EIP-AGRI Focus Group
Sustainable mobilisation of forest biomass

MINIPAPER 4: Decision support tools

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Introduction

What's the Mini paper about?

The ownership of much of the European forests is fragmented in the hands of individual private forest owners. There are at least 2.7 million individual private forest owners and 90 000 public forest holdings in Europe (FAO 1980 – 2010). This highlights the great importance of individual and family owners in private forest wood harvesting, particularly in countries that have a high percentage of this kind of ownership (Schmithüsen and Hirsch, 2010), and it represents a significant area of forests and potential wood volume that could contribute to the wood mobilisation in Europe. The sustainable management of forests has been well studied over recent decades, with many papers and methodology written about to achieve that goal. However, while the knowledge to achieve sustainable forest management in theory is well known, the problem comes in putting that theory into practice, often due to insufficient practical knowledge in addition to the changing economic, social or environment context which require more complex models. (Gadow et al., 2001; Burger, 2009; von Detten, 2011; Rist and Moen, 2013; Álvarez et al. 2013, Borges et al. 2014, Diaz-Balteiro et al., 2017).

Forest and woodland information and data exists in a variety of forms and often in large data sets which are not easily available to individual forest owners. The basic information that a forest manager needs is to understand their forest inventory, relevant constraints, the production potential (in terms of quantity and quality) and the future potential of the forest (Ludwig, 1993). In forecasting production modellers

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have historically been looking for mathematical equations and models to predict it, which often rely on assumptions based on the best available historic. This kind of model helps to predict the best economic outcomes and optimum thinning regimes at stand level.

To support non-industrial private forest owners (NIPF) in sustainable forest management existing data should be presented in a simple and user-friendly way and should be made easily available.

The questions that need to be addressed are – what data is available; how can it best be made available and used and what else is still needed. It may just be the innovative use of existing data rather than the need to develop new datasets? A major problem is that in many cases the models don't exist or where they do they are not being used by the forest owner or manager. When data is gathered and tools are developed, it is also essential that potential users are informed and trained, which is not always the case. The ideal situation is when final users are involved in the development of Decision Support Systems (DSS) to better understand their requirements and the barriers they need to overcome and the ability to provide feedback to allow adaption of the decision support system to their requirements, while considering the principles of credibility, salience, and legitimacy (van Voorn et al., 2016).

The main aim of this paper is not to create a detailed overview of what has already been developed in the form of different decision support systems or tools, it is more to highlight what is available that might help encourage the sustainable mobilisation of forest biomass and also to identify research gaps and innovations needs.

This mini-paper will cover three main areas of innovation:

1. *Innovative use of existing available data sources (user friendly) & New Inventory technologies*
2. *Decision support tool(s) for forest owners*
3. *Support for Marketing wood products*

Why is this Mini paper needed?

The mini-paper aims to meet the goals of the sustainable supply of quality wood for the growth of forestry sector and the mobilisation of wood to meet the needs of growing bioeconomy. It is not enough that data is gathered, the biggest challenge is to put a practical value to that data and to use it to support forest owners in their decision making. Tools and decision support systems can support easy and efficient communication between the supply side (forest owners) and demand side (forest based industry).

The flow of information and tools to support efficient communication among different actors along wood supply chains can have a significant influence on wood mobilisation across EU and beyond.

1. *Innovative use of exiting available data sources (user friendly) & New Inventory technologies*

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Different stakeholders along wood supply chains and policy makers need models and decision support systems that help them to evaluate their decisions for the future, both for short and long term development. The availability of such models and predictions depend to a large extent on the quality and availability of data.

2. *Decision support tool(s) for forest owners*

Individually NIPF can't be important market players but if they collaborate and have joint appearance on the market then they can become important players at local and even on the global market. But forest owners need support, in the form of information, guidance and tools to enable them to achieve this.

3. *Support for Marketing wood products*

The principles of marketing if applied properly can improve profitability of wood supply chains. Marketing is an evolutionary process that links forest owners to end users (wood processing industries, Bioenergy sector and others). It is a complex process and can benefit from support through different tools and web platforms.

Uptake of any decision support system or developed tool is heavily influenced by the extent and quality of **stakeholder engagement** during the development phase. It is not only about development of tools or web based platforms, development should go hand in hand with stakeholder's engagement and active (two way) communication among scientists (developers) and users.

Dissertation

Recently, many new technological innovations and methods have been introduced, and it is due to the fast growth in computer science that has led to improvements in hardware and software. Those innovations come from a variety of different disciplines, such as artificial intelligence, nanotechnology, electrotechnical engineering, etc. Some of well-known technological advancements are machine learning algorithms, 3D technology, big data analysis and robotics. This technology and methods are used in different disciplines of forest science like: i) forest inventory (LiDAR of Multispectral photogrammetric approaches); ii) Big Data and machine learning for massive forest inventory data analysis; iii) optimisation approaches (LP, ILP and Mixed LP) and iv) geographical information systems and spatial data sets. But we must consider that in the end the decisions are taken by a decision maker. So, at the end we have the subjectivity or expert opinion and the Multi-Criteria Decision Making that is essential in multi-objective forest management.

Over the last decade researchers have developed numerous DSS and Tools in the forestry and land use sectors throughout Europe, while their uptake and use has not always been that successful. The Research Agency of the Forestry Commission in Great Britain has carried out social research in order to identify why the level of adoption has often been lower than expected in order to ensure more effective Support Systems can be developed in future.

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The report 'Uptake of Decision Support Systems in the Forestry Sector in Great Britain 2013' found that a fundamental problem in the design of DSS was that unless they are seen to improve upon existing decision making practices they will not be taken up. It can mean that, for example, local stakeholder knowledge and judgement could be more useful than the outputs of science-based DSS, or that other new kinds of engagement at the interface between science and decision making work better, such as moving from a knowledge-transfer model to more of a knowledge–exchange/interaction model. The key result of the report was that Systems or Tools should not be developed in isolation from the intended users, and that researchers must begin with a better understanding of the actual problems faced by the decision makers. (http://www.forestry.gov.uk/fr/dssuptake and http://www.forestry.gov.uk/fr/decisionsupport).

The defence among different stakeholders is that it often depends on the value that each one gives to the resource (wood or non-wood resource). Therefore the importance of Multi-Criteria Decision Making methods like AHP (Saaty 1980) or MAUT (among others) is growing.

1. *Use of exiting available data sources (user friendly)*

Most countries have some sort of national forest inventory process that could provide the basis for providing information to owners, agents and for wider collaborative working. This could inform marketing strategies, depending on how available the data is and what is available publicly.

At the European level the EFISCEN inventory database contains forest inventory data that can be used in the EFISCEN model (**http://www.efi.int**) . Input data is available for 32 European countries. The input data for these countries has been derived from their national forest inventories. The EFISCEN Inventory Database can be used by anyone who seeks information on Europe's forests and its resources. The design of the database is aimed at providing forest resource information to the modeller, policy and decision makers, researchers and the general public. However, the problem with the national forest inventories is the lack of homogeneous systems and protocols in Europe. In order to avoid this problem, the recent COST Action FP1001. (USEWOOD: Improving Data and Information on the Potential Supply of Wood Resources: A European Approach from Multisource National Forest Inventories) is looking for the homogenisation of forest inventory variables in Europe.

New approaches to identifying and monitoring plant health are being developed, exploring the extent to which tree health can be detected using remote sensing data. A huge range of new data is freely available from the Copernicus programme (headed by the European Commission (EC) in partnership with the European Space Agency (ESA)), which collects the data through its Sentinel satellites, using various technologies. It provides accurate, timely and easily accessible information to improve the management of the environment, understand and mitigate the effects of climate change and ensure civil security.

For example, French forest databases have been used to:

- know the producers through "RESOFOP" surveys (Private Forest Observation Network);
- anticipate the volumes and qualities of the potential resource;
- analyse management documents and groupings of territorial development plans;
- observe indicators of wood mobilisation and prices.

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Another example is the SigPac tool in Spain (http://sigpac.magrama.es/fega/h5visor), than opens the agricultural and forest *cadastre* data in a user-friendly form.

On the other hand, there are cartographic datasets that could be directly or indirectly used in forestry. Another data source available is OpenStreetMap as an example of collaborative spatial dataset, where road information is stored, and is frequently updated and validated.

2. *Decision support tool(s) for forest managers*

The Decision Support Tools (DST) make the assessment of the data easy and are the main ways of transferring the knowledge to the user or forest manager. Different DSTs have been developed throughout the EU and beyond. The main aim has been to improve forest management (Packalen et al., 2013; Borges et al., 2014b; ForestDSS, 2016; Capsis, 2016; Nobre et al, 2016). A comprehensive overview on different forest management decision support systems (DSS) is available on: **http://www.forestdss.org/CoP/**. It provides a repository of DSS descriptions, country reports and good practice examples.

Forest management plans (FMP) for small-scale forestry serves a number of different tasks; first of all as decision support for the forest owner but also asa communication link between the owner and other actors. A small-scale FMP typically describes the initial forest state and management proposals over the short term. Many existing FMPs therefore lack long term projections, systematic analyses of different management options, multi-criteria decision analysis and sometimes contain potentially contradictory objectives, such as, nature conservation and timber production. These contradictory components are, on the other hand, included in recently developed forest decision support systems (DSS), such as the Swedish **Heureka System** (Wikström 2011). Forest DSSs are frequently used by large and medium sized forest holdings but also have great potential to be used by smaller NIPF owners. One example is the recently introduction within Swedish forest owners associations of "forest owners strategies" based on the 'Heureka' analysis of individual forest holdings.

Another interesting initiative was developed in the frame of EU funded project **SIMWOOD**. The SIMWOOD Information System is a web interface (hosted by the European Commission's Joint Research Centre), containing qualitative and quantitative information about wood mobilisation efforts across Europe. A significant amount of the material and knowledge that is contained in the System has emerged from the SIMWOOD project. The challenge with the Information System has been in structuring the data in a user-friendly manner to encourage a maximum number and range of users. The purpose of the system is to allow users to locate the information on a wide variety of topics, including harvesting techniques, ecosystem services and policy, to name a few. They may also be searching for information on regions that are similar to their own, in which case the regional descriptions of wood mobilisation contexts such as forest types, markets and ownership, as well as best practices to encourage sustainable wood mobilisation, would be of interest to them. To make it appealing to different user groups different entry points are available to access the same knowledge, which includes lists, search tools and maps. A significant effort is made to extrapolate information gathered at a local level to the EU context.

Although anyone can use the tool, forest owners have been identified as the primary target audience. The target *user* audience however, is not the forest owners, but the persons from whom they will seek advice (forest professionals and forest owners associations). Furthermore, the tool is intended to be a support

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to regional stakeholders and for policy making on multiple levels and scales. These stakeholders are therefore also targeted users of the System. Finally, it is expected that researchers will make use of the tools as well.

Another EU funded project **S2Biom** aims to support the sustainable delivery of non-food biomass feedstock at local, regional and pan European levels through developing strategies and roadmaps. These are supported by a "computerised and easy to use" toolset and databases. The toolset aims to provide easy access to a systematic, visually attractive and readily understandable spatially specific overview of data on biomass cost-supply; characteristics of conversion and pre-treatment technologies; biomass hubs and yards; matching biomass to technologies; market demand; and policies for biomass for bioenergy and bio-based products**.** It also provides optimal design and evaluation of biomass delivery chains and networks at local, regional, national and European scale in the EU-28, Western Balkans, Ukraine, Turkey and Moldova at regional, national and European wide scales. The tools developed in S2Biom are made available through a general user interface which can be accessed at **http://s2biom.alterra.wur.nl/**

In the UK experts have been struggling to find the best solution for woodland owners to develop management plans for their woodlands that are compliant with sustainability criteria (UK Forest Standard - UKFS), but are also useful to carry out practical management/harvesting. Currently the management plans promoted, and supported through grants, are designed to ensure the plan complies with UKFS and the requirements for EAFRD funded forestry grants, but the plans are not always user friendly for owners and further implementation plans are usually required to carry out actual work in the woods, e.g. harvesting. So if there are practical and user friendly management/implementation plans used in other countries that could be shared it would be useful, together with the platforms for data storage and user interaction.

Decision support tools for owners should cover not only the economic factors of woodland management, thinning regimes, infrastructure needs, harvesting and extraction techniques, species choice, etc., but also biodiversity and wildlife management. For example in England the Forestry Commission is working with environmental NGOs to develop a web based portal to provide woodland wildlife species requirements to inform woodland managers.

A good example of a user friendly support tool from the UK is the Ecological Site Classification tool (ESC), details of which can be found here **http://www.forestry.gov.uk/esc** . ESC 3 is a desktop Application to help guide forest managers and planners to select ecologically suited species to sites, instead of selecting a species and trying to modify the site to suit. ESC 4 is shortly to be available. Other support tools available can be found at **http://www.forestry.gov.uk/fr/decisionsupport** . You might find the following paper of interest which probably answers some of the questions – see **http://www.forestry.gov.uk/fr/dssuptake**

The Ecological Site Classification Decision Support System (ESC-DSS) is a Windows desktop application to help guide forest managers and planners to select ecologically suited species to sites, instead of selecting a species and trying to modify the site to suit. ESC-DSS is widely used in both the public and private forestry sectors in Great Britain, and has more recently been used as part of compulsory scoring as part of the EAFRD grant appraisal process.

ESC 3 provides a user friendly way of working out options for tree species and native woodland communities on individual sites, incorporating optional future climate change projections for the 2050

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and 2080 low and high scenarios of UKCIP02 to allow users to incorporate future suitability into planting decisions. ESC 3 matches key site factors (by inputting Grid Reference and Soil Type) with the ecological requirements of different tree species and woodland communities, as defined in the National Vegetation Classification (NVC) for Great Britain. More precise estimates of soil quality and suitability of tree species and woodland communities can be obtained by inputting more detailed site information. An improved ESC-DSS 4 is shortly to be made available. **http://www.forestry.gov.uk/esc**

Similar to other agriculture enterprises, mechanisation has rendered forestry an isolated occupation. Owners rarely meet in person if there are not formal (or even semi-formal) meetings organised by either an active forest owner or a tasked administrator (e.g. Government/municipal representative). However, like in so many other domains, Internet communications can play a major role in bringing forest owners together - even if only in a virtual sense. Online forums, whether on Facebook, Twitter, or websites with dedicated discussion pages, provide contact opportunities for otherwise isolated forest owners. Often, technical questions can be asked and expertise shared among other forum users. New ideas, interesting events, useful publications, etc. can easily be shared and discussed in a way not possible through irregular face-to-face meetings. Equally important is the social aspect of such forums, where people with at least one thing in common can speak/interact with their peers.

Example: Boards.ie **Discussion Forums**, which contains a dedicated Forestry page, under the sub-section on 'Farming and Forestry'; link: **http://www.boards.ie/vbulletin/forumdisplay.php?f=1529**

Creation of clusters to structure the logistics chain of woody biomass in France were supported by an EU funded project "Activation of private forest owners for the improvement of forest energy supply - AFO". The objective was to increase the supply of biomass energy and change the behaviour of forest owners.

For example, in 2012 a national French programme "MOVAPRO" was developed in Aquitaine. The main aim was to reduce the barriers of the sustainable mobilisation of the wood for small owners through working on the value chain.

There are different needs for each type of user, and this should be taken into consideration when developing tools. For example, **FlorNext®** focused in owners, **FlorNext Pro®** for technicians, and **Apptitude** focused in researchers and regional strategy. There are good examples of user-friendly tools focused in NIPF users at a stand level, i.e.: Eucatool® (Rojo-Alboreca et al. 2015) using models of eucalyptus globulus in Galicia (Spain), FlorNext® (Pérez-Rodríguez et al. 2016) using models of *Pinus pinaster* and *Quercus pyrenaica* in Nordeste (Portugal) and Web Globulus 3.0 using national models for *Eucalyptus globulus* in Portugal (Palma, 2016).

3. Support for marketing wood products

Many NIPF organisations and collaborations can have a significant role in marketing of wood from their forests. Sweden and Finland are examples where very strong and well organized forest owner associations have been developed. For example, in Sweden, about 112 000 family forest owners cooperate in four regional associations organised as producer cooperatives, owned and managed by the members of each association. The central organization is LRF Skogsägarna, the Federation of Swedish

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Family Forest Owners, with their head office in Stockholm (http://www.lrf.se/om-lrf/in-english/). The regional organizations have existed since the 1930s (cf. Wennebro 2008).

Close cooperation between the Nordic forest owners' national organisations started in 1946. Since 1995, when Finland and Sweden joined the European Union, the organisation has been represented in Brussels at EU level by a joint lobbying office, the Bureau of Nordic Family Forestry. They work with and through the CEPF (Confederation of European Forest Owners) which acts as the umbrella federation of European Family Forest Owners representing the interests of Nordic Forest Owners towards EU-institutions, forest-based and related industries and other organisations active in this field.

WoodChain Manager (WCM) is a web portal that offers different interactive tools suitable for the organisation and optimisation of forestry works, supporting:

- Creation of interactive transparent descriptions of forestry wood chains
- Creation of transparent calculations of forestry mechanisation costs
- Stipulation of forestry production norms
- Conversions between volume, weight and energy units

The application has been developed by the Slovenian Forestry Institute enables a simple selection of a technological models for the production of round wood and green chip. The tool looks at the economics and the available technology within the entire complex forestry wood chain and allows for the selection of machines and their mandatory or optional accessories/attachments, from felling to the end user. Visualisation of technological components along the forestry wood chains and presentation of costs enable optimisation and easier understanding of otherwise very complex chains. Wood Chain Manager has been developed to help forest owners to control and optimise costs of harvesting. (**http://wcm.gozdis.si/**).

In the UK there have been online auctions and some online selling, but it has not been successful for smaller scale woodland owners who don't have regular availability of product and would be better off amalgamating with other sellers. In England the Forestry Commission sell larger quantities of timber through an online timber auction portal called *e-Timber Sales* see **http://www.forestry.gov.uk/auctions.** Ideas about internet sales of wood biomass and other round wood assortments have also been tested and developed in some central European countries (like Holzborse IHB **http://www.ihb.de** in Germany and there are other examples of portals that are more or less successful). In Ireland the state forestry company (Coillte) has been selling roundwood via an electronic auction system since 1997. Private forest owners can also avail of this system by selling their timber through Coillte.

Proposals for research needs from practice

Knowledge gaps to be cover by research, research needs from practice:

a) **The Development of new tools for long term forest planning** is essential, as these tools contribute to the transfer of research results into practice. Multi-objective approaches to introduce

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environmental and social indicators (i.e. birds and animal's populations per 1000 ha depending on the treatment chosen, as well as CO^2 storage etc.) with specific focus on NIPF should be introduced.

b) A problem with new technologies is that there are often large quantities of data to deal with. **Fostering the use of machine learning algorithms in the field of forestry sector** could contribute to simplify the complex data and it might also enable the results to be transferred better. Machine learning is a subfield of computer science and deals with developing algorithms from empirical data. Three major fields of machine learning are text analytics, image analysis and numerical analysis. There is some use of machine learning algorithms used for remote data analysis, but the unused potential is huge. Machine learning could be used to analyze forest owners and to identify typical groups and their characteristics. With classification algorithms, responsive owners could be identified and this information could be used to target more potentially active forest owners. Nonlinear machine learning algorithms could also improve the estimation of biomass potential available in forests.

c) Another area for research and future action that is needed is in the **marketing of forest products**. Some trials of online marketing took place in the UK, and there are some working examples around Europe that could be shared to enable forest actors to optimise added value opportunities for their forest biomass/products and reap the benefits of economies of scale. In the UK there have been online auctions and some online selling, but it has never really taken off, particular for smaller scale woodland owners who don't have regular availability of product and would often be better off if they could amalgamate product with other sellers. In England the Forestry Commission sell larger quantities of timber through an online timber auction portal called e-timber, see **http://www.forestry.gov.uk/auctions** However, this seems to work for large scale sales, rather than multiple smaller sales, which are what is really needed to mobilise that many smaller potential forest actors throughout Europe.

d) **Development of innovative Decision Support System (DSS) that facilitate low carbon and low cost wood supply chains –** actors along the supply chain (from forest owners, harvesting companies, transport companies to consumers (wood industry and bioenergy sector) should be linked and each part of the chain should have options for optimisation of costs and carbon emissions. For example – with economies of scale through cooperation of forest owners and joint organisation of larger scale harvesting operations, the costs of harvesting operation can be reduced, the transport of harvesting machines will be optimised as well as the transport of the produce to market. Larger forest operations also mean larger volumes of wood product will be offered on the market so transport can be optimised, again cutting carbon; costs will be lower and the added value of wood can be higher. Tools for assessment of costs taking into consideration different terrain conditions, forest infrastructure, available technologies as a basis for transport or harvesting optimisation would also be beneficial.

e) **Development of DSS focusing on small woodlots owners** as well as wood buyers and forest contractors focusing on small wood lots, keeping in mind that those small woodlots together constitutes a significant element of European forest land.

f) Many parts of the EU have huge underutilised potential in their forests. Often the challenge is to link the four main pillars of the Wood Supply Chain (WSC) which are: i) forest owners, ii) forest entrepreneurs, iii) transport and iv) wood industry/energy sector. Through participatory processes

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(bottom-up approach) innovation needs should be collated and considered when addressing challenges (low level of technically available potentials and lack of cooperation along the WSC). The solution could be the development of an integrated network involving actors from government, industry, academia and civil society that will stimulate exchange of knowledge, strengthen innovation adoption and enhance resource efficiency (and effectiveness) and competitiveness along the whole WSC. **An innovative, user oriented ICT platform for smart optimisation of WSC, for supporting low GHG behaviour from tree harvest to primary wood consumers** (wood industry, energy and pulp and paper industry sectors) should be developed. Development and deployment of such systems would be much more effective if they are worked up across several Member State and not just by the private sector only. Challenges can be better addressed in a transnational framework, through mechanisms of cooperation, mediation and compromise among stakeholders either through exchange or joint actions.

g) Forest owners may or may not be comfortable using online tools and/or computers in general. However, even those who are proficient with such tools may benefit from training on how best to use and contribute to discussion forums. Constructive, professional users will hopefully help any such forum to succeed, but it cannot be assumed that all users will be motivated to contribute in this manner. In this regard, forest **owners may well require training on how to create and maintain a healthy online community**, analogous to the training requirements of a moderator for a face-to-face group. If online groups are not already in place, then trained forest owners could then help develop new ones in their region.

h) Tools to improve the **transnational cooperation** among wood supply chain actors at national and transnational level for integrated reduction of greenhouse gas emissions through **optimising the processes in the wood supply chain** from forest owners to the end users.

Further development of a 4 step methodology of active cooperation among the different actors in chain of values according to the demand for forest products and the mobilisation potential of forests. Steps should be as follows:

Step 1. Collaboration between the actors;
Step 2. Motivation of producers;
Step 3. Value chain analysis / orientation and cost reductions;
Step 4. Competitiveness gain at all stages of wood processing.

Proposals for innovations

- While there has been much research throughout Europe on overcoming the barriers to further mobilisation of Forest Biomass the real need is to practically engage with the forest actors to bring about that mobilisation. Engaging woodland owners and their agents can be made easier with the better organisation of groups of owners into associations or other forms of collaboration, but it is essential to be able inspire them to become active. One way would be to bring together case studies and successful examples of mobilisation from throughout Europe and using an intelligent database to group different scenarios, enable owners to identify situations that inspire them to act. An add-on to

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this would be to provide contacts for the various actors in the case studies and a social platform to allow communication and networking between all parties.

- Create a suite of training materials for forest owners that enable them to use various new tools such as the online forums. Topics could cover basic computer skills, to research skills and how to find critical information online, and onto dedicated instruction for sector-specific tools.
- Tools to **increase competitiveness of the whole forestry sector** through developing and implementing transparent forestry contractor's quality assessment system. Following the example of established web platforms, which enable bringing together providers and users within the economy and tourism sectors (for example booking.com or Airbnb.com), and in respect of the characteristics of the forestry sector business processes, a transparent and objective web information system for the assessment of the quality of harvesting contractors (and forest agents/managers) implementing one or more forestry work phases could be developed.

  The basis for this information system could be an innovative methodology for assessing the work of harvesting contractors (following the method of accommodation categorisation – i.e. No. of stars for hotels or reviews). In addition to the categorisation of forestry contractors, a method for final users (forest owners) direct ranking of quality of implemented works could be included.

  The developed methods could be used via a web portal, which could bring together all forestry wood chain stakeholders. Forest owners should be able to find available harvesting contractors/companies with a quality assessment mark and available ranking. The request for work and offers for specific work could be managed through the platform offering more than just virtual meeting place but also other relevant information for harvesting and managing forest in general. The main challenge is: can we bring the idea of "booking.com" from the tourism sector to make forestry harvesting sector more transparent?
- Further development of existing harvester simulator training tools. Harvester simulators are today widely used in forest machine operator education and training. Such simulators can be further developed to also include the future development of a thinning stand, 10, 20 or 30 years after the thinning operation. This can be done by including existing long term planning systems with growth models for individual trees. In this way, it will be possible to not only evaluate the time (and cost) for the thinning itself, but also the longer term economic output of the thinning. In this way it will be possible to get forest machine operators that perform better in achieving optimum scenarios for future forest composition and structure.

Further research needs coming from practice, ideas for EIP AGRI operational groups and other proposals for innovation can be found at the final report of the focus group, available at the FG webpage **https://ec.europa.eu/eip/agriculture/en/focus-groups/sustainable-mobilisation-forest-biomass**

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Conclusions

While there are many tools and methods available to help NIPF owners put sustainable biomass mobilisation theory into practice, there are many barriers preventing their wider use and these will only be overcome through more appropriate transfer methodologies, which includes the development of simplified tools. To ensure there is a more successful uptake in the use of these tools they need to be user friendly which only happens when there is a checking and testing by forest owners and other stakeholders before implementation.

Decision support systems and tools for owners should cover not only the economic factors of woodland management, thinning regimes, infrastructure needs, harvesting and extraction techniques, species choice, etc. but also topics of biodiversity, natural conservation and wildlife management.

It is always a challenge to identify a primary target audience of a DSS or tools. While it can be a NIPF owner directly, it is more often that tools will be developed for the persons from whom they will seek advice (forest professionals and forest owners associations) or even policy makers.

The implementation of new technologies in forestry is slow, especially in Eastern and Southern Europe. The latter could be explained by lack of 1) funding, 2) information and 3) knowledge of stakeholders and potential users. Curriculums at Universities do not always cover important innovations; therefore the gap between what is available on the market and the technologies that are actually implemented is getting wider and wider. By supporting projects with interdisciplinary approaches and focusing on the implementation of new technologies, the forestry sector would gain greater efficiency and automatization.

The marketing of wood products should also be supported with other information such as market development (at national and international level), export/import trends, development of price indices and especially with the effective support in times of natural disasters and calamites, when fast and well organised action should be taken to support forest owner's in reducing or avoiding the damage and losses.

References

http://www.eustafor.eu/organisation/bureau-of-nordic-family-forestry-nff/

Ref. Wennebro, T. 2008 (Ed.). En samlad kraft. Norra skogsägarna 75 år. ISBN 978-91-633-3338-5.

Álvarez, C. M., Segura, M., Ginestar, C., Uriol, J., Segura, B. (2013). Sustainable Forest Management in a Mediterranean region: social preferences. Forest Systems, 22(3), 546-558.

Borges, J. G., Nordstrom, E. M., Garcia-Gonzalo, J., Hujala, T., Trasobares, A. (2014a). Computer-based tools for supporting forest management. The experience and the expertise world-wide. Dept. of Forest Resource Management, Swedish Univ. of Agricultural Sciences.

Borges, J. G., Nordstrom, E. M., Garcia-Gonzalo, J., Hujala, T., Trasobares, A. (2014b). Computer-based tools for supporting forest management. The experience and the expertise world-wide. Dept. of Forest Resource Management, Swedish Univ. of Agricultural Sciences.

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Burger, J. A. (2009). Management effects on growth, production and sustainability of managed forest ecosystems: Past trends and future directions. Forest Ecology and Management, 258(10), 2335-2346.

Capsis (2016). Capsis: Computer-Aided Projection for Strategies In Silviculture. Capsis projects. http://capsis.cirad.fr/capsis/models [accessed 02.12.2016].

Diaz-Balteiro, L., Alonso, R., Martínez-Jaúregui, M., Pardos, M. (2017). Selecting the best forest management alternative by aggregating ecosystem services indicators over time: A case study in central Spain. Ecological Indicators, 72, 322-329.

ForestDSS (2016). ForestDSS wiki. http://www.forestdss.org/ [accessed 02.12.2016].

Gadow, K.v., Pukkala, T., Tomé, M. (Eds.). (2001). Sustainable forest management (Vol. 1). Springer Science & Business Media.

Larocque, G.R., Bhatti, J., Arsenault, A. (2015). Integrated modelling software platform development for effective use of ecosystem models. Ecol. Modell. 306, 318-325.

Ludwig, D. (1993). Forest management strategies that account for short-term and long term consequences. Can. J. For. Res. 23(4), 563-572.

Nobre, S., Eriksson, L.O., Trubins, R. (2016). The Use of Decision Support Systems in Forest Management: Analysis of FORSYS Country Reports. Forests 7(3): 72.

Packalen, T., Marques, A.F., Rasinmäki, J., Rosset, C., Mounir, F., Rodriguez, L.C.E., Nobre, S.R. (2013). Review. A brief overview of forest management decision support systems (FMDSS) listed in the FORSYS wiki. Forest Sys. 22(2), 263-269.

Palma, J.H.N. (2016). Web Globulus 3.0. http://home.isa.utl.pt/~joaopalma/modelos/webglobulus/ [accessed 02.12.2016].

Pérez-Rodríguez, F., Nunes, L., and Azevedo, J. (2016a). A software tool for accurate assessment of costs and CO2 emissions in wood transport using OpenStreetMap© Mathematical and Computational Forestry and Natural-Resource Sciences 8(1):35-53.

Pérez-Rodríguez, F., Nunes, L., Sil, A., Azevedo, J.C. (2016b). FlorNExT®, a cloud computing application to estimate growth and yield of maritime pine (Pinus pinaster Ait.) stands in Northeastern Portugal. Forest Systems, Volume 25, Issue 2, eRC08.

RAUCH, Peter, TRIPLAT, Matevž, KRAJNC, Nike, et al. SWOT analysis and strategy development for forest fuel supply chains in South East Europe. *Forest Policy and Economics*, ISSN 1389-9341. 2015, vol. 61, str. 87-94,

Rist, L., & Moen, J. (2013). Sustainability in forest management and a new role for resilience thinking. Forest Ecology and Management, 310, 416-427.

funded by European Commission

Rojo-Alboreca, A., García-Villabrille, J.D., Pérez-Rodríguez, F. (2015). EucaTool®, a cloud computing application for estimating the growth and production of Eucalyptus globulus Labill. plantations in Galicia (NW Spain). Forest Systems, Volume 24, Issue 3, eRC06, 4 pages.

Saaty, T.L. (1980). The Analytic Hierarchy Process. Planing priority setting, resource allocation. McGraw-Hill. New York.

TRIPLAT, Matevž, PRISLAN, Peter, KRAJNC, Nike. Decision-making tool for cost-efficient and environmentally friendly wood mobilisation. *South-east European forestry*, ISSN 1847-6481, 2015, vol. 6, no. 2, str. 179-190,

Valente, S., Coelho, C., Ribeiro, C., Marsh, G. (2015). Sustainable Forest Management in Portugal: Transition from Global Policies to Local Participatory Strategies. International Forestry Review 17(3):368

van Voorn, G.A.K., Verburg, R.W., Kunseler, E.-M., Vader, J., Janssen, P.H.M. (2016). A checklist for model credibility, salience, and legitimacy to improve information transfer in environmental policy assessments. Environ. Modell. Softw. 83, 224-236.

von Detten, R. (2011). Sustainability as a guideline for strategic planning? The problem of long-term forest management in the face of uncertainty. European Journal of Forest Research, 130(3), 451-465.

Wiersum, K.F, Elands B.H.M., Hoogstra M.A. (2005). Small-Scale Forest Ownership across Europe: Characteristics and Future Potential. Small-scale Forest Economics, Management and Policy, 4(1): 1-19

Wikström, P., L. Edenius, Elfving, B., Eriksson, L.O., Lämås, T., Sonesson, J., Öhman, K., Wallerman, J., Waller, C., Klintebäck, F. 2011. The Heureka forestry decision support system: An overview. Mathematical and Computational Forestry & Natural-Resource Sciences. 3(2): 87-94.

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funded by European Commission