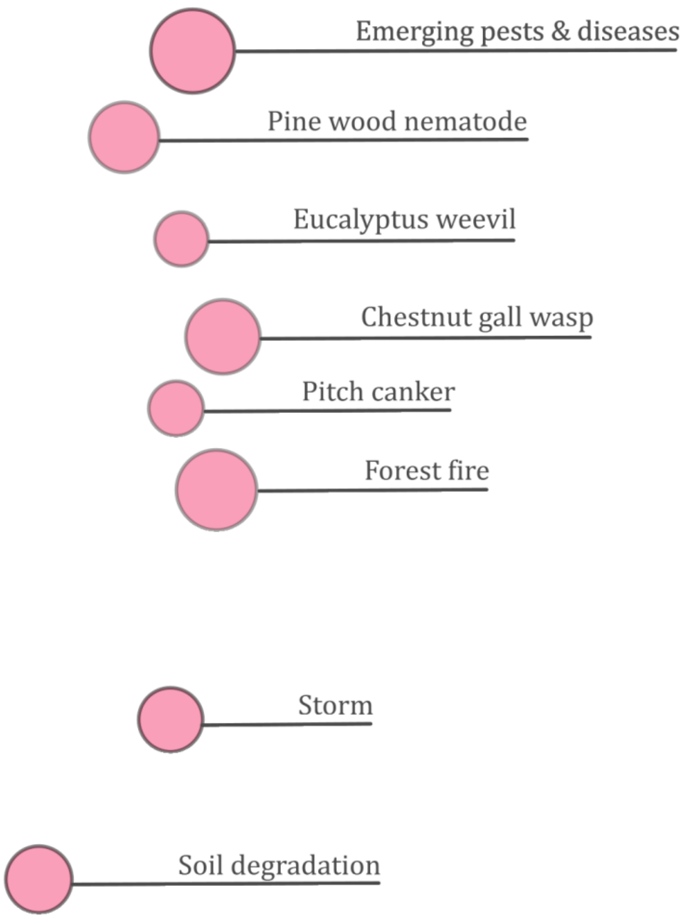
Minutes of the forest fire risk workshop

Fire behaviour software: a good tool to enhance forest fire management plans



Centro de Ecologia Aplicada Baeta Neves, ISA, Lisboa, Portugal
22 and 23 May 2017

Author of the minutes: Eduard Mauri (EFIATLANTIC)

Reviewer of the minutes: Conceição Colaço (ISA)

Workshop organisers: Conceição Colaço (ISA), Francisco Rego (ISA)

Table of contents

Agenda

PLURIFOR PROJECT
FOREST FIRE RISK WORKSHOP:
FIRE BEHAVIOUR SOFTWARE: A GOOD TOOL TO ENHANCE FOREST FIRE MANAGEMENT PLANS

MONDAY **22 MAY 2017**	**Organiser:** CEABN/ISA **Language:** English **Venue:** Centro de Ecologia Aplicada Baeta Neves, Instituto Superior de Agronomia, Tapada da Ajuda, 1349-017 Lisboa

9:00	Welcome and objectives of the workshop — Francisco Rego (ISA)
9:10	WP2: definition of the tools for task 2.2
	List of tools already in use by the different partners (5 min presentation) 9:10 - Portugal 9:15 – Asturias 9:20 – Basque Country 9:25 – Galicia 9:30 - Discussion 9:50 – Presentation and small training on TIGER software to discuss the possibility to be used by the different partners (Francesco Giannino – University of Naples, Italy) 11:15 – Coffee break 11:30 – Return to the TIGER software 12h30 - "Transboundary risk transmission and risk governance – case studies from fire prone forests in western USde apre", por Alan Ager, USDA Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory, USA. (this conference will be held in another building)
13:15	Lunch break at CEABN
14:00	Practical cases
	Presentation of practical cases in forest fire management plans using FARSITE and FlamMap. Small training on FlamMap software to discuss the possibility to be used by the different partners (Carlos Loureiro – GIFF: Gestão Integrada de Fogos Florestais).
16:00	Discussion of the potentialities of the different software to enhance the fire management plans from each partner
16:20	Definition of the next steps and product resulting from GT2
17:00	Coffee break
17:30	Small specific training with the TIGER software
19:30	Closure
20:00	Dinner (place to be designated)*

* At each partner own expenses

PLURIFOR PROJECT
FOREST FIRE RISK WORKSHOP:
FIRE BEHAVIOUR SOFTWARE: A GOOD TOOL TO ENHANCE FOREST FIRE MANAGEMENT PLANS

TUESDAY 23 MAY 2017 FIELD TRIP	**Organiser:** Name, Organisation, Telephone, E-mail **Language:** English **Place:** Coruche region
8:30	Departure from Instituto Superior de Agronomia (main building)
10:00	Arrival to the Coruche Region to see in place some of the plans presented the day before. Discussion with forest owners and with the local forest associations about the constraints and strengths of the different fire management plans.
13:30	Lunch at the Coruche region
14:30/15:00	Return to Lisbon
16:30	Arrival to Lisbon (it is possible to take participants directly to the airport/train station)

Note: Please bring your laptop so that you can use TIGER software.

Forest fire risk WP2 objectives

Forest fire risk partners and associated partners

Region	Organisation	Contact person	Associated partners
Portugal	ISA	Francisco Rego (risk coordinator)	
Asturias	CETEMAS	Andrea Hevia	Servicio de Emergencias del Principado de Asturias Celulosas de Asturias S.A. Asociación Asturiana de Empresarios Forestales, de la Madera y el Mueble Servicio Regional de Investigación y Desarrollo Agroalimentario Consejería de Agroganadería y Recursos Autóctonos de Asturias
Euskadi	Hazi	Alejandro Cantero	Diputación Foral de Álava Diputación Foral de Bizkaia Diputación Foral de Gipuzkoa Gobierno Vasco - Departamento de Desarrollo Económico y Competitividad
Galicia	CIG	Cristina Fernández	Subdirección Xeral de Prevención e Defensa contra os Incendios Forestais Servicios Agrarios Galegos

Tools and risk management plans to be developed within PLURIFOR project

As decided by the PLURIFOR Technical committee n°2 meeting (25-26 January 2017 at NEIKER, Parque Tecnológico de Bizkaia, Parcela 812, calle Berreaga 1, Derio, Spain), the following tools and risk management plans will be developed by the forest fire risk team in WP2:

- To write a best practice brochure to explain the steps to develop fire management plans using:
  a) Typology of past fires using historical records;
  b) Fuel maps;
  c) Simulation tools as FARSITE & FlamMap (possibly TIGER);
  d) Existing case-studies as examples (Portuguese and other partners)

Attendees

Attendees

Participants

First name	Last name	Organisation	Workshop Monday 22 May	Field trip Tuesday 23 May
Alejandro	Cantero	Hazi	Yes	Yes
Amelia	Uria Peña	BASOEKIN, S.L.	Yes	No
Ana	Águas	CEABN/ISA	Yes	Yes
Eduard	Mauri	EFIATLANTIC	Yes	Yes
Edurne	Lacalle	USSE	Yes	Yes
Elena	Canga	CETEMAS	Yes	Yes
Enrique	Jiménez	CIF-INGACAL	Yes	Yes
Francisco	Dans del Valle	Compañía Galega de Silvicultores, S.L.	Yes	Yes
Ricardo	Marinho	Instituto para o Desenvolvimento Agrário Da Região Norte	Yes	Yes
Rui	Almeida	ICNF	Yes	No
Sandra	Sánchez García	CETEMAS	Yes	Yes
Tânia	Pereira	ICNF	Yes	No
Vasco	Silva	CEABN/ISA	Yes (PM only)	No

Organisers

First name	Last name	Organisation	Workshop Monday 22 May	Field trip Tuesday 23 May
Conceição	Colaço	CEABN/ISA	Yes	Yes
Francisco	Rego	CEABN/ISA	Yes	No

Guest speakers

First name	Last name	Organisation	Workshop Monday 22 May	Field trip Tuesday 23 May
Carlos	Loureiro	Gestão Integrada de Fogos Florestais	Yes, as speaker	Yes, as speaker
Carlota	Barata	Associação Produtores Florestais de Coruche	PM only, as participant	Yes, as speaker
Duncan	Heathfield	World In A Box	Yes, as speaker	Yes, as participant
Francesco	Giannino	University of Naples	Yes, as speaker	No
Mariana	Ribeiro	Associação Produtores Florestais de Coruche	No	Yes, as speaker

Apologies

First name	Last name	Organisation
Andrea	Hevia	CETEMAS

Absent

First name	Last name	Organisation
Rosário	Alves	Instituto para o Desenvolvimento Agrário Da Região Norte

The following associated partners didn't register for the workshop:

From Portugal[1]:

- Altri Florestal (associated to ISA)
- RAIZ - Instituto de Investigação da Floresta e Papel (associated to ISA)

From Asturias:

- Servicio de Emergencias del Principado de Asturias (associated to CETEMAS)
- Celulosas de Asturias S.A. (associated to CETEMAS)
- Asociación Asturiana de Empresarios Forestales, de la Madera y el Mueble (associated to CETEMAS)
- Servicio Regional de Investigación y Desarrollo Agroalimentario (associated to CETEMAS)
- Consejería de Agroganadería y Recursos Autóctonos de Asturias (associated to CETEMAS)

[1] These Portuguese associated partners aren't directly linked with wildfire risk so they were not invited. Instead, the invitation went to the forest authorities (associated partner) and to a forest owners association.

From Euskadi:

- Diputación Foral de Álava (associated to Hazi)
- Diputación Foral de Bizkaia (associated to Hazi)
- Diputación Foral de Gipuzkoa (associated to Hazi)

From Galicia:

- Subdirección Xeral de Prevención e Defensa contra os Incendios Forestais (associated to CIF)
- Xunta de Galicia (associated to CIF)
- Servicios Agrarios Galegos (associated to CIF)

Presentation of the tools/knowledge

WP2: definition of the tools for task 2.2

Goal

To present software tools currently used by each PLURIFOR partner involved in forest fire risk management.

Content

Portugal

Francisco Rego: "Wildfire risk: the next steps"

In Portugal, the major need is to improve the prevention step of forest fire risk management plans. For this, developing and validating new tools can be necessary. FlamMap is the standard software in Portugal used to simulate fire spread.

As fuel reduction is expensive, the location of these areas must be optimised. The aim in prevention is to choose the most cost-effective areas where to concentrate fuel reduction. To locate them, fire behaviour is simulated in different scenarios. Learning from past wildfires to know how and where fire spreads is also a commonly used source of information. These strategic areas for fuel reduction are then proposed to forest authorities.

For Portugal, FlamMap and FARSITE softwares should be improved and adapted to Europe, as an alternative TIGER, which is a European/Italian software tools that could be used for the remaining European countries.

Asturias

Sandra Sánchez: "Use of LiDAR data to create a forest fuel map in Asturias"

Asturias is currently creating fuel maps at regional scale (within Asturias), in collaboration with different organisations and research centres. They are evaluating the existing forest data available to consider using fuel models from Galicia and adapt them to Asturias, or using LiDAR data (0.5 points/m^2, canopy height, scrub height, canopy density scrub density) along with forest maps (vegetation type, stand structure and scrub formation), both from the Spanish national forest inventory, to create their own fuel models.

The result will be a raster fuel model map. Fire risk maps could be obtained when combining fuel model maps with slope, aspect, road map and population distribution.

Euskadi

Alejandro Cantero: "List of tools already [used] in the Basque Country"

Official tools used in forest fire management are: forest fires statistics, forest fire plans and weather warnings. Not official tools are: fire risk maps based in Spanish airborne LiDAR campaigns (2008 and 2012, the next will be 2017) and field data.

Combining Spanish national forest inventory plots and airborne LiDAR data, they are able to model tree height, dbh, volume, scrub height; and map them in a 100 x 100 m grid based in ForRisk project equation. In ForRisk project terrestrial LiDAR had been used to assess the distribution of biomass within stands (trees and scrubs). Moreover, airborne LiDAR data is used to generate the landscape (.LCP) file (25 x 25 m grid with 8 covers; a new one will be generated in 2017) necessary for FARSITE forest fire simulation.

Fire risk maps are then produced combining these previous data with slope, aspect, fuel model, crown base height, stand height. Risk zones are the demarcated.

Geographical data generated is available through the free web viewer Visor Geoeuskadi.

To assess the accuracy of these risk zones, post-hoc FARSITE and FlamMap simulations are done with data from real forest fire. Simulation results are compared to the real burnt surface: very similar burnt surfaces are obtained.

Galicia

Enrique Jiménez: “Use of fire behaviour software for forest fire risk management in Galicia”

PLADIGA is the annual forest fire management plan for Galicia. It currently needs to improve fuel maps and tools for prevention actions at landscape level. To do so, CIF started working in Caladas district (one of the 19 fire districts in Galicia). Used software tools are FlamMap and FARSITE.

Digital elevation model and vegetation maps were easy to get from the Spanish national forest inventory. Airborne LiDAR was not used for vegetation information because resolution in some areas was too poor. A field classification guide through a visual inspection was created to assess the fuel model within a forest stand.

FlamMap simulations where conducted with WindNinja software for wind modelling. From these simulations high priority zones to reduce fuel were retained, with especial interest to limit flame height.

In the near future, they want to: include historic data, include typologies of forest fires, consider specific scrub fuels, evaluate preventive fuel treatments and consider objective functions.

Discussion

F. Dans doubts that PLADIGA is a real forest fire management plan for Galicia. He states that this document is more a report of what has been done during the previous forest fire campaign and the means that are available for the following one.

F. Rego concludes that these regional risk management approaches have many common points, with some differences in the data used. FlamMap and FARSITE are the common software used, but they have some limitations, mainly due to their usage complexity and time-consuming data input. TIGER software can be an alternative.

Presentation, practical cases and training on software: TIGER, FARSITE, FlamMap

Goals

Learn about different fire behaviour software to enhance forest fire management plans, with especial emphasis on TIGER software, the most recent one.

Discuss about the possibilities to be used by the different partners as a forest fire risk management tool.

Content

TIGER

Led by F. Giannino and D. Heathfield

This software was developed as collaboration between scientific research and a private company. It is intended to be used by forest authorities.

Aim of the presentation: show what makes TIGER different from other fire behaviour simulators, how it works and how it is used by the Italian forest service.

Fire propagation model: introduction

To simulate fire behaviour it is necessary to model how fire propagates within a homogeneous landscape cell. Three approaches exist:

- Empirical: fire propagation is related to real fire spread measured during a fire event. Good data is needed and these models are difficult to export.
- Semi-empirical: is the main stream. They are simple, fast to calculate even for big extents.
- Physical: these models are very heavy and complex, require lots of inputs, calculation time and computational power, even on small extents.

The aim of TIGER was to be between semi-empirical and physical models.

The model

Aims: to be able to use backfire to firefighting, so fire behaviour has to be quickly calculated. Better integrate fire-wind interaction within the model: in other models wind is just a coefficient, while in fact, along meteorological wind, fire also creates its own local wind as form of convection winds that influence fire propagation, including brand dispersion. This is considered into TIGER.

In a cell of the TIGER model, ignition, vegetation water content, combustion and temperature balance interact to model fire spatial spread (with a spatial model) along with wind, convection, diffusion, irradiation, insolation, and spotting (for ignition).

A limitation of FARSITE is that the model needs the rate of fire spread within a homogeneous cell (fuel model), regardless of the vegetation structure/description within this cell. It needs calibration.

However, in TIGER, rate of fire spread in function of time is adapted, for a given fuel model, according to different vegetation moisture content (because ignition is delayed as humidity increases) and terrain slope. Accurate fuel model maps are crucial for TIGER to give an accurate simulation.

Along with vegetation moisture and terrain slope, wind is the other variable modifying fire spread in function of time. Wind flow model for wind turbines has been adapted to fire behaviour. The model predicts wind flow using a digital elevation model and the roughness of the land. From a weather forecast giving the speed and azimuth of the wind, the model gives the azimuth and speed of the wind at every landscape cell. This is integrated into TIGER software, not like WindNinja software, that is not integrated. TIGER cannot cope with very complicated terrain (slopes > 70%), as wind flow becomes highly time consuming. The wind model also integrates convection flow created by the fire itself. Even if wind is set calm, the model considers the convection airflow created by the fire itself.

The model is deterministic. Some stochastic simulation is intended to be introduced, but this would need to run several simulations of a single scenario to calculate the mean result.

Three limitations to export TIGER to Portugal are:

1. DEM currently exists within TIGER just for Italy,
2. cloud system (for storage and computation) needs to be rented by a country authority (as ICNF in Portugal), and
3. Portugal has different fuel models than Italy, so they have to be entered into TIGER (in TIGER, fuel models represent the speed of fire spread in function of time for different moisture content and wind speed).

However, one of the advantages of TIGER is that it is modular, so very easy to tune parameters. These parameters are in the cloud, so updates and bug solutions are immediately transmitted to users.

TIGER MEG

Aim of this software: education, forest fire prevention training and forest fire management brainstorming (pre- and post-fire).

Main features:

- Two simulation types: forward run (from ignition to extinction) and backward run (from burnt area to ignition area).
- Ready and easy to use.
- Use of already available databases (input data and maps).
- Grid of 25 x 25 m.
- Cloud-version software: computation is done in the cloud, and some data is already uploaded the cloud as preloaded data that does not change (like DEM) is already there.

In the viewer, the 25 x 25 m grid (containing the DEM) overlaps the orthophotos. Fuel maps and ignition area (an area enclosed by at least three points; if it is a forward run) can then be uploaded. If fuel maps are not digitally available, they can be “painted” by the user with a tool that allows assigning a fuel model to each cell. Similarly, a polygon can be manually drawn to indicate ignition area. To complete the scenario, date, hour, wind conditions (speed and azimuth) must be set.

Other adjustable parameters are the burning time and the interval between two mapped fire lines.

For the moment TIGER is just operational for Italy, where DEM and adapted fuel models exist.

Other limitations still exist within the software:

- Firefighting operations are not considered by TIGER. To simulate them, it has been proposed to stop simulated fire spread at the moment when firefighting operations begin, apply fuel model changes as result of these operations, and then start a different scenario at that moment to see how fire behaviour would chance. Compering this new scenario with the "non-intervention" one assesses how firefighting operations influence fire behaviour.
- There is no tool yet to locate critical spots (priority areas where modifying vegetation as preventive interventions helps to reduce fire spread through the landscape). This can be achieved by simulating many fires through the landscape in the most likely scenarios and comparing where fire spread occurs more frequently.
- Up until now, the only simulated fire is surface fire, but with the intention to add also crown fire.

Simulation results can be exported to Excel (report), to Google Earth (spread) and other GIS formats.

The speed of all this process allows forest fire managers to simulate a fire underway, even according to different scenarios, in order to forecast fire behaviour and give instructions to firefighters.

TIGER FFAS

Aim: forest firefighting teams training through virtual reality.

Main features:

- Two vegetation layers: surface vegetation up to 2 m high and crown more than 2 m high.
- More complex and detailed combustion models than TIGER MEG, allowing surface fire can pass to crown fire.
- Grid of 1 x 1 m.
- Smoke submodel to simulate smoke effects.
- Vegetation types with different species within, spreading fire according to their characteristics.
- Firefighting operations interaction, with different fire attack methods: manual extinction, manual and mechanical vegetation removal, water attack (land or airborne).
- A virtual landscape is generated to interact through virtual reality, one firefighter at a time.

In Italy, TIGER FFAS is used to train forest fire fighters of the national forest service to similar situations of a real forest fire.

Demonstration of TIGER MEG

Demonstration mainly showed how to:

- Run the simulation forward and backward.
- Adjust the parameters to create a scenario.
- Export the results to Excel and Google Earth.
- Create a customised fuel model map using the “paint tool”.
- Simulate firefighting by modifying fuel model (as the creation of a fire breaker) and running simulation again to see the impact.

FARSITE and FlamMap

Led by C. Loureiro

Aim of the presentation: show how FARSITE and FlamMap are used by GIFF to build forest fire prevention plan in Portugal.

Different approaches are used.

Risk control approach

Main question to answer: what will be the risk of investing in a forested area?

This question can be divided in two:

- Fire history maps and fire return interval: how likely is fire to happen?
- Potential for fire spread and fire intensity: how easy a fire would be to extinguish?

The main inputs for potential fire behaviour are:

- Fire history
- Land-use classes, from which fuel models are derived
- Topography

Strategic fuel management is done according to:

- Values to protect
- Resources optimisation
- Cost reduction

Many scenarios are built according to different occurring winds.

Prevention optimisation approach

Main question to answer: find the optimal locations for fuel management areas in the landscape.

Firebreaks (undergrowth removal and tree thinning and pruning) are costly to establish and maintain. The same year the firebreak is established the arriving fire will die there without intervention. After the first year, because of understorey vegetation growth, the presence of firefighters is necessary. Fire intensity will be very low and the fire could be extinguished. Undergrowth vegetation has to be treated every four to five years to assure these effects.

Using FlamMap, GIFF Company analysed the effect of existing firebreaks on fire spread, and searched for alternative options. In all simulation, fire is let free, without suppression.

As a result, fire does not stop at firebreak, but when and just after crossing a treated area it propagates more slowly and with less intensity. Before it speeds up again, firefighters have a time span to more easily attack the flames. However, firebreaks increment the length of the fire line and generate a more heterogeneous burnt area. In conclusion, there are more fire lines, but a higher proportion of them can be directly attacked.

FlamMap used to simulate different scenarios where different fire breaks are located according to experts' knowledge. Three wind scenarios where simulated: no wind, SE wind, and only topographic wind. The most optimum scenarios were evaluated as those having the lowest proportion of areas burnt with high and extreme intensity.

Case of study: how to protect microreserves

Main question to answer: how to reduce the chances that a microreserve (several hectares) burns

This is only the best approach if you are protecting a small protected area that you want not to burn, assuming that fire will come from outside. Fuel management is not possible into these micro protected areas. Fire must pass around, so protected areas are surrounded by a buffer zone where fuel management is done.

As land-use maps can be not up to date, on field check is necessary. Land-use is converted to fuel model, but as fuel models for FlamMap and FARSITE come from USA, they do not always represent the actual fuel present and how fire will really spread through them. USA fuel models have to be adapted to the Portuguese ecology.

Crops are the less flammable land us. The best strategy is to incentivise agricultural owners to continue cultivating their fields. Fire history is also helpful, along with modelling, to decide where to place fuel treatments and firebreaks.

Discussion

Led by F. Rego

F. Dans questions about whom are the users of these software tools and the end-users of the products generated by them. They seem to be used by forest services and forest firefighters.

F. Rego & C. Colaço answer that forest service agents, forest firefighters would have to use these tools accompanied by forest owners associations. These tools are useful to demonstrate to forest owners why it would be important to intervene in critical areas where fuel reduction would help preventing fire spread.

F. Dans would like that these tools incorporate socio-economic variables that influence forest fire ignition, as some of these variables allow explaining fire risk.

E. Jiménez notes that PLADIGA includes forest fire statistics and could be a source of information.

F. Rego states that statistics on ignitions can be used into fire simulations. Moreover, different forest management practices can be incorporated into the scenarios to forecast how fuel management influences fire spread.

F. Giannino states that, when modelling, fire spread is more important than vegetation structure, so when adapting your regional vegetation to fuel models, you have to know the fire propagation in your vegetation according to wind and moisture content.

F Rego: fire spread can be adjusted with the physical properties themselves (physical limits of combustion and fire spread). The weakest point is not about knowing the on-site vegetation, but the propagation fire model within this vegetation. However, thanks to the increasing computing capacity and thanks to LiDAR technology, that gives the distribution and description of the fuel within a cell or even as continuous data, could this suppose the end of fuel models?

F. Dans wonders if fuel models used do really represent the intensively managed stands typical of the European Atlantic forestry, of if they reflect unmanaged stands more representative of USA, where most of fire behaviour simulators come from? Example: do fuel models include pruned pine stands with left pruned branches, eucalyptus coppice…? Productive stands change quickly (pruning, thinning…), this is a problem as fuel models in a forested landscape would also change frequently.

C. Loureiro answers that European productive stands have their own fuel models, and they are adapted to the Portuguese most common conditions. However, the number of fuel models must be limited to help retaining one for each stand. In Portugal, because forest tenure is very fragmented, territorial fuel model variability can be very high, impossible to model. In these cases the solution implies choosing a single model for a big area.

Fuel models need to characterise: quantity of fine, medium and coarse fuel (green and dead), quantity of grassy and scrub biomass (green and dead), and the height of the undergrowth.

E. Jiménez confirms that in Galicia fuel models are also adapted to their regional forests.

F. Rego argues that, in fact, current national forest inventories measure more vegetation variables than those needed for fuel models.

R. Almeida finds it difficult to upload information into the FARSITE and FlamMap models.

D. Heathfield states that TIGER solves this problem, as some data is already preloaded (DEM and wind maps), while other is easy to upload (hand mapping fuel models).

R. Almeida confirms that getting fire spread calculation results within a minute span (like in TIGER) can help real time decision making during firefighting. Concerning fire prevention: the main necessity of ICNF is to know which fuel management places need to receive yearly maintenance and in which maintenance would be only needed every 2-4 years.

F. Giannino: the limitation [to answer the second question] is how to connect vegetation data to the most appropriate fuel model. Even within a 25 x 25 m grid resolution, vegetation distribution can be heterogeneous.

C. Loureiro: if you want to control fire in a smaller area, you need more information.

F. Rego: the use of forest fire behaviour simulators will be different depending to end-users. According to him, there are three types of them:

- agents responsible of firebreaks: they need a general image of fire spread though the landscape,
- forest owners that do forest treatments: they need to know what can be done at stand level to reduce fire spread, and
- forest firefighters: they need to know how wind influences fire spread.

Fire behaviour simulators are useful at municipal level, as local authorities responsible of forest management usually do not know fuel models in their municipality and how to manage them to reduce forest fire risk.

R. Almeida remarks that an untreated problem is the flying ambers. He wonders if they are currently included into the models. ICNF wants to know the probability of ambers arriving at a specific location.

F. Giannino: TIGER simulator can do it, but different simulations with different scenarios are needed.

Training on TIGER software

Led by F. Giannino

Aim: test the combination of fuel model, slope and wind climate on fire behaviour. How to export results to Google Earth and Excel.

The participants could test the effects of a firebreak on fire spread, doing the same simulation with and without this feature. Without firebreak fire spread following the wind, with firebreak, it stopped there and then spread laterally, as trying to surround this feature, although than slower.

Demonstration of FARSITE

Led by C. Loureiro

The most tedious step of FARSITE is preparing spatial information using a GIS and then exporting it to FARSITE. Once exported, it is impossible to make any spatial data change. The size of the pixel is limited by the resolution of the DEM: all other layers must have the same resolution.

Compared to FlamMap and TIGER, FARSITE requires more inputs, such as moisture content of biomass and meteorological data.

GIFF demonstrated that using Portuguese fuel models, fire spread in Portugal is more accurate than using fuel models from USA. It is a common procedure to test the accuracy of the models by comparing the spread of real fire with the spread of fire simulated under the same conditions.

Concerning the influence of forest roads on fire spread, raster resolution is too coarse to assume that a whole pixel is covered by a road. To reflect the effect of forest road width on fire behaviour, spread factor has to be adjusted for pixels containing a road in order to slow down fire progression. If the landscape contains linear features that are effective fire stoppers, they can be imported from a layer containing them. They can simulate lines of firefighters attacking the fire line.

FARSITE cannot be used during firefighting operations because data preparation is too slow.

Demonstation of FlamMap

Led by C. Loureiro

FlamMap is simpler than FARSITE, as it does not need meteorological data, only wind data (azimuth and speed), like TIGER.

Due to lack of time this was the only relevant point signalled about FlamMap.

Conference by Alan Ager: "Transboundary risk transmission and risk governance – case studies from fire prone forests in western US"

Goal

Evaluate how forest fires spread through tenure boundaries in western USA.

Content

In western USA, different public and private tenures intermingle. Forest fires can start in a type of tenure and spread to another adjacent one, and this is a risk. Lots of fires starting in national forests spread outside.

By simulating lots of fires (over 10,000) with a stochastic distribution of ignitions, it is possible to track from where a fire starts to where it goes. Historical series are too short to be used for the same exercise.

For a given tenure, outgoing proportion of fire (as burnt area) is similar to incoming proportion. Network analyses assess who is sending fire to who, so it can be predicted which would be the most affected communities, and from who they will receive the fire, so with who communities should collaborate to reduce incoming fire risk. The results are also useful for forest owners (public or private) so they would know who they could affect with their outgoing fire.

It is also possible to locate areas that transmit fire to other tenures or to inhabited areas ("fire givers" and "fire receivers"), and know which areas burn by self-fire ("fire is your own problem"). For a given point on the landscape, the closer to the border with another type of tenure the point is, the higer are the chances to receive fire from elsewhere.

All this implies adding a layer of complexity in forest fire and prevention, and that forest fire management has to be done at a bigger extent than ones ownership. So, mismatch of the scale for planning is common: the scale of prevention plans is not congruent with future fire events. Another difficulty for people is to understand stochasticity of fire simulation. However, this study acted a trigger to start exchanges between forest fire managers of different tenures.

New concepts from this study to forest fire management:

- Risk transmission

- Scale of risk
- Community firesheds (sources of fire)
- Community exposure
- Transboundary risk governance
- Scale mismatch

Conclusions

Discussion

According to F. Dans it is necessary to direct each end-user towards the most appropriate fire behaviour simulator. Three types of end-users should be considered: forest owners and their associations, forest practitioners and professionals and governmental forest service agents.

Due to the lack of time and the absence of the Spanish governmental forest service agents (Consejería de Agroganadería y Recursos Autóctonos de Asturias, Servicio de Emergencias del Principado de Asturias, Diputación Foral de Álava, Diputación Foral de Bizkaia, Diputación Foral de Gipuzkoa, Xunta de Galicia, Subdirección Xeral de Prevención e Defensa contra os Incendios Forestais), the discussion didn't go much further. The only governmental forest service agents present in the meeting were ICNF from Portugal (R. Almeida and T. Pereira).

Decisions

No decisions were taken during the discussion.

After the meeting, C. Colaço proposed to E. Mauri that the forest fire risk group should produce a synthetic guide to help end-users on choosing the most appropriate software tool for fire prevention. This should be point c) of the "best practice brochure to explain the steps to develop fire management plans" that will be produced as a WP2 output for this risk.

Field trip

General plan

<table>
<tr><th>Where</th><th>What</th><th>Who</th></tr>
<tr><td rowspan="2">Coruche municipality, 70 km NE of Lisbon</td><td>Visit to firebreak strips (two sites)</td><td rowspan="2">Carlos Loureiro, Gestão Integrada de Fogos Florestais
Carlota Barata, Coruche forest owners association
Mariana Ribeiro, Coruche forest owners association</td></tr>
<tr><td>Visit to a burnt area in 2016</td></tr>
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Content

Visit to firebreak strips

Coruche forest owners association manages a woodland called Erra (*zona de intervenção florestal*, or ZIF; about 15,000 ha, mainly composed of *Eucalyptus globulus* plantations, *Pinus pinaster* stands and *Quercus suber* stands). This area has a forest fire prevention management plan developed by Gestão Integrada de Fogos Florestais and implemented by the association forest agents. Forest owners are not obligated to join their local forest association. The main tasks of these associations in Portugal are forest fire prevention and pests and diseases prevention and management. The permanent monitoring team and the forest firefighters are partly paid by forest owners' memberships and partly subsidized.

The visited features are the firebreak strips, located through the landscape according to the ZIF forest fire prevention plan, after fire spread simulations using FlamMap and after analyzing regional fire history. Firebreaks are still under implementation.

Two schools of firebreaks exist:

- Total vegetation clearing firebreaks: where vegetation is completely removed from the strip.
- Shaded fuel breaks: where undergrowth is removed but trees are thinned and pruned, leaving more fire tolerant tree species in place, avoiding lateral and vertical fuel connectivity.

Shaded fuel breaks are those implemented in Erra ZIF. Its establishment is more expensive (about 800 €/ha), but it requires less maintenance, as shadow from trees slow down understory growth and wind speed.

The first visited firebreak was established in 2014, in a *P. pinaster* stand burnt in 2003. The stand regenerated correctly after fire, with high stem density. Shaded fuel break opening consisted in undergrowth removal, tree thinning (leaving taller and more fire resistant tree species in priority, cork oaks in this case) and pruning up to 2 m high. Undergrowth should be cleared every three years to avoid vertical fuel continuity. In this site this operation has to be done by slash cutter due to tree density.

This strip, 50 m wide, is located along a paved road that follows the crest of a hill, at the side from which prevalent winds come from. This would allow firefighters to extinguish the fire line there. The theoretical structure of firebreaks, given by the Portuguese forest authority, consists in a primary network of 125 m wide firebreaks with narrower perpendicular branches. However, this structure is almost never respected. Erra ZIF has lateral strips that separate watersheds. Its main function is to avoid lateral spread of the fire. High intensity fires can easily cross firebreaks pushed by the wind, bu will easily remain laterally restrained by these lateral strips.

The second visited firebreak was established in 2017 in a low density cork oak stand. Undergrowth could be cleared using a disc harrow. Pine trees were mostly removed, and those left were pruned.

Coruche forest owners association paid and executed fuel breaks according to forest fire prevention plan. Subsequent maintenance has to be done by the forest owners. When opening and maintaining a fuel break, thinned trees and pruned branches have to be removed or incorporated into the soil. Removal is the most used technique, as it is less expensive and can generate revenue from biomass sales. Forest owners association can help to coordinate maintenance operations, especially between forest owners that don’t have machinery.

Visit to a burnt area in 2016

The visited 2016 burnt area (mainly of *E. globulus*) had planned firebreaks, although they were not executed at the time of the fire. Flames run 6 km in one hour and a half. The higher the forest fire risk is, the higher the density of the firebreak network should be. Higher risk areas are those containing great proportions of unmanaged mature stands, which usually have high vertical and lateral fuel continuity.

Firebreaks are always located along roads and forest trails, so they can be easily reached by firefighters and by machinery for maintenance operations.

Workshop evaluation

Questions

Workshop content

		Strongly disagree	Partially disagree	Partially agree	Strongly agree	Not applicable	No opinion
1.	I was well informed about the objectives of this workshop and they were clear to me.			9	2		
2.	This workshop fulfilled my expectations.			6	5		
3.	The content is relevant to my job tasks concerning forest risks management.		1	4	5	1	
4.	The quality and depth of knowledge of this workshop were appropriate and represented state-of-the-art tools/technologies.				10		1

Workshop design

		Strongly disagree	Partially disagree	Partially agree	Strongly agree	Not applicable	No opinion
5.	The workshop activities/case studies stimulated my learning.			4	7		
6.	The activities/case studies in this workshop gave me sufficient practice and feedback.			8	3		
7.	The difficulty level of this workshop was appropriate.			5	6		
8.	The pace of this workshop was appropriate.			2	9		

Workshop instructor/facilitator/lecturer

		Strongly disagree	Partially disagree	Partially agree	Strongly agree	Not applicable	No opinion
9.	The instructor/facilitator/lecturer was well prepared.			1	10		
10.	The instructor/facilitator/lecturer was helpful.			1	10		

Workshop results

		Strongly disagree	Partially disagree	Partially agree	Strongly agree	Not applicable	No opinion
11.	I accomplished the objectives of this workshop.	1	1	4	5		
12.	I would be able to use the tools that I learned in this workshop on my tasks concerning forest risks management.	2	1	4	3	1	
13.	The exchanges with other professionals/instructors/lecturers were fruitful and will be useful for accomplishing my tasks concerning forest risks management.			5	6		

Self-paced delivery

		Strongly disagree	Partially disagree	Partially agree	Strongly agree	Not applicable	No opinion
14.	The workshop was a good way for me to learn its content.			4	7		

Field trip

		Strongly disagree	Partially disagree	Partially agree	Strongly agree	Not applicable	No opinion
15.	The field trip was appropriate for the content of the workshop.			4	4	3	
16.	The exchanges with the professionals during the field trip were relevant and helped me to understand the issues about this forest risk management.			3	5	3	

Improvements and values

How would you improve this workshop? (Check all that apply)

_6_Provide better information before the workshop.
_4_Clarify the workshop objectives.
___Reduce the content covered in the workshop.
_3_Increase the content covered in the workshop.
___Update the content covered in the workshop.
___Improve the instructional methods.
___Make workshop activities more stimulating.
___Improve workshop organization.

_1_Make the workshop less difficult.
_1_Make the workshop more difficult.
_1_Slow down the pace of the workshop.
___Speed up the pace of the workshop.
_1_Allot more time for the workshop.
___Shorten the time for the workshop.
_1_Improve the tests used in the workshop.
___Add (more) video to the workshop.

What other improvements would you recommend in this workshop? *The order of the answers is not relevant.*

Integration of tools into forest management planning al local scales (operational organisation).
Articulation between other risks management plans and producing intervention plans.
More time to explain the work carried out by the partners.
Provide previous information about field trip content.
Organisers should provide practical information to participants (hotels nearby and shared transportation).

What is least valuable about this workshop? *The order of the answers is not relevant.*

Lack of previous information, more information before the workshop was needed.

What is most valuable about this workshop? *The order of the answers is not relevant.*

Exchange of experience and knowledge between participants. *This point has been expressed by 2 participants.*
The feedback between the other teams involved in the project, as well as with the experts on wildfire simulations.
To get to know up-to-date tools to simulate wild fires.
The presence of foreign experts.
The first impact with fire simulator.

Opinions given by the Unión de Selvicultores del Sur de Europa (USSE) after the workshop

Following the discussions that took place in the workshop following the presentation of the different fire simulators software in Lisbon, we would like to emphasize the fact that the tools that are developed for each risk within the PLURIFOR project should be useful for managers, technicians and forest owners that work on the field and who are ultimately involved in the implementation of risk management plans in their forest properties.

As was expressed during the workshop and reflected in the conclusions from the perspective of managers, technicians and forest owners, with regard to these fire simulators software the following issues should be taken into account:

1. From the users' point of view:

It should be recalled that in most countries in southern Europe the responsibility for preventing the risk of forest fires falls on the operational scale of forest owners and managers, mostly natural or legal persons of a private nature.

It is also necessary to emphasize that prevention operations are formulated in management plans in those forests that have some planning. Although not all forests have these plans, their numbers increase year by year in a considerable way promoted by the requirements of forestry regulations and certification systems and in particular by the progressive professionalization of foresters and forest managers who work very closely with forestry associations.

Consequently, fire simulation software should also target the managers and technicians of forest owners' associations, in addition to the relevant services or authorities, designing tools that are appropriate to the technological capabilities and also to the budgetary constraints of the majority of these users.

For the correct management of these tools, the training planned in the later phases of the project (WT4) should be addressed to all potential users.

Consideration should also be given to the possibility for forest owners to benefit from simulators to increase their knowledge of fire behaviour, as explained at the workshop concerning training for forest service workers or forest fire services.

2. Concerning it utility:

- It could be useful for associations' technicians to locate critical points in regions and on forest owners' estates and thus recommend fuel management strategies for them.
- These strategies could be incorporated into forest management plans, with more realistic fuel models, with strategies more in line with local constraints, wind, topography… All this would allow substantial improvements in fire prevention and fight to be achieved at landscape scale, and take a qualitative leap with respect to the conventional preventive measures that are handled in the current planning.
- In turn, if the user was also the competent service of the administration, subsidies or premiums could be established to help owners who had the risk prevention integrated into their management plans and to carry out prevention work annually.

3. Socio-economic risk factors:

As was also stated at the meeting, we would like to analyse the possibility of including in the work the socio-economic factors that influence the risk of forest fires, factors that in many regions are decisive to correctly approach prevention of the risk of forest fires. On this topic, we have worked on previous projects that could be very useful in developing the fire prevention plan in different regions. One of these projects is FOMFIS, a cooperation project which developed methodologies to incorporate socio-economic risk factors. Therefore the tool and the subsequent writing of the plan should be oriented in this sense, taking into account these mentioned elements.

4. Fuel models:

We recall the need to revise fuel models to incorporate models that reflect the silvicultural changes introduced by current forestry activities, especially in cultivated or productive forests, but also in those of intensive social or recreational use, typical of the different ecosystems that exist in the south of Europe.