly these services will be offered to clients is a part of the business plan of the institute or company that will further implement the service. This issue was broadly addressed within the consortia and general directions will be presented in the final review meeting. The details of the complete process chain are therefore not provided, but a conceptual outline with the most crucial steps of the MS.MONINA site-level service is provided in Figure 1.

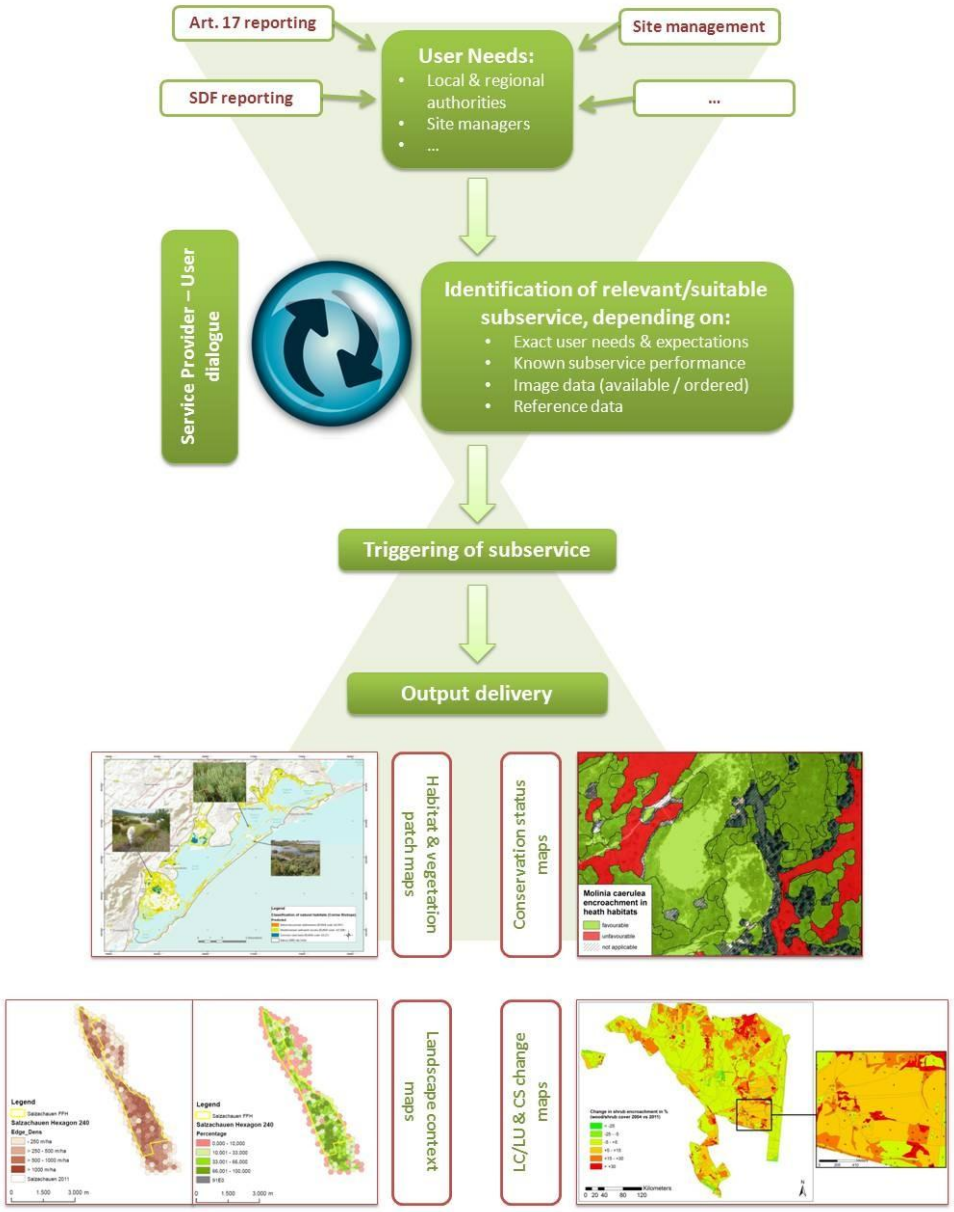

Figure 1: Concept of the MS.MONINA Site service, illustrating all major steps of the process chain

The MS.MONINA Site level service will provide on-demand geo-spatial information on nature protection sites to various users, such as site managers, local and regional authorities, etc. Thanks to a variety of different subservices, the service can deliver a broad range of information outputs relating to natural habitats, to suit user needs stemming from various policy requirements (e.g. Habitats Directive Art. 17 reporting, Standard Data Form reporting, site management,…), in probably all biogeographical regions of Europe.

The diversity of information outputs can roughly be categorized in:

- **Wider landscape context maps**, indicating e.g. overall landscape-configuration, fragmentation,…
- **Maps of habitat patches and vegetation types** (ranging from broad habitat groups to Annex I habitats and even subtypes)
- **Maps of conservation status** of habitats and areas, based on remote sensing of meaningful indicators (e.g. tree encroachment in open habitats, invasive species, soil moisture, land use intensity,…)
- **Change detection maps** of land cover, land use or conservation status indicators

The site level service can be triggered by a request from a user, after which a service coordinator examines the request and identifies suitable subservices and outputs. In an interactive dialogue, the user and service provider(s) subsequently match exact user requirements and expected outputs, to avoid misunderstandings and unrealistic expectations. Next, required image and reference input data are collected and the subservice is activated, leading eventually to the delivery of the output product to the user. Note that the process of service activiation is described in more detailed way in case of the EU-service (Deliverable 3.4) as well as in the Service portfolio online handbook (Deliverable 8.9).

Some additional challenges will undoubtedly pop up when integrating all subservices into a single, operational site-level service. The following aspects were (briefly) discussed within MS.MONINA:

User interface

Given the complexity of both biodiversity needs and Earth Observation techniques, it is doubtful whether a classical 'product browsing and ordering' approach will work. The proposed structure of the MS.MONINA site level service therefore acts as an **inspiration guide** for some possibilities, but the final output will be shaped after a dialogue between the service provider and the customer. This tends to be on individual basis for every case because it depends on the client's needs, the availability of data (both EO and reference data), and also the level of understanding between the service provider and client. This last aspect will be facilitated when service providers are familiar with the type of habitats the customer is managing and the biogeographical region where they are active, when customers have at least basic knowledge about Earth observation, and when they speak the same language both technical and colloquial wise.

Selecting the optimal subservice

Different service providers offer similar output types for the same habitats (up to 8 different subservices for the same type of output). Some of these are more cost-efficient than others, and in an ideal operational scenario, the most efficient and effective tool should be selected. Some of these aspects are discussed in the comparative analysis of the subservices (Deliverable 5.4).

Intellectual property rights

Private companies (here: SMEs), universities, governmental and non-governmental institutes have different visions on how to deal with the intellectual property rights. This has to be clearly understood when algorithms

from different partners are integrated into a single service. A general understanding of consortium partners in this respect is reflected in Deliverable 8.1 (IPR strategy & scientific dissemination plan).

Cost calculations and pricing

An indication of the producer's cost level is provided in the fact sheets of the subservices (§ 3 above), and Deliverable 5.4 provides an exploratory analysis of production costs in relation to demand, workload, equipment, etc. However, in a real-world situation, a complex interaction of level of details, size and location of the area of interest, the preferred time window, etc. as well as the business strategy of the company or institute, will further influence the eventual market price. At this time of point, neither service providers nor users/clients do have a clear understanding of how much it is appropriate or worth to pay and how much they can potentially save (in terms of costs and money) as compared to traditional ground-based surveys. In general clients would expect product prices which tend to be lower than existing contracts, but with an equally high quality level. From what was derived from the user feedback questionnaires and personal interviews, only the fact that information could be provided more frequently and steadily potentially outbalance the potential trade-off in terms of quality.