eurisy
acting collectively to bridge space and society

EURISY REPORT

Forest and biomass management using satellite information and services

This document was produced by Eurisy with kind contribution, support, and advice from:
Mr. Jan Bocian, Research Innovation Group Sp. z o.o.
Prof. Katarzyna Dabrowska Zielinska, Polish Institute of Geodesy and Cartography
Mr. Heinz Gallaun, Joanneum Research
Mr. Vladimir Gancz, ICAS (Romanian Forest Research and Management Institute)
Mr. Tim Green, European Forest Institute
Dr. Filip Hajek, Forest Management Institute (ÚHÚL), EARSEL
Prof. Barbara Koch, University of Freiburg, Germany
Prof. Steffen Kuntz, Astrium GEO / Infoterra GmbH
Dr. Stefanie Linser, Environment Agency Austria (EAA)
Mr. Ion Nedelcu, Romanian Space Agency (ROSA)

In cooperation with: MORE 4 NRG, INTERREG IVC

With the support of: esa

Contents

1. Background

This document is part of Eurisy's collaboration with the consortium of regional authorities involved in MORE4NRG, an INTERREG IVC project aiming to favour the exchange of good practice and experience on the topic of sustainable energy.

Eurisy's work with MORE4NRG focused on forest management and biomass in particular, contributing new ideas as to how satellite services can contribute to sustainable local energy strategies.

The topic of forest and biomass management was chosen in collaboration with Maramures County Council, one of the partners in the Consortium. Indeed, a scoping exercise with stakeholders from Maramures on the one hand (County Council, Energy Agency, SMEs, Forest Park Administration) and forest and satellite service experts on the other, has revealed the far-reaching environmental and socio-economic implications of the forest resource locally.

2. Satellite information and services: some useful definitions

Information derived from satellite imagery is the result of interpreting raw data collected from satellite sensors via remote sensing to produce quantitative and qualitative information about objects and features on Earth, such as land use, vegetation density, hydrological resources and others. This information is usually integrated in **Geographical Information Systems (GIS)**, which allow the users to consult, edit, analyse, share, and display geographic information and aliment other computer-interfaces, such web-platforms, which are suited to users not familiar with GIS environments. **Satellite navigation services** and **Location-Based-Services (LBS)** employ the capacity of satellites to precisely determine the position of fixed or moving objects in space and time. Applications are vastly used in transport and fleet management, but also in referencing any data collected on the field through mobile devices (i.e. where biomass is located and its qualities). **Value-Added Service Providers** are either private or public organisations that specialise in the acquisition of satellite data, its processing, and the delivery of satellite-derived information (more often than not satellite data is combined with other data sources in doing so). In the case of the satellite navigation (satnav) services, service providers offer the application – i.e. the software, as part of an IT system, and/ or the mobile devices used in the field.

3. Satellite information for forest and biomass management

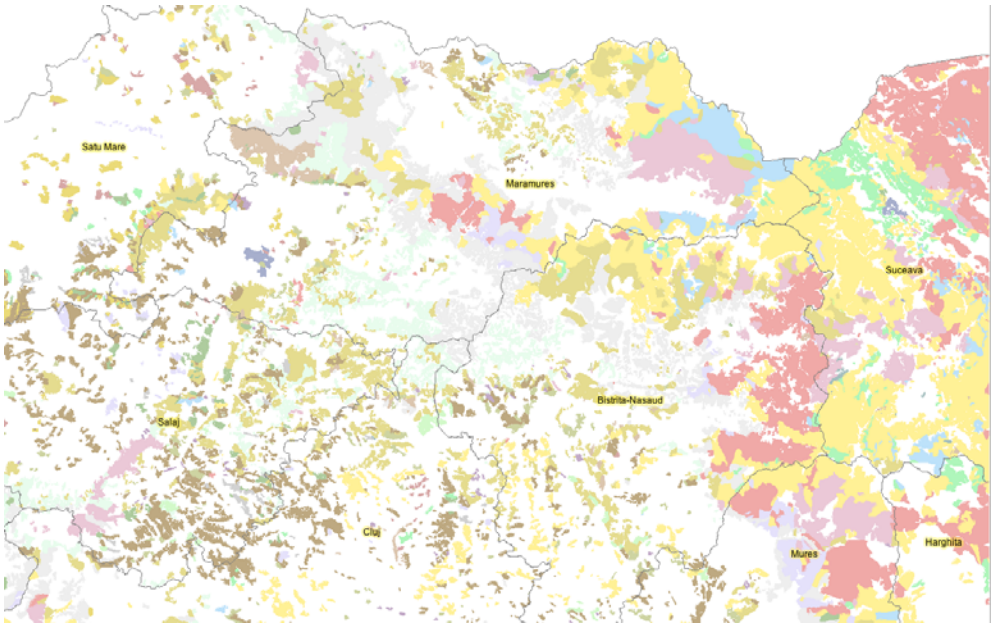
In the framework of GMES (Global Monitoring for Environment and Security) the European Commission invests in making the benefits of satellite imagery capacities available to European users. **GSE Forest Monitoring,** a specific programme that addresses forest management needs, is one part of GMES. Under this programme, a series of operational satellite services have been developed to support decision-making and sustainable forest management, on a global, national and sub-national scale.

Furthermore, a series of operational **satnav applications are already available**, as Europe prepares for the launch of Galileo-enabled services. Satnav applications are used in particular for operational field work and logistics, such as collecting information about the

forest and biomass resource in the field, or optimising pellet production chains from the forest to the pellet factories.

Operational services for environmental reporting and forest management, can be used by organisations on a regional, national and international levels in order to support decision-making and to improve policies that enable:

- sustainable forest management (inventorying, monitoring, rapid mapping in case of incidents such as fire, storms etc)
- compliance with specific protocols and binding conventions, such as Natura 2000
- related user- or policy-driven environmental and economic activities, such as biomass production)



General forest vegetation map covering the Maramures Region, Romania

a. How forest information is produced using satellite data

Generally, satellite images with a resolution ranging between 1m (allowing the identification of single trees) up to 30 m are used to provide a base layer of reference information (a forest map). Often, these satellite images already exist (e.g. on European level from the years 2000, 2006 and 2009, respectively which were acquired to support the European CORINE land cover assessment) and can be used free of charge for forest mapping purposes. Also, it is to be noted that archive imagery is much cheaper than new ordered imagery.

The forest cover information can be deployed in order to establish so-called "reference plots or field samples". These assigned plots can be visited by foresters in the field to collect data which cannot be recognised directly by remote sensing (e.g. biomass, increment, stand volume, timber quality, soil and growth conditions, carbon stock potential etc.). In addition, the field plots can be used to verify the forest information identified in the satellite data.

b. Some advantages of forest mapping using satellite data

NB. The "art of remote sensing" is to select the most appropriate methodology in terms of resolution and thematic content. The analysis of the level of detail required, as well as the context in which it will be used (existing information, existing tools, human resources,

organisational issues, property of the data, etc.), is an absolute pre-requisite to work out the optimal solution for a user in a given situation.

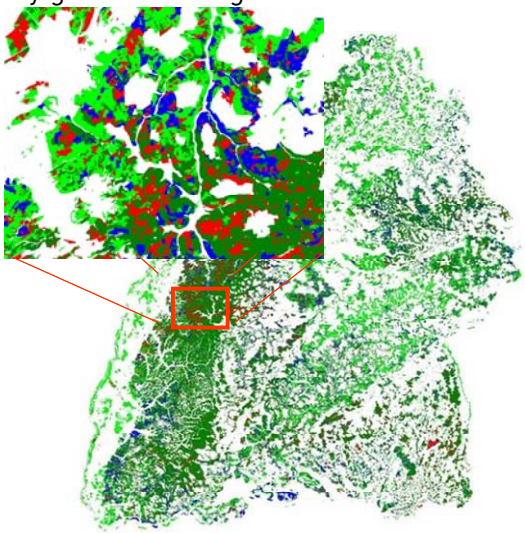
This being said, forest inventories using a combination of satellite-derived and other types of information can be both more accurate and more efficient than conventional methods. The CORINE Land Cover Map for Europe showed that one of the largest change occurred for the forests area. The updated information is crucial for proper forest management and assessment of biomass. For instance they allow for:

- **the collection of detailed information at a given scale more frequently** (forest inventories are typically updated every 10 years, satellite information enables more frequent updates, for instance every 3 years)
- **significant cost reductions in comparison to field surveys or aerial information alone**. This is particularly relevant for commercial activities related to sustainable forest use, but also to spot illegal logging, to determine damage from forest fires, storm damages or other natural catastrophes, or when forest information needs to be updated for repetitive biomass inventories. Here, field visits can be reduced to only those sample plots where remote sensing shows that a change has occurred;
- **the reduction of sampling errors, and the total number of field samples, leading to further cost reductions**.
- **more opportunities to create economies of scale and cost efficiency as more stakeholders use the same source of information**, in addition to the obvious advantage in terms of integration and coordination. A satellite image could be used for multiple aims, beside forest management, especially at very high resolution: transport network cartography and management, land use/land cover mapping, town/villages development planning and management, etc.
- **the transition from always limited (i.e. expensive) information derived statistically from field sampling to continuous coverage over large areas**;

4. Good Practice: use of satellite information by regions

a. Natura 2000 reporting in the State of Baden-Württemberg, Germany

The state of Baden-Württemberg covers an area of approx. 30,000 km2 whereas approx. 14000 km2 are covered by forests. Although there is a very good knowledge on state owned forests, a lot of information is lacking on privately-owned forests. In 2003 the State was required to report on NATURA 2000 sites in less than two months.



Given the time imperative, satellite information was chosen as a solution and the forest was thus mapped within 6 weeks. It was deployed by the state forest service to identify old deciduous stands with a high natural value, which were then visited in the field.

b. Interregional and international protection of drinking water resources in forest areas: Province of Carinthia (Austria), and Slovenia

The Forest Department of Carinthia and Slovenia are both concerned by the water resources in the transborder region of the Karawanken mountains. While in the Alps water is still an abundant resource, the preservation of the origin of drinking water reservoirs, mainly located in the forested areas and the protection of those areas is essential for Austrian and Slovenian neighbours.

Sharing knowledge on their resources and coordinating their protection strategies and actions was a main concern for stakeholders on either side of the border. Together, they have worked in the framework of INTERREG III A on a project with the objective of mapping and classifying the forest parameters such as tree species distribution, crown coverage and age classes over a transborder region of 90.000 hectares, using satellite information. The derived forest information has been inserted into an expert system as one of many other variables. It enables the planning authorities as well as the local foresters to identify deficits in forests and to take countermeasures if necessary. Furthermore, the information thus obtained is used to define shared goals for the forest stand structure regarding forestry policies and multi-purpose forest management with the main target of protecting drinking water sources. The project had a strong relevance to the European Water Framework Directive.

c. Mapping protection forests in the Province of Salzburg, Austria

Given the relief of the Province of Salzburg, Austria, forests have a strong protection role against avalanches and stone falls in steep alpine areas. It is therefore essential that the appropriate preventive measures to maintain the forest and its protective role can be implemented by forestry and agricultural authorities on the local level.

While previously relying on aerial imagery, the Forestry Management Dept. of the Province decided to commission a forest inventory on a regional scale using satellite data, which provided a less costly solution, with improved precision. The following indicators were mapped: forest contours, forest types and species, natural age classes and clear cuts.

The cartography allowed the authorities to have a synoptic view on the composition and the state of the forest and to develop framework guidelines for forest management strategies.

The protection forest development planning (WEP) is based on the Austrian forest law. The derived forest layers have been inserted into the GIS and are still used by the planning authorities as well as by local foresters.

d. Biomass and potential assessment and production planning in the Voivodship of Lodz, Poland

The Marshal's Office of Lodz Voivodship, through its Department for Economy and the Department for Agriculture and Environmental Protection, and in partnership with pellet company Dalkia, are working on a project where remote sensing is being employed for two objectives:

- for a study on where land use can be converted for willow plantations, for pellet production
- to understand how biomass potential and how biomass sources evolve over the year

The project was initiated in 2010, and according to the result of the study, the first willow plantations should take place in 2012.

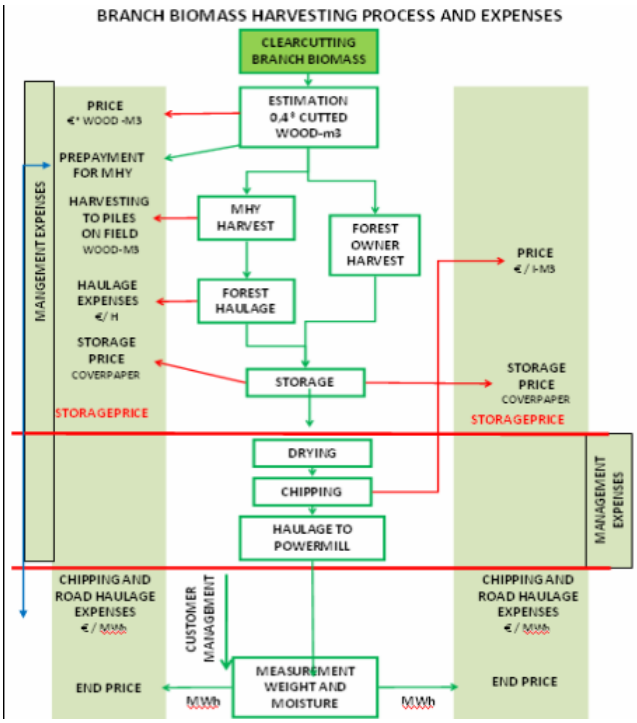
The advantages of satellite-based information are that they enable the Voidvodship to reconcile economic with socio-economic and environmental imperatives. In fact, the furniture sector is quite dynamic and employs many. Agriculture is also developed, and a lot of the land is used for food production, thus land use for pellet production must not compete with land use for food production. Willows therefore must only be planted in poor soils that are unsuitable for agriculture. Similarly, pellet production should be organised so as not to compete with wood-plate trade, which is more profitable. Potential evaluation ensures that pricing mechanisms prevent that from happening.

e. Use of satnav applications for biofuel production optimisation by the Forest Management Association Päijät-Häme, Finland

The Forest Management Association Päijät-Häme groups 7188 forest owners and covers 252000 hectares of forest. Annual cuttings total 1,55 million m^3 for an annual production of 475 GWh/year. Wood is delivered to 6 major energy utilities.

This supply chain is managed using a satnav application and an IT platform which is collectively used by all the actors of the supply chain: the forest owners, the buyers, the harvesters in the forests and the transport companies.

The satnav application allows the storing of data on the location of the wood and spruce, and their qualities, such as the moisture content. Based on this type of information, the itineraries of collecting trucks are calculated automatically so that they are most efficient. Contractors use the service as operational management tool as well: for stock-keeping, reporting, invoicing and contract monitoring purposes.



5. Recommendations for Local and Regional Authorities

- Large parts of European forests belong to private or public owners. This said, the way the forest is managed has its most immediate effect on the local population – both from an environmental and economic point of view. Hence, the forest resource should be accounted for in local policies. This requires local leadership and a long-term vision for the region.

- In order to optimise the use of modern information technologies, the more local stakeholder organisations (agencies, SMEs, NGOs etc) are involved, the better. This generates economies of scale, gains in coordination and cost efficiency as well as new ideas on the use/protection of the forest resource. Consulting with local stakeholders before setting up a project is paramount in making sure that current and future needs are taken well into account and prioritised.

- Innovation and the Knowledge Society are the driving forces of today's economy. The focus of local innovation policy should therefore be both on creating favourable framework conditions for the future implementation of innovation and its take-up by local economic actors, and on leading by example by using operational innovative technologies to help solve local problems of today

- Satellite information and services are cost-effective, environmentally friendly and suitable tools to create the knowledge necessary for informed, integrated management and the protection of forests, taking into account their multifunctional role related to biodiversity, natural resources, economical value, CO_2 storage and protective functions.

  Independent and frequent monitoring of large areas from space allows faster and more comprehensive reactions. This becomes even more important with respect to the expected increase of more and stronger weather anomalies (storms, draught, fires, floods) a consequence of global warming. Here, satellite information and services can contribute to become not only better prepared but to improve the mitigation of global warming impacts in the near future and to provide quickest possible overview and analysis of the damaged areas.

  Obtaining and sharing this knowledge is crucial for involving and coordinating stakeholders who may otherwise have conflicting interests (e.g. purely economic VS environmental rationale).

- The trend is towards a generalised use of these technologies, under the impulse of the European Union; regions who wish to stay abreast with the latest advances can already be proactive about adopting these new technologies and capacity building, as shown in the examples above.

Eurisy is mandated and financed to support local and regional authorities explore the case for using satellite technologies in a variety of fields and will do so on request.

6. Other Sources

- GSE Forest Management Programme: http://www.gmes-forest.info/
- Classification of European Biomass Potential for Bioenergy Using Terrestrial and Earth Observations: www.ceubiom.org
- Biomass Energy Europe: http://www.eu-bee.com/
- The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries: www.un-redd.org