

Development of a simple and efficient method for field assessment of fire severity (ForFireS)

Contract Number 382167 FISC

Final Report

1. Background

The European Community, represented by the Commission of the European Communities, represented by the Director of the Institute for Environment and Sustainability (IES) of the Joint Research Centre (JRC), and Inventaire forestier national (IFN), a French public institution, following the Invitation to Tender No 2005/S 176-174127 of 13/09/2005 and the IFN's Tender (offer of 20/10/2005) have entered a contract the subject of which is a service on "Development of a simple and efficient method for field assessment of fire severity".

The contract was signed on 04/09/2006.

The present document, together with the Manual, Field Guide and database with fire severity data collected during two test campaigns carried out in 2007 and 2008, is the Final Report.

2. IFN partners and subcontractors

IFN worked with the following partners and subcontractors:

- Instituto Superior de Agronomia (ISA), Department of Forestry, Lisbon, Portugal
- Ministerio de medio ambiente y medio rural y marino, formerly Ministerio de medio ambiente, Dirección general por la biodiversidad, Madrid, Spain
- Groupement d'intérêt public « Aménagement du territoire et gestion des risques » (GIPATGeRi), Bordeaux, France, formerly « Association régionale pour la défense des forêts contre l'incendie »

The above-mentioned institutions were described in the original tender.

- Centre tecnològic forestal de Catalunya (CTFC), as a Spanish institution proposed by the Spanish Ministerio de medio ambiente y medio rural y marino

3. Manual

The Manual is the main document which describes the method. It contains:

- An introduction which gives the background of the project and the purpose of the Manual;
- The outlines of the method, which uses data collected on sample plots in the field to compute indicator values, rated from 0 (no impact of the fire) to 4 (very heavy impact of the fire), whose combination yields for a given fire an overall assessment on a scale from 0¹ to 4;

¹ If this value can be found for a plot it should not be relevant for a fire.

- The description of the data which must be acquired before carrying out the field work, their link with the EFFIS database and how to stratify a very large fire;
- The properties of the sampling network (node layout, plot shape and size) and the rules to design it for a given fire;
- The description of all field collected data, sorted according to the objects they are related to (plots, trees standing on the plots, regeneration present on the plots), with the coded values when they are used;
- The structure of the Microsoft ® Access database with an extensive description of the tables, which are divided into three sets, one for the data acquired before and during the field work, one for the recorded intermediary and final computation results and one for temporary results, and of the forms used as a main menu, for entering data and for processing them; the metadata themselves are recorded in two tables;
- A detailed account of the way each indicator is computed and their values are combined at the plot and fire levels with all relevant logical and mathematical formulas;
- Rules about the way to record the sampling grid size and plot co-ordinates;
- A description of the practical workflow for a fire severity assessment
- The list of the equipment necessary for field work;
- The texts in SQL mode of all the queries used for processing the data and storing the results.

Everything that the assessment manager needs to know to carry out the task is to be found in the Manual.

4. Field Guide

The Field Guide is destined to the field crews in charge of the observations and measures.

In this guide the following instructions are given:

- The rules of searching for a point in the field;
- Plot description and setting procedure;
- Data description and collection procedure;
- The rules of data recording in the field.

To raise the interest of the crews who are in charge of field tests the Field Guide gives information about the use of the collected data.

The bigger part of the Field Guide contents can be found in the Manual. Specific rules about data collection are given in the Field Guide only. The Field Guide is designed to be used without reference to the Manual. Thus, both documents are necessary to have a complete knowledge of the method.

It contains plot, tree and regeneration paper forms as well as two cheat sheets where all the codes are displayed.

The Field Guide is proposed with a typography and layout that allow it being printed out on half size paper (A5) while remaining legible.

For the test campaigns Catalan, French and Portuguese versions of the Field Guide in use were made available.

5. Field Tests

5.1. Scope

During the summer of 2007, field tests were carried out on 21 fires, among them 19 large ones (at least 50 ha). Both smaller fires happened in French Aquitaine were productive maritime pine forests grow on mostly flat grounds and where fire prevention and fire suppression have reached a high level of efficiency especially thanks to the activity of our GIPATGeRi partner. See following table.

Country	Region	Fire_ID	Fire Date	Area (ha)	Number of points	Performed by	Test Date
France	Mediterranean	2006_0142	22/07/2006	369	25	IFN	04/09-23/10/2007
France	Mediterranean	2006_0153	02/06/2006	192	27	IFN	20/08-22/08/2007
France	Mediterranean	2006_0316	11/08/2006	111	24	IFN	28/08-05/09/2007
France	Mediterranean	2006_0376	05/08/2006	72	28	IFN	16/07-20/07/2007
France	Mediterranean	2007_0125	27/06/2007	516	24	IFN	11/09-14/09/2007
France	Mediterranean	2007_0613	26/07/2007	190	27	IFN	24/10-25/10/2007
France	Aquitaine	2006_9999	13/06/2006	18	6	GIPATGeRi	24/09/2007
France	Aquitaine	2007_9999	12/05/2007	12	6	GIPATGeRi	17/09-18/09/2007
Portugal		2006_0037	09/07/2006	462	26	ISA	13/08-23/08/2007
Portugal		2006_0051	12/07/2006	319	25	ISA	08/08-10/08/2007
Portugal		2006_0071	26/07/2006	327	22	ISA	20/08-22/08/2007
Portugal		2006_0072	08/08/2006	255	17	ISA	06/08-07/08/2007
Portugal		2006_0081	06/08/2006	414	25	ISA	27/08-29/08/2007
Portugal		2006_0307	10/08/2006	499	17	ISA	16/08-17/08/2007
Portugal		2006_0323	13/08/2006	90	28	ISA	29/08-31/08/2007
Portugal		2006_0398	25/08/2006	1 104	23	ISA	22/08-24/08-2007
Portugal		2007_0622	29/07/2007	1 415	27	ISA	18/09-20/09/2007
Portugal		2007_1174	21/08/2007	3 355	20	ISA	17/09-18/09/2007
Spain	Catalunya	2006_0076	21/06/2006	158	22	CTFC	02/09-13/09/2007
Spain	Galicia	2006_0168	08/08/2006	661	23	CTFC	15/10-28/10/2007
Spain	Aragón	2006_0322	12/08/2006	1 390	26	CTFC	14/09-24/09/2007

Fire perimeters were provided by IES, except in the Aquitaine region where they come from a ground survey. As these fires are not recorded in the EFFIS database they were given “9999” identifiers.

Two-person test crews spent in the field:

- 25 days in the French Mediterranean region;
- 2 days in the French Aquitaine region;
- 25 days in Portugal;
- 20 days in Spain.

During the summer of 2008, field tests were carried out on 11 large fires. See following table.

Country	Region	Fire_ID	Fire Date	Area (ha)	Number of points	Performed by	Test Date
France	Mediterranean	2008_0036 ²	11/05/2008	43	27	IFN	07/07-11/07/2008
Portugal	Minho-Lima	2008_0018	26/04/2008	34	21	ISA	23/08-24/08/2008
Portugal	Lezíria do Tejo	2008_0078	06/07/2008	294	24	ISA	04/08-08/08/2008
Portugal	Baixo Mondego	2008_0128	17/07/2008	195	24	ISA	11/08-12/08/2008
Portugal	Pinha Litoral	2008_0129	09/07/2008	63	20	ISA	06/08-07/08/2008
Portugal	Veiga	2008_9999	06/04/2008	87	31	ISA	08/08-20/08/2008
Spain	Catalunya	2007_0175	04/07/2007	268	26	CTFC	19/08-22/08/2008
Spain	Huelva	2007_0623	29/07/2007	893	31	CTFC	31/07-05/08/2008
Spain	Canarias	2007_0870	29/07/2007	14 648	27	CTFC	28/05-03/06/2008
Spain	Castellón	2007_1488	29/08/2007	8 126	33	CTFC	09/06-17/06/2008
Spain	Salamanca	2007_1700	31/07/2007	339	35	CTFC	19/07-22/07/2008

Fire perimeters were provided by IES, except the Veiga fire in Portugal which comes from a ground survey. As this fire is not recorded in the EFFIS database it was given a “9999” identifier. Its perimeter is attached to the database of the final report.

Two-person test crews spent in the field:

- 4 days in the French Mediterranean region;
- 12 days in Portugal;
- 26 days in Spain.

5.2. Lessons learned

5.2.1. Point Co-ordinates

The organisations in charge of the tests designed the sampling networks. This task showed that several sets of co-ordinates had to be used:

- Rectangular co-ordinates in the local projection for designing a rectangular grid in each country or even in each part of a given country like France or Spain;
- Rectangular or geographic co-ordinates using the WGS84 ellipsoid in the GPS receiver to reach the points;
- Rectangular co-ordinates in the ETRS89 Lambert Azimuthal Equal Area projection used by the JRC.

In the field, a point can be moved under certain circumstances so that it is necessary to distinguish theoretical co-ordinates from the actual ones.

It is thus prescribed:

- To prepare the sampling network using a local projection system;
- To convert the co-ordinates into WGS84 geographic ones which can be loaded into the GPS receiver;
- To record the actual WGS84 geographic co-ordinates read on the GPS receiver display in the field;
- To convert the actual WGS84 geographic co-ordinates into ETRS89 LAEA rectangular co-ordinates.

To ensure complete information, local co-ordinates of the test plots and the projection properties are made available to the JRC with the final report.

² According to the French Prométhée database the fire date is 10/05/2008 and its extent 62 ha.

5.2.2. Plot Cover and Situation Regarding the Fire

The first test campaign showed that it was necessary:

- To set out unreachable points; they are the ones without actual co-ordinates;
- To record the plot land cover before the fire, the points on agricultural or urbanised land being left out of the survey even if they are inside the fire perimeter as it is known; it can be used for fire perimeter correction;
- To record whether a plot was burnt or not; not burnt plots are not surveyed but can be taken into account to assess the fire severity if they are considered inside the perimeter or to correct the perimeter.

5.2.3. Reducing the Number of Measured Trees

During the first test campaign, sampling plots had a fixed area of 500 m². After plots were found in Portugal and Spain with more than 40 trees to describe and measure, it was decided to limit their number by reducing the radius of circular plots to the size within which 20 trees are located or to measure a fraction of the trees on rectangular plots. Although the second test campaign has shown that the latter rule is not easy to implement it has been kept but it is stressed that rectangular plots should be installed in exceptional cases.

5.2.4. Forgoing Some Data

Data collected during the first test campaign were numerous and their extent could be considered as a maximum. Experience gathered during the tests and attempts at devising the computation of indicator values showed that:

- The accuracy of some measurements or assessment was not reliable;
- Not all data were necessary for computing indicator values, even if they could be used to break down various fire characteristics and develop further studies.

Thus, the amount of data collected during the second test campaign was lower than during the first one. On the other end, an estimation of the total ligneous cover rate on the plot before and after the fire was added to the collected data with the purpose of harmonising indicator value computation on forest and non-forest land.

5.2.5. Time Requirements

During the field tests, crew leaders had to record the time spent reaching the points and carrying out the different tasks into which the operations can be divided. This assignment, which is not a part of the method itself, increased the overall time spent for the work.

During the first test campaign, the average number of points surveyed per day was 6.1.

During the second test campaign, the average number of points rose to seven, which shows that the changes brought out to the procedures had a significant impact. This appears too in the time spent per tree, which dipped from 1.86 minutes to 1.45 minutes. This is mostly due to the changes in the method, as the time elapsed between both campaigns makes it rather unlikely that the experience acquired during the first one was of much use during the second one.

The best result, in Portugal, was 10 points per day. This relates at least partly to the fire extents, which were much smaller in Portugal than in Spain, with shorter distances between plots. Moreover, rectangular plots, where tree measurements can take more time than on circular plots in case their number exceeds 20, were more frequently installed in Spain.

5.2.6. Assessment values

A summary of the assessed severity of the fires surveyed during the field tests is given in the following table.

Test Campaign	FIRE_ID	Fire Severity
2007	2006_0037	2
2007	2006_0051	2
2007	2006_0071	2
2007	2006_0072	2
2007	2006_0076	2
2007	2006_0081	2
2007	2006_0142	2
2007	2006_0153	1
2007	2006_0168	2
2007	2006_0307	2
2007	2006_0316	2
2007	2006_0322	3
2007	2006_0323	2
2007	2006_0376	2
2007	2006_0398	2
2007	2006_9999	2
2007	2007_0125	3
2007	2007_0613	2
2007	2007_0622	1
2007	2007_1174	2
2007	2007_9999	2
2008	2007_0175	3
2008	2007_0623	3
2008	2007_0870	2
2008	2007_1488	2
2008	2007_1700	1
2008	2008_0018	2
2008	2008_0036	2
2008	2008_0078	3
2008	2008_0128	2
2008	2008_0129	3
2008	2008_9999	2

If we break down the results by year and by severity class, we get the following table, where the cell contents are the number of fires.

Test Campaign	Fire Severity 1	Fire Severity 2	Fire Severity 3	Total
2007	2	17	2	21
2008	1	6	4	11
Total	3	23	6	32

As might be expected, no fire has a 0 severity, as this would mean an absence of fire. It is not the case at the plot level, where the heterogeneity of fire impacts can translate into not burnt plots. The highest severity was not found, either. The results from the second test campaign, where the centre class 2 is less frequent, are more satisfactory than the ones from the first test campaign, where discrimination between the fires seem to be weaker. Using an estimation of the loss in total ligneous cover rate has

yielded results that are more varied, as the following table shows. The cell contents are the number of plots

Test Campaign	Erosion aggravation risk 0	Erosion aggravation risk 1	Erosion aggravation risk 2	Erosion aggravation risk 3	Total
2007	13	211	163	3	390
2008	18	73	134	15	240
Total	31	284	297	18	630

6. Database

The database is divided into two different files.

- The **ForFireS_2007.mdb** file stores the information about the forest fires surveyed during the 2007 test campaign. The structure of the tables befits the plot, tree and regeneration properties collected according to the rules that had been drafted before the tests. Indicator values and severity assessment were computed using those data. Queries and forms can be found in this file.
- The **ForFireS.mdb** file is the state of the database as it is proposed at the end of the contract, after changes made following the lessons learned during the first test campaign. It stores the information about the forest fires surveyed during the 2008 test campaign. It is designed to be used for further fire severity assessment. The Manual gives its description (table structure, forms and queries).

More information about the files complementing the database is given in an annex to the present report.

7. Conclusions

The proposed method should enable Forest Services to assess in a standard way the severity of forest fires and to enrich the European database. Data collected on sampling plots are located precisely and can be used beyond the mere computing of indicator values as they were designed. It is very likely that combining ground data and satellite pictures will yield interesting results.

Lattes, 26/09/2008
François BERGEOT

Annex

Information about the Data Files

1. LIST OF DATA FILES

1.1. Microsoft ® Access Files

File Name	File Contents
ForFireS.mdb	Final ForFireS database with data collected during the 2008 test campaign and computed results.
ForFireS_2007.mdb	Database used during the 2007 test campaign with collected data and computed results. Its structure is different from the final one.

1.2. Microsoft ® Excel Files

File Name	File Contents
Coordinates_local_2008.xls	Spreadsheets with the local Cartesian co-ordinates of the 2008 sampling points in Portugal and Spain. In Portugal, theoretical co-ordinates, in Spain theoretical and actual co-ordinates. Projection system information.
Coordinates_local_2007.xls	Spreadsheets with the local Cartesian co-ordinates of the 2007 sampling points in Portugal, Spain and France (when ETRS89_LAEA co-ordinates not available). Theoretical co-ordinates. Projection system information.

1.3. Microsoft ® Word File

File Name	File Contents
Projected_Coordinate_System.doc	Properties of the projection systems used in Spain and Portugal.

1.4. ESRI ® ArcGIS Files

File Name	File Contents
Veiga.dbf Veiga.prj Veiga.sbn Veiga.sbx Veiga.shp Veiga.shx	2008_9999 perimeter files

2. REMARKS ABOUT INDIVIDUAL FILES

2.1. ForFireS.mdb

2.1.1. Table AREAE

The fields PLOT_LATITUDE_THEORETICAL, PLOT_LONGITUDE_THEORETICAL, PLOT_LATITUDE_ACTUAL, and PLOT_LONGITUDE_ACTUAL have been left blank for the plots surveyed in Spain during the summer of 2008. The plot co-ordinates in the local projection systems can be found in the file Coordinates_local_2008.xls.

2.1.2. Table AREAE_COMPUTATIO

The fields PLOT_LAEA_X and PLOT_LAEA_Y have been left blank.

2.2. ForFireS_2007.mdb

Table AREAE: Only co-ordinates fitting the required the ETRS89_LAEA projection system are to be found in the fields PLOT_ABSCISSA and PLOT_ORDINATE. Missing co-ordinates are given in local projection systems in the file Coordinates_local_2007.xls.