Resin resource monitoring & modelling in a context of climate change

Round 1 Interregional workshop of the RESINS iNet

21/22, January, Madrid, Spain

Report

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Innovation Networks for Cork, Resins & Edibles

Coordinator

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CONTENTS

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https://incredibleforest.net/content/interregional-workshop-resin-resource-modelling-context-climate-change

1. Agenda

The European natural resin sector –industry, resin workers, forest owners, technicians, and administration– needs trustworthy yield data and models for strategic diagnoses, monitoring of the state of conservation, planning and supply forecasts. Monitoring schemes are also required for standardised economic, forestry and labour sector statistics.

This Interregional Workshop brought together the sector with researchers, forest modellers, and responsible for forest inventories. The goal was to elucidate which specific data are required and which data can realistically be provided with the available techniques and technologies. The two-day event combined a seminar about the state of art and the sector's requests. Multi-actor sessions were animated by an innovation facilitator, to cover the first of the identified **iNet Priorities** related to sustainable production of natural resin from Mediterranean forests, **Resource modelling in a context of climate change**. The quality and relevance of delivered knowledge was collectively assessed for identifying priorities and future activities.

Venue: National Institute for Agricultural and Food Research and Technology (www.inia.es), Madrid

Monday, January 21, 2019	
11:00	**Register of participants**
12:00	**Opening session** ***Welcome by the Director of INIA*** Esther Esteban Rodrigo ***The Resin iNet of INCREdible, the European thematic network on Mediterranean NWFP*** Javier Calvo, CESEFOR ***Objectives and structure of the workshop*** Sven Mutke, INIA-iuFOR
Session 1. Resin production from pine forests: resources, inventory and monitoring – where are we?	
12:30	*Portuguese resin traceability & statistics (SiResin)* Paula Soares, ISA-U.Lisboa
12:45	*Resin in Spanish National Forest Inventory & statistics* Elena Robla, MAPAMA
13:00	*Potential of French maritime pine forests for resin production* Armand Clopeau, EFI, on behalf of Herni Husson, CRPF Nouvelle-Aquitaine
13:30	**Lunch**
14:30	*Resin tapping in Castilla y León –keys of a success story* Javier Ezquerra / Álvaro Picardo, Junta de Castilla y León
14:45	*Development of a web/Android app for resin traceability* Javier Calvo, CESEFOR-SustForest Plus project
15:00	*Pine forests in Tunisia – an opportunity for local employment in resin production?* Ibtissem Taghouti / Mokhtar Baraket, INRGREF
15:15	*Panel Discussion*
16:00	**Coffee break**
16:30-18:00	· ***What are the main data gaps, and inconsistencies between regions and countries?*** · ***How could these gaps be filled and the systems harmonised?*** · ***Which other unofficial or indirect data sources could be prospected to complete the picture?*** *Group work*

Tuesday, January 22, 2019	
Session 2. Threats & challenges for resin tapping in pine forests – what are we facing?	
09:00	*Disturbance legacies, climate and biotic stressors help to explain widespread decline of P. pinaster in mixed forests in Central Spain* Guillermo Gea, INIA
09:15	*Maritime pine decline in Northern Castile, droughts and implied pathogens* Julio Diez Casero, iuFOR-U. Valladolid
09:30	*Rural abandonment and evolution towards megafires – a rural renaissance needed?* Conceição Colaço, ISA-ULisboa
09:45	*Panel Discussion*
Session 3. Resin yield data & models, a support for resource mobilisation – what can science tell us?	
10:30	*Yield data and models for a sustainable resin sector* Mariana Ferreira, LURESA Resinas
10:45	*What information is needed for market and profitability analysis of resin tapping systems?* Armand Clopeau, EFI-SustForest Plus project
11:00	**Coffee break**
11:30	*SustForest Lab & sampling protocols for Maritime pine resin as forest resource* Ricardo Alía, INIA-iuFOR
11:45	*Climate and soil factors influencing individual tree resin yield* Aida Rodriguez, UPM
12:00	*Process based models for resource monitoring in* Pinus pinaster Marta Gonzalez García, CETEMAS
12:15	*Remote sensing approaches to forest resource inventories for resin yield modelling* Rafael Alonso, föra
12:30	*Panel Discussion*
13:30	**Lunch**
Final Session. Needs and challenges for the sector that forest models can respond	
14:30	***What models does the resin sector need? What data do the models need? Are they available?*** *Group work*
15:00	***Which assessment and monitoring systems or tools are available or possible? Is it feasible to forecast resin availability under a global change sceneries)?*** *Group work*
16:00	*Plenary Session*
16:30	**Closure**

2. iNet themes and knowledge gaps

In May 2018, the Resin iNet Scoping Seminar held in Valladolid gathered value chain actors of the European resins sector from Spain, France and Portugal, the three countries that have historically led resin production in Europe, During the meeting, a large number of innovation priorities were put on the table, of which four were finally chosen as the most pressing:

1. Resource modelling in a context of climate change.
2. Progress in the compatibility of resin harvesting with other forest uses.
3. Improvement of the working conditions of the resin tappers.
4. Development of new natural resin derivative products.

The first of the Resin iNet priority themes emerged during the Scoping Seminar was the was the uncertainty of resin supply in the medium and long term. **Resource modelling** was therefore targeted in the Madrid workshop: the need for monitoring systems and predictive models for evaluating the resin productive potential of Mediterranean forests, both at present and in the future, according to different environmental and socioeconomic scenarios. This implies a need of sound field data sourcing, or **resource monitoring**, as base previous to any model construction.

Additionally, the participants in the Scoping Seminar in May 2018 stated that the serious threats faced by resin forests are not yet well perceived by technicians, public decision-makers and society in general. In order to address this lack of awareness, the generation of reliable data and statistics is seen as a necessity maing them available to sectorial stakeholders and society. A further reflection in the General Assembly of the INCREDIBLE network at Padua (December 2018) led to the redefinition of the first key theme as "***Long term resource availability in a context of climate change***", for better reflecting the primarily non-academic but essentially sectorial nature of this challenge, the uncertainty surrounding the continuity of resin production in the medium and long term, especially considering the threats to resinous forests due to climate change, forest fires, pests and diseases.

The workshop aimed for discussing two fundamental questions within this theme (further detailed in a series of more specific questions in each session, cf. Annex 1):

What is the potential for resin production in each geographic region?

In a context of global change, will the geographical area and productivity of the maritime pine change?

The **operational objectives** of the workshop were that at the end, the participants would

1- be familiar with INCREdible network and objectives;
2- have a grip on resin resource availability and potential in the different countries;
3- be aware of the main threats & challenges for resin tapping in pine forests;
4- know about the state of art, potential and requirements of forest modelling for resin production;
5- agree on the needs and challenges of the resin sector that forest inventories models can respond.

3. Workshop

3.1. Presentations

The two-day meeting hosted two types of activities: three sessions with sixteen presentations by experts, and three working group dynamics.

Sixteen speakers (gender ratio 7M:9F) were invited for offering a overview of the state of art and knowledge gaps, delivering up-to-date information from administration, enterprises and research on resin that allowed the participants to put in common a perspective on challenges and opportunities for the sector. All but one presentation got clearance of the speakers and have been uploaded open access at https://www.incredibleforest.net/resources-resins.

Resource inventory and monitoring for natural resin from pine forests

Annually collected Non wood forest products, case of resin tapped from the trees, do not accumulate in forest, which implies that they are not properly quantified by national forest inventories, nor in detailed forest management unit (FMU) inventories for operative forest management planning. On the other hand, resin tapping as economic relevant activity had been abandoned thirty years ago and came back only the last years in Portugal and Spain, a reason why no ongoing research existed any more on the topic some fifteen years ago.

That was actually one of the main findings of the workshop: the lack of accurate yield data. Without experimental resin sampling following standard protocols for several years and sites, completed with soil and weather variables, no data for sound model building will be available. In the short term, only coarse scale approximations might supply a first approximation, putatively from georeferenced raw resin yield data that might be provided by industry and forest administrations (Alía & Auñón, 2019; Rodríguez García, 2019).

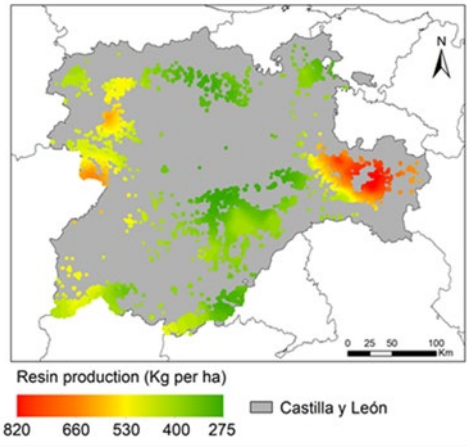
In Portugal, since 2016 an online system (*SiResin*) for registering each individual activity in the natural resin sector (tapping, transportation, storage, import/export, and transformation) has been working aimed at resin traceability & statistics. More than 220 operators have since registered and declared 19,000 tonnes of resin tapped in three years, though this value is still inferior to figures for Portugal offered by the National Institute for Statistics, about 8,000 t annually, valued in 8-9 million euros. A weak point of the SiResin system is that the mandatory declarations are prior estimations made in spring before starting the summer tapping season, limiting hence the accuracy for actual yield data (Soares & Santos, 2019).

In Spain, the National Forest Inventory registers more than one million hectares of maritime pine forests, where forest inventory data allow for defining typologies of stands. If models existed for correlation of stand or tree parameters and mean resin yield, geographic information systems might offer mapping of potential resin yields at different scales and confidence levels, for planning resin tapping activity. Lately the Spanish National Forest Inventory has included in the field protocol the measurement of new specific tree parameters for maritime pine, which will allow downscaling from coarse estimates based on few simple parameters (figure) to finer scales and integrating meteorological data, once resin yield models are available establishing significant correlations (Robla *et al*., 2019). This precise information would allow for accurate profitability assessments before starting a new resin tapping business leasing a forest area, for instance by self-employed workers (Clopeau & Orazio, 2019). Modelling approaches in forest growth and yield had centred traditionally in stand and tree biometry, still lacking on one hand the spatial explicit projection of

those main variables, on the other hand sound data-based correlations patterns that allow for linking them with resin productivity (Alía & Auñón, 2019; Alonso, 2019; González García, 2019; Rodríguez *et al.*, 2019).

For the moment, resin amount yielded from Spanish pine forests related by National Rural Statistics to have been exceeding 12,000 tonnes annually since 2014, after two decades (1991-2010) with most years having not even reached 2,000 t (Robla *et al.*, 2019). One fine-scale resin yield data source and traceability tool might be an Android App that allows for logistics and resin traceability, under development by the SustForestPlus project at CESEFOR in Spain (Calvo, 2019).

The leading resin producing region in Spain is Castilla y León, employing currently more than 1,000 workers, with 12,000 t resin tapped annually from 3.2 million trees (120,000 ha), processed in 7 distilleries (Ezquerra & Picardo, 2019).



Source: R. Alia (INIA, unpubl. data)

In case of France and Tunisia, resin tapping is currently not a relevant economic activity, though more than one million hectares of maritime pine in France and nearly 150,000 ha of Aleppo pine in France and 360,000 ha in Tunisia might potently allow for development of the pine resin value chain if profitable, and if resin tapping were compatible coproduced with other forest goods and services, especially timber sourcing. In Tunisia, resin tapping has potential as competitive base for livelihood given current salary level in its rural areas (Clopeau & Orazio, 2019; Husson *et al.*, 2019; Taghouti & Baraket, 2019).

Threats & challenges for resin tapping in pine forests

Nevertheless, there are several relevant risks of natural hazards in the Atlantic and western Mediterranean region affecting actual and potential resin production, linked both to biotic and abiotic agents, and on a background of ongoing climate chance. One singularly relevant factor to be taken into account in this context is the incidence of forest fires, recently even megafires. For instance, only in the dry season 2017 nearly 540,000 hectare of forests and shrubs burned in Portugal, 23% of them maritime pine forest, which is more than one sixth of the total area of this species lost in a single year (Colaço *et al.*, 2019).

In the core area of resin tapping in Castilla y León and Spain, the sandy plains between Segovia and Valladolid, symptoms for maritime pine decline have been reported, caused putatively by increasing drought events, lowering of groundwater levels, lack of silviculture (excessive stocking), and by the incidence of several pathogen fungi, namely *Heterobasidion annosum* and *Ophiostoma minus* (as well as *O. ranaculosum, O. ips*, and *O. piliferum*) (Diez, 2019).

In French maritime pine forest, the most relevant natural hazard are windstorms. For instance, in January 2009 cyclone Klaus destroyed more than 210,000 ha of Maritime pine stands (one-fifth of its total area), storm Martin nine years before already 150,000 ha (Husson *et al.*, 2019). Additionally, the whole distribution range of the species is facing a high risk for accidental introduction and spreading of the pine wood nematode, a fatal quarantine pest that has already been causing decline (pine wilt disease) of maritime pine in Portugal since detection in 1999 (Lee *et al.*, 2011).

Resin yield data and models, a support for resource mobilization

The resin tapper is the key actor whose activity transforms an only potential productivity of the pine forest into actual natural resin available for the industry. If European resin demand is estimated in 300,000 t yearly, part of importation and of hydrocarbon resins might be substituted by domestic natural resins (Clopeau & Orazio, 2019).

For responding the question what information is needed for market and profitability analyses of resin tapping systems, first of all sound estimations and predictions are required for resin production potential in southern Europe, in comparison with resin tapping systems used around the world, determinant for the evolution of resin price scenarios in the international market. Profitability will depend also on labour costs, tapping techniques and resin yields per tree and per hectare, allowing for cost-benefit analysis, adapting production potential according to market evolution.

In an attempt to provide the required models, in an ongoing SUDOE-Interreg project, *SustForest Plus*, resin yield models are developed at three different scales: (1) spatial models to select geographic areas of high production, (2) yield classification models of forest stand types, and (3) fine scale predictive models for yield potential to be linked with stand variables of a given forest. For model building and adjustment, data from different sources and at different scales are needed, and if resin yield were not to be started from scratch, the collaboration of the complete value chain to provide these raw data would be essential: researchers and modellers will depend on combining reports from forest owners and forest managers, who know the leaseholder of each single resin yield section and its stand variables, from the resin tappers themselves, and from the processing companies that know whom they by what amount of resin from. One initiative to bring together in a common a repository this kind of data is the creation of the so called *SustForest Resin Lab*, conceived as a European heterogeneous network of plots for resin testing that will gather from intensive sampling plots providing data at tree level, to resin territories with information on resin production and social and economic data. This plots network has a protocol for warranting that content does not violate contributor's privacy, copyright, confidentiality and non-disclosure rights (Alia, 2019).

At macroeconomic and societal scale, the opportunity for resin tapping for the whole community (forest sector, national economy, Europe) should be focussed in a multi-criteria analysis including environmental and social externalities, sustainability and compatible forest ecosystem services (Clopeau & Orazio, 2019). Addition of more pine forests tapped for resin benefits rural economy in terms of direct and indirect jobs and avoidance of rural abandonment, maintaining rural communities alive. Discussion move around question such as: What kind of social models can be used for tapping activity - self-employment, cooperatives, associations, private companies? Which costs do these alternatives imply in terms of salaries, social security, assurance, working conditions, safety? How do these costs impact on the price of resin as raw material? What would carbon footprint and energy balance for this activity be like? How can waste and contamination be reduced (resin flow stimulants based on other agents than acid, plastics bags or pots to collect resin, the kind of drums for transport)? How can this activity contribute to protect forest as actively managed and profitable systems, preventing abandonment, fires, pest and diseases? Those technical issues aside, aspects for social development were stressed: job creation, positive effect on nearby villages, and if these communities are willing to support this kind of activity in their neighbourhood (Ferreira, 2019).

3.2. Working group sessions

Session 1. Resin production from pine forests: resources, inventory and monitoring – where are we?

Four working groups were established to answer specific questions related to the objectives established for the first session of the Workshop.

The groups addressed the following thematic perspectives:

- Productivity
- Traceability
- Data Sources
- Socio-economic data

PRODUCTIVITY PANEL

Question 1. Which is the ultimate purpose for data collection and statistics?

The main purpose of data collection and statistics generation is to know the production capacity and the performance of the extraction activity at different spatial and temporal scales for the public administration, forest managers, resin workers and industry, for strategic planning in its activity areas.

Question 2. What kind of data has priority to be obtained, the potential or the real resin production?

The real production, since from it the potential production can be obtained under different hypotheses.

To obtain consistent data, the key element of the data system is measuring resin production at individual resin tapper level, geographically referenced. Obtaining this type of production data should preferably be done by means of resin tapping sampling. The production data obtained must be correlated with site, stand and tapping techniques covariates, as well as with the skilfulness of the individual resin tapper, before the generation of indices and derived statistics, ,

The panel proposed:

- Normalize extraction methods for resin production sampling.
- Establish a network of permanent plots to obtain consistent yield data over several years.
- Involve the forest owner where the plots are installed, making them aware of the benefits of participating in the trial.
- Remunerate the resin tapper for his collaboration and make him aware of the importance of the work.

Question 3. What are the key data to improve the sectorial performance and productivity?

Improve productivity per tree.

TRACEABILITY PANEL

Question 1. What are the main strengths and weaknesses of the Portuguese SiResin register?

Strengths:

- It is a general system that covers all resin transactions, internal and external.
- All relevant members of the value chain are involved.

Weaknesses:

- Incomplete, since the data collected are only pre-campaign forecasts.
- Lack of reliable means of verification and contrast.
- It does not provide a direct benefit or side utilities to users.
- It is based on control by control and the user doesn't have a return in terms of utilities that will improve their business performance.
- It is not user friendly.

Question 2. Can SiResin be extended to other regions?

Yes. It would be interesting to extend it to all countries with resin production, once the weaknesses of the system were resolved.

1. Develop a system that provides added value to agents and users, such as product traceability, logistics management or administrative and documentary management.
2. Build a simple and easy-to-use system based on user-oriented computer applications.
3. Provide specific training to users on the use of the system.
4. Ensure accurate collection and processing of relevant data. Ensure that the agents responsible for entering the data into the system act objectively and coherently. Care must be taken to ensure confidentiality in the processing of data.
5. To give fluidity to the introduction of data and recovery of statistics, at the closest possible moment to the generation of the data.

Question 3. Would it be interesting/necessary to implement a traceability system to the European level?

Yes, if its implementation provides benefit or add value to users.

Traceability systems implemented in the agro and forest products value chains tend to integrate utilities such as logistics and document management, support for quality and environmental management processes, food traceability, chain of custody for sustainable forest management and it even takes a role in the transmission of information to the consumer through guarantee marks. This type of integration makes the effort of implementing and managing the traceability system profitable, by providing services and added value to all users of the system.

Other measures to make a data reporting system work would be to remunerate the participation by means of payment or tax benefits and, in the event of detection of non-compliance with reporting obligations, to establish a sanctioning regime.

NEW QUESTIONS (to be answered)

How to finance the implementation and maintenance of a system of control and traceability of products derived from natural resin?

DATA SOURCING PANEL

Question 1. How are we going to get the needed data? Who must collect the key data?

The main effort should be done by the administrations and public bodies specialised in the control of primary and industrial production and trade data, such as National Institute of Statistics and the

national ministries or regional administrations, according to the corresponding distribution of competences.

In Spain, there is a significant lack of data from the private sector; main sources of resin production figures are the public forest owners. The industry can provide data that would be more accurate that data provides by forest owners.

How to get the data:

To get the data a register of producers is needed, for registration of forest owners, resin tappers and resin industry facilities. The forest owners and resin tappers would declare the production area to georeference the production data. The whole value chain would declare resin production, trade interchanges, incomes, benefits and costs.

Question 2. Which are roles of public administration and of the sector?

The information to be checked must be contrasting by Ministry of Agriculture, Treasury and labour administration.

Question 3. Is the resin industry willing to participate in a system for collecting data? (Other sectors provide themselves their own data because the recognize their value)

Companies wouldn't share information if data source protection is not guaranteed.

Question 4. Which practical use/interest does declare real production offer value chain actors?

If there were a guarantee of geographic brand or label for the natural resin produced in Europe, recognised by European consumers, there would be great interest not only in declaring actual production, but also in carrying out complete traceability of the product.

A precise knowledge of the real production contributes to the size of the sector in the short and medium term, which would make it possible to propose public and private strategies and sectorial policies from which all members of the value chain would benefit.

SOCIOECONOMIC DATA PANNEL

Question 1. What kind of socioeconomic data are needed for a better sectorial performance?

- Import/Exports
- Global price of resin
- Working conditions. Wages, who… (public, private companies, self-employed resin tappers)
- Productivity per tree, per ha and per man.
- Demand and its evolution
- Interest in product certificate of forest products and resin

Question 2. Would it be interesting to register the tappers in an official register?

Yes, main reasons are:

- For safety rules
- Professional training
- Technical rules
- National laws

Question 3. Which other data do we need related with sustainability to support marketing actions?

Sustainability of the whole system

- Acid and other stimulants used.
- Damages and diseases.
- Wild fire prevention.
- Comply with natural conservation rules.

Question 4. Might certification of sustainable forest management (SFM) contribute to added value and VC "maturing" as modern sector (e.g. for cosmetics)?

There is no clear answer among the attendees, although it is considered that this is very likely to be the case.

Question 5. Which are main market uncertainties? E.g. how can global prices dependence & competition from tropical resins & tall oil be tackled?

The evolution of supply in the medium and long term is an absolute unknown, especially China's position as a currently net importer after having dominated for years global exports, and the evolution of Brazil's exports. Resins derived from tall-oil are another factor of concern.

Climate change will have unpredictable effects on the ecological conditions, as well as on the distribution area of resin forests.

The reinforcement of natural resin of Mediterranean origin against its direct competitors must come hand in hand with technological improvements that increase productivity and profitability, as well as the use of commercial advantage in the European market of the environmental characteristics of natural resin linked to the territory, low carbon footprint, sustainable forest management and zero kilometer economy.

3.3. Take-home message

- The resin forests of the Mediterranean countries face threats that may jeopardise the viability of natural resin extraction and supply in the medium and long term: climate change, pine wood nematode, competitiveness of resin from tropical pines.
- The Mediterranean and European resin sector must assume the problems suffered by the resin forests as a whole, since the supply of the whole value chain depends on these forests.
- At present, it is not possible to make precise diagnoses or forecasts on the real state and evolution of the productive resource capacity on a regional or European scale due to the inconsistency of the available data which are dispersed, not homogeneous between regions, incomplete or imprecise. Predictive models are lacking due to the absence of standardised data collection and processing systems and methods for model fitting, as well as a lack of interregional organisational structure and of funding for the generation of data on a regular and consistent basis for the whole territory.
- The state of the art would allow the development of a complete data infrastructure for the resin industry in the short and medium term if willingness and funding are available. The entire natural resin value chain must be involved to advance in the construction of a data infrastructure.
- The economic viability of natural resin extraction activity is subject to fluctuations in global markets, and must be analysed from a multi-factorial perspective, considering productive, technical, socioeconomic and environmental factors.

- A brand of label identifying European or Mediterranean natural resins as an environmental and socially sustainable, wild-collected commercial product differentiated from competitors would contribute to a greater interest in the knowledge, monitoring and defence of the region's resin forests.

4. Conclusions

4.1. Improved definition of the theme

- The European Union is a net importer of products derived from natural and synthetic resins, which in part can be replaced by local natural resin production.
- The current and predicted decrease of *Pinus pinaster* areas available for resin tapping due to the incidence of forest fires, meteorological phenomena and pests poses a serious threat to the sustainable production of natural resin in Mediterranean forests.
- The potential for mobilisation of the resin resource in the forests of the Mediterranean basin depends on the evolution of international markets, on labour costs of extraction, the efficiency and innovation of resin tapping techniques and of course on the productivity of the forests.
- The social interest of the mobilisation of the resin resource must consider not only the microeconomic cost-benefit analysis of the exploitation itself, but also the macroeconomics, the positive externalities, the contribution to environmental and social sustainability, and the ecosystem services it provides.
- Resin extraction activity and the establishment of processing industries in rural areas have positive implications for the territory in form of endogenous economic activity and job creation.
- Resin yield prediction of a given forest stand through models would be possible if sound data were available, given the clear correlation between environmental, stand and tree variables and mean resin yields.
- Nevertheless, yield models require dataset combining actual resin production with these quoted parameters.
- A preliminary version of a production model could be obtained in the short term, if forest modellers had access to stand variables and geo-localisation of individual resin leases and their real production corresponding to the quantity bought by processing industries (traceability).

4.2. Improved understanding of the knowledge gaps

- At present there are few and limited datasets on current and potential resin production.
- The SiResin registration system is a good initiative to tackle the lack of traceability, although the data collected until now are incomplete, the means of verification are limited, it does not provide users with any added value and is not easy to use.
- Data hold by resin value chain actors (enterprises) on the actual production of resin leases are difficult to access, because they considered sensitive information.
- A precise version of a production model requires for its calibration long series of production, and associated environmental and stand variables.

4.3. New themes

- Observatory of the global markets for natural resin, derivatives and substitutes.
- Carbon footprint of natural resin derivatives from Mediterranean forests.

- Study of the possible impact of polluting elements and residues originated by the resin extraction activity, and reduction proposal.
- Study of the role that resin producers can play in the prevention of fires, pests and diseases.

4.4. New knowledge gaps

- The physiological mechanisms linked to resin tapping are still insufficiently described, and more research is needed.
- The *Pinus pinaster* decay in inner Spain requires an investment effort in research for a better understanding of the factors implied, as well as the strategic participation of managers, owners and forest workers in its control.
- What business models are most suitable for resin extraction? How do the costs associated affect the price of the resin?
- What is the socioeconomic relevance of the resin processing industries in the territory?
- How does local population perceive the resin tapping activity and the processing industries?
- How can a control and traceability system of products derived from natural resin be established and funded?

4.5. Potential solutions

- Establishment of a network of samples sites to obtain long-turn series of resin production data and associated environmental and stand variables, with standardised tapping methods to obtain reliable yield data series comparable to each other, including intra-seasonal monitoring of production by means of periodic resin tapping in the proposed network of plots throughout the campaign.
- Awareness raining among forest owners, resin producers and industry of the importance to establish the network and the cession of real production data. A confidentiality agreement would facilitate the contribution of traceable real production data by the economic agents involved.
- Use of first-generation production models for the selection of areas of high production and productive classification of small-scale forest stands with application of the models through Geographical Information Systems.
- Development of resin production models or integration in existing forest growth and yield models at stand level.
- Use of the new resin parameters included in the ongoing Spanish national forest inventory for the supraregional scale models.
- Multi-criteria analysis: The socioeconomic implications of the resin tapping activity should be analysed by means of a multi-criteria evaluation that, in addition to productive factors, considers the positive externalities, the contribution to environmental and social sustainability, and the ecosystem services it provides.
- Proposal for a user-friendly digital system for the traceability of natural resin and its derivatives at exploitation, regional, national and European level, generating added value for the user in terms of logistics and administrative management, and allowing the monitoring and sharing of resin production data in real time. The system should allow the capture of data relating to the

type of stimulants used, damage and diseases observed in the mass of origin, aspects related to fire prevention and compliance with applicable rules for conservation of habitats and species.

- Creation of a SiResin-like inter-regional register of forest owners, resin workers and first and second transformation industrial facilities, and implementation of a production declaration system.
- Creation of an observatory of the global market for natural resin, derivatives and substitute products.

References

Alía R., Auñón F. (2019). SustForest Lab & sampling protocols for Maritime pine resin as forest resource. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Alonso Ponce R. (2019). Remote sensing approaches to forest resource inventories for resin yield modelling. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Calvo J. (2019). Development of a web/Android App for logistics and resin traceability. SustForest Plus Project. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Clopeau A., Orazio C. (2019). What information is needed for market and profitability analysis of resin tapping systems ? "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Colaço C., Skulska I., Salgueiro A. (2019). Rural abandonment and evolution towards megafires – a rural renaissance needed? "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Diez J.J. (2019). Maritime pine decline in Northern Castile, droughts and implied pathogens. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Ezquerra J., Picardo A. (2019). Resin tapping in Castilla y León: Keys of a success story. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Ferreira M. (2019). Yield data and models for a sustainable resin sector in the Mediterranean area. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

González García M. (2019). Process based models for resource monitoring in *Pinus pinaster*. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Husson H., Rupil L., Clopeau A., Orazio C. (2019). A species for the future resin production: maritime pine is the most common French softwood. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Rodríguez García A. (2019). Climate and soil factors influencing individual tree resin yield. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Robertson L., Cobacho Arcos S., Escuer M., Santiago Merino R., Esparrago G., Abelleira A., Navas A. (2011). Incidence of the pinewood nematode *Bursaphelenchus xylophlius* Steiner & Buhrer, 1934 (Nickle, 1970) in Spain. *Nematology* 13(6), 755-757.

Robla E., Adame P., Alberdi I., Fernández Centeno G, (2019). Resin in Spanish National Forest Inventory & statistics. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Soares P., Santos C. (2019). Portuguese resin traceability & statistics. "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Taghouti I., Baraket M. (2019). Pine forests in Tunisia – an opportunity for local employment in resin production? "Resin resource monitoring & modelling in a context of climate change", 1st Interregional workshop of the Resin iNet, Madrid, January 21/22m 2019. H2020 project no.774632 RUR-10-2016-2017 European Commission.

Annex 1

Questions to be answered during the 1st Resin iNet IWS Madrid 1-2019

"Resin resource monitoring & modelling in a context of climate change"

Session1. Resin production from pine forests: resources, inventory and monitoring – where are we?

Scope and outreach for reflections in flash presentations:

1. What do we know about the pine forest, its current and potential resin productivity, and the resin sector in your country? What are the official statistical data, their sources and methodologies?
   (…focusing in the value chain from forest to first transformation, and beyond)
2. What are the main data uncertainties, current and for the years coming, limiting the full development of the resin sector?
3. Which is the actual, ultimate purpose of the inventory, statistics and traceability systems for forests and their resin production?

Further questions for panel discussion

4. What are the main data gaps and the inconsistences between regions and countries - how could these gaps be filled and the systems harmonised?
5. Which other unofficial or indirect data sources could be prospected to complete the picture?

Session 2. Threats & challenges for resin tapping in pine forests – what are we facing?

1. What are the most serious challenges and threats our pine forests are facing, and how could they impact the resin production?
2. Which main uncertainties result for the current and forthcoming situation of the resin sector?

Session 3. Resin yield data & models, a support for resource mobilisation – what can science tell us?

1. What kind of data, and models, does the natural resin sector need to develop the business in a sustainable way?
2. Is it feasible to assess, and model, the potential of resin production of our territories? At which territorial and temporal scale (scenario) and how accurately?
3. Which assessment and monitoring systems or tools are available or can be developed?
4. What data are needed for feed this models? Are they available?
5. Is it feasible to predict the evolution of the natural resin sources under a global change scenery (CC, new pests & diseases)?

Further questions for the final

Session. Needs and challenges for the sector that forest models can respond.

1. What data, systems and devices are needed for assessing, monitoring, and modelling maritime pine growth and resin yield?
2. What data, systems and devices are needed for assessing, monitoring and predicting maritime pine decline?