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EUFIRELAB:
Euro-Mediterranean Wildland Fire Laboratory, a “wall-less” Laboratory for Wildland Fire Sciences and Technologies in the Euro-Mediterranean Region

Deliverable D-02-05

Methods for wildland fuel description and modelling: Commonly used methods

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SUMMARY

Deliverable D-02-05 respects to the common procedures used by EUFIRELAB partners to measure, describe, inventory and map wildland fuels. This is an attempt at the definition of European standards for methodologies.

The contents of this deliverable are the end result of a survey prepared in the frame of D-02-03 that gathered each partner’s methods, and it was updated since then. This document summarises and updates the responses to the questionnaire and draws trends concerning the current methods.

The degree of standardisation among partners is relatively high. Most of the differences found are likely to be an outcome of the available equipment and specific research objectives.

1 INTRODUCTION

Deliverable D-02-03 was the first attempt to propose or identify the use of common methodologies among EUFIRELAB partners.

Following such effort, Deliverable D-02-05 presents the final inventory of common methodologies, hence realizing (more than proposing) the existence of adopted standards used by European researchers in order to characterize wildland fuel properties, and classify, appraise and map fuel assemblages.

Deliverable D-02-03 was established according to the following sequence of procedures:

A preliminary questionnaire was prepared by P025 and uploaded to the EUFIRELAB web site, and participants were requested to assist in refining the final version of the survey. The questionnaire inquired about the methods used (and why are they used) to obtain information on fuels.

- After receiving and integrating the suggestions for improvement, the final questionnaire version was uploaded to the EUFIRELAB web site to be filled in.
- The concerned partners downloaded the questionnaire, filled in the relevant information and uploaded their contributions to the same folder in the web site.
- Based on the contributions received, a draft was prepared and uploaded again for comments and suggestions.
- A final version was written, taking into account the feedback received from the interested partners.

Deliverable D-02-05 updates D-02-03, summarizing the responses given, and discussing the information collected.

2 RESULTS

2.1 INTRODUCTION

The obtained results are based on the information provided by partners P001, P010, P012, P013, P018, P025, and P033 belonging to the EUFIRELAB consortium.

The results are displayed in two tables, respectively pertaining to fuel properties and fuel classification and inventory, and in a text section dedicated to fuel mapping (only P033 develops work in such field).

The tables synthesize the responses, and are presented in terms of the methods used by each partner, and the overall relevance of the method within the surveyed teams' universe.

Additional data is detailed in section 3.

2.2 FUEL PROPERTIES TABLE

The following table summarises the methods used by the contractors for characterising the fuel properties

Fuel property	Used by
Specific gravity, density or mass to volume ratio:	
Weighing and volume measurement by water displacement	P001, P018, P025
Weighing and volume measurement by mercury displacement	P018
Weighing and volume estimated from physical measurements	P025
Surface area to volume ratio	
Image analysis and measurements on cross-sections	P010, P013
Physical measurements assuming simple geometrical shapes	P010, P013, P018, P025, P033
Surface estimated from geometry, volume by water displacement	P001, P018, P025
Water immersion	P025
Ash content: weighing after heating in a muffle furnace	P001, P018, P025
Heat content or caloric value: adiabatic calorimeter	P010, P018
Moisture content	
Oven-drying	P001, P010, P012, P013, P018, P025, P033
Electrical conductivity	P001, P025

2.3 FUEL CLASSIFICATION AND INVENTORY TABLE

The following table summarises the methods used by the contractors for classifying and inventorying the fuel.

Methods	Used by
Fuel stratification	
Classical U.S. Forest Service classification	P001, P010, P013, P018, P025, P033
Adaptations of the Classical U.S. Forest Service classification	P001, P025
Description type: Qualitative descriptions	
Vegetation type	P010, P013, P018, P025, P033
Photo-series	P013, P025, P033
Description type: Quantitative descriptions	
Standard (NFFL) fuel models (U.S. Forest Service)	P010, P018, P025, P033
Modified (NFFL) fuel models (U.S. Forest Service)	P010, P018, P025, P033
Custom fuel models (U.S. Forest Service)	P013, P018, P025, P033
Description type: Quantitative-qualitative descriptions Photo series of fuel models	P013, P018, P025, P033
Destructive sampling	P001, P010, P013, P018, P025, P033
Non-destructive sampling	
Points	P001, P018, P025
Quadrates	P001, P013, P018, P025, P033
Line intercepts/transects	P001, P013, P018, P025, P033
Belt transects	P001, P025
Calibrated visual estimation	P013, P033
Double sampling and estimation with equations	P010, P013, P018, P025

2.4 FUEL MAPPING

Partner P033 uses both direct and indirect remote sensing methods to map wildland fuels.

Tree height, crown base height and canopy cover are important determinants of crown fire activity which are required by landscape fire growth simulators (namely FARSITE).

These three variables are directly assessed with LIDAR (MORSDORF et al., 2004) on a small scale of 14 km^2

Tree height estimates have a 2-m resolution with accuracy below 1 m.

The accuracy of cover and crown base height remain to be validated; their resolution is respectively 2-m and 5-m.

The indirect methods are based on radiative transfer models (KÖTZ et al., 2004), have a 30-m resolution and operate on a scale of 24 km^2.

Such methods are applied in the estimation of fuel moisture content and Leaf Area Index, which can be a valuable crown bulk density indicator.

P001 develops cooperation with P033 in this specific domain.

3 ANALYSIS OF RESULTS AND CONCLUSIONS

3.1 PHYSICAL PROPERTIES

3.1.1 Mass to volume ratio

The estimation of fuel particles' mass to volume ratio differs among partners on the technique used to determine the volume component.

The use of water displacement seems to offer a good compromise between accuracy and simplicity/cost.

3.1.2 Surface area to volume ratio

All partners conducting surface area to volume ratio measurements use estimation procedures, which rely on physical measurements that assume basic geometrical shapes.

However, the combination of an estimation of surface area by geometry and volume by water displacement can be an adequate alternative when dealing with more complex-shaped fuels, such as leaves and spines.

Only two teams use image analysis procedures that require more expensive equipment.

Finally, usage of the water immersion method has not expanded beyond its developer (P025): it is not easy to achieve standardization in the use of such technique.

3.2 CHEMICAL PROPERTIES

3.2.1 Ash content

The ash content is studied through a well-established method: weighting after heating in a muffle furnace at 600°C during 8 hours.

3.2.2 Heat content

The ash content is studied through a well-established method: adiabatic calorimeter.

Near-infrared reflectance spectroscopy is an alternative to adiabatic calorimeter, whose reliability has been proven, but it is not used by the EUFIRELAB members.

3.2.3 Extractive content

None of the partners addresses extractive content measurement, possibly because it's not an input to current fire behaviour models.

3.2.4 Conclusion

In general, the differences in methodology regarding quantification of particles' fuel properties are currently small enough to guarantee adequate standardization.

Also, it is important to mention that the role of most of these fuel characteristics in fire behaviour models is secondary.

3.3 FUEL MOISTURE CONTENT

It is a critical variable in fire behaviour and fire danger rating.

Perhaps this explains why all partners exclude the many indirect methods that are available, and use, for research purposes, the most reliable and accurate method of oven-drying.

Additionally, P001 and P025 use the T-H moisture meter, an Australian device based on electrical conductivity methods, which has been calibrated and provides very good results for fine dead fuels.

The results with living material are not satisfying because part of the water is extracted from the fuel sample during its preparation.

3.4 FUEL DESCRIPTION METHODS

3.4.1 Fuel stratification and description

Unit 2 partners generally share common methods to classify, describe and inventory fuels in the field.

All of them adopt or adapt the fuel stratification of the U.S. Forest Service, which is implicit in ROTHERMEL's fire spread model.

Modifications to such stratification scheme were mentioned by P001 and P025.

It is probable that the number and type of fuel strata will evolve in the future, as a response to fire modelling needs.

Concerning the type of description, the adoption of qualitative descriptions, fuel models (in ROTHERMEL's sense) and quantitative-qualitative descriptions is also universal.

3.4.2 Destructive and non-destructive samplings

Destructive sampling is a necessary step in the characterization of wildland fuel beds and complexes.

However, only P018 and P025 mention the application of such procedures to the canopy layer.

This is understandable, because fire modelling research and applications to fire management have traditionally neglected the contribution of crown fuels to fire behaviour.

Recent and future advances in crown fire behaviour modelling will hopefully result in more studies of the tree canopy as a fuel.

Non-destructive sampling of physical descriptors in quadrates and along line transects is universally used, but point sampling and belt transects do not have the same degree of importance.

The same is true for calibrated visual estimation, while double sampling and estimation with equations is a widespread procedure.

Partners share many methodological procedures and there is a relatively high degree of standardization.

It is probable that the majority of the differences between partners are an outcome of the available equipment and specific research objectives.

4 REFERENCES

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