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GOLIAT, a project to develop tools for firefighting and land use planning

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Abstract

The GOLIAT project is a consortium of academics and firefighting operators and land-use planning professionals of Corsica. One goal of GOLIAT project is to provide four operational decision support tools. To reach this goal, a survey of past fires occurred in Corsica since the twentieth century beginning is made. This inventory contributes to build up a database with a web display interface easy to use as fire patterns history. A fire behavior and impact simulator prototype for vegetation fires, a geolocation tool for hot spots using UAV images, and a guide of good practices of prescribed fires in the undergrowth are building. At the same time, experimental fires are carried out to improve knowledge about high intensity fire and the experimental results were compared to the predictions provided by a complete physical 3D model, namely FireStar3D.

1. Introduction

The GOLIAT project brings together academics from the University of Corsica, Aix-Marseille University, University of Toulon and Lebanese University with Corsican fire-fighting operators and land-use planning professionals and a company carrying out computer developments. The partners are : the National Forestry Office, Fire and rescue Service of Southern Corsica, Fire and Rescue Service of Northern Corsica, Regional Nature Park of Corsica and Arobase company. The aim of the program is to develop tools, studies, guides, and awareness-raising activities to provide a response to wildfire issues. This program is co-financed by the Corsican Collectivity and the French State. It started in January 2020 and will last for three and a half years.

The GOLIAT project is divided into three main objectives. The first objective is to deepen the phenomenological and historical knowledge of vegetation fires in Corsica. Research is carried out to increase knowledge of the behavior of vegetation fires, the fires that have occurred in Corsica, and the methods used to control fire in traditional Corsican society. The second objective is to build decision-making tools prototypes that meet the needs of firefighting and land-use planning operators. Four prototype tools are under development: 1) A database associated with an information display tool dedicated to fires that have taken place in Corsica 2) A behavior and impact simulator for vegetation fires 3) A geolocation tool for hot spots using UAV images 4) A guide to prescribed burning in the undergrowth. The third objective is to carry out many awareness-raising and prevention actions on the vegetation fire problem in Corsica, aimed at schools, public and local authorities.

In the context of global warming that we are experiencing, intense fires affect several countries growing and over larger periods. Prescribed burnings are used by operators for land-management thanks to its low cost and high efficiency in hard-to-reach areas. In the context of this program, high intensity fires across Corsican *Genista salzmannii* vegetation and prescribed burnings on a Mediterranean pine forest are instrumented and studied mixing numerical and experimental approaches and disciplines such as physics, chemistry, ecology, and UAV vision.

2. Decision support tools

From the needs expressed by the firefighting and land-use managers, the GOLIAT project has been elaborated to provide decision support tools usable by them when fire occurs.

Three tools are created to give to firefighters in a web display information about the past and the future of Corsican fires.

When a fire will occur, using the GPS position of the ignition point, operators will have web server services to see (1) the past fires information correlated with meteorological data, (2) the prediction of the future fire front positions and heat fluxes and (3) the geolocation tool for hot spots obtained from UAV IR images.

One tool is created specifically for land managers, it concerns a guide to prescribed burning in the undergrowth in *Pinus laricio* forest.

2.1. Fire database associated with an information display tool

A survey of past fires occurred in Corsica since the twentieth century beginning is made. This inventory contributes to build up a database. This last contains information about fires, which size is greater than 10 ha, occurring in Corsica since 1904. It also contains meteorological data (Fig. 1) and noteworthy events in relation with the firefighting. 2 048 fire contours and 1 593 ignition points are included, a work is in progress to show this information in a web server in a format display adapted for firefighters easy to use as a fire patterns history.

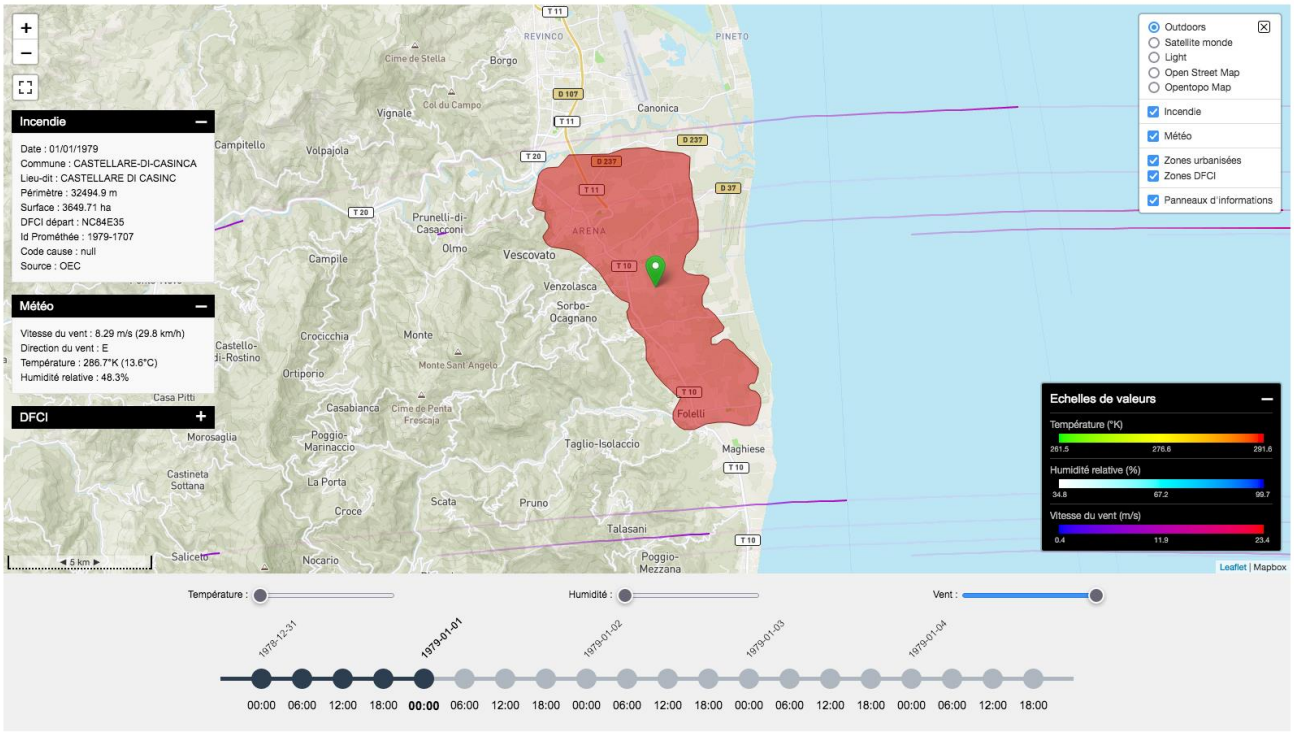

Figure 1- Screenshot of the web interface presenting data associated to a past fire

The meteorological data which allowed this representation come from the Copernicus project (https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-uerra-europe-complete?tab=overview) (Fig. 2). A script has been created that collects the dates of all fires and collects weather data from T-24h to T+96h with a 6h time step.

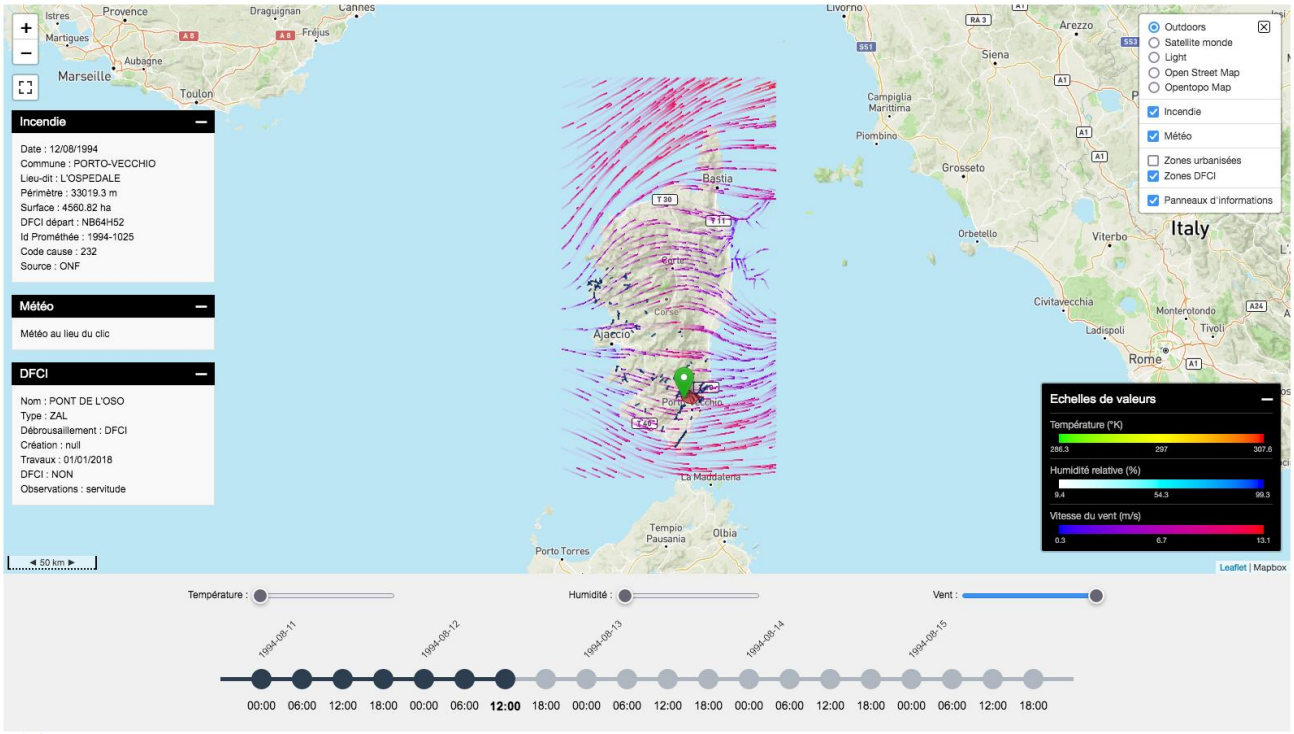

Figure 2- Wind flow all over Corsica screenshot

2.2. A behavior and impact simulator for vegetation fires

The behavior and impact fire simulator is developed on the requirements drawn up between researchers and operators. Physics used to predict fire behavior is the last version of the Balbi model (Balbi *et al*. 2020) developed at the University of Corsica. This simulator will predict from an ignition point or a contour (Fig. 3) the fire front evolution (Fig. 4) and an acceptable safety distance (Rossi *et al*. 2011). Indeed, the knowledge of the impact zone in front of flames is a relevant information for firefighters to stay in safety conditions when they fight fire.

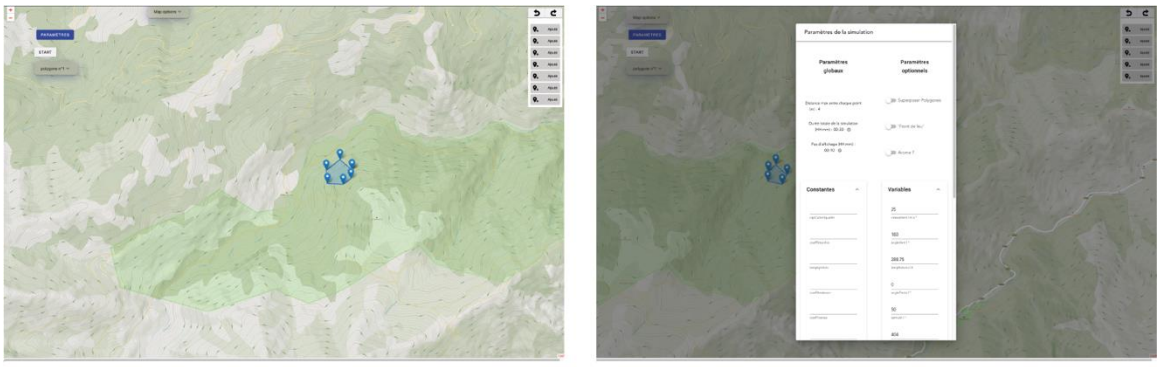

Figure 3- (a) Start contour screenshot (b) Simulation parameters configuration panel

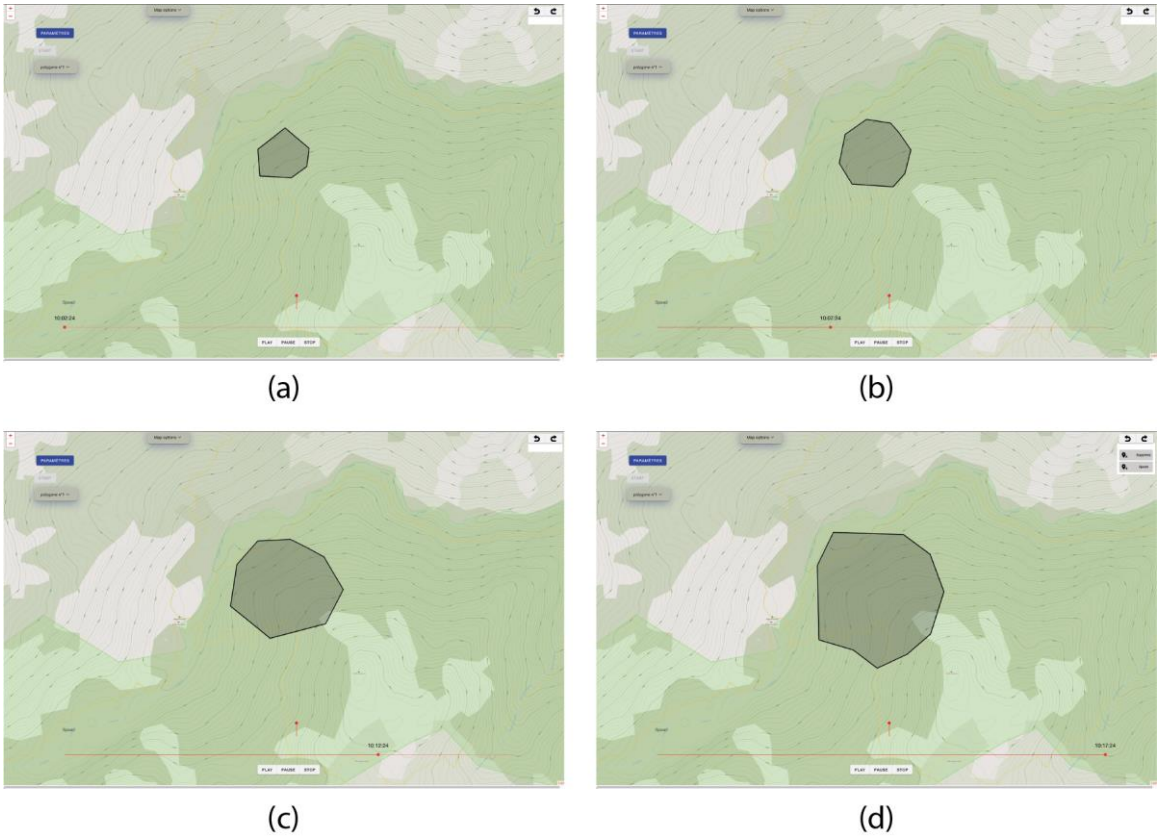

Figure 4- Fire front evolution simulation (a) t = …

Experimental fires were conducted with the main objective of providing data to test the predictions of the theoretical physical fire models, in the case of a high-intensity fire spreading upslope at field scale (Fig. 5). To understand and investigate the different phenomena encountered in this type of fires, the experimental results were compared to the predictions provided by the multiphase code FireStar3D (Fig. 6) (Frangieh *et al*. 2020). These predictions were used to examine the fire front dynamics, to evaluate the fire intensity that was difficult to accurately assess during the experiment (Fayad *et al*. 2022).

Figure 5- Experimental fire at Speluncatu (Corsica)

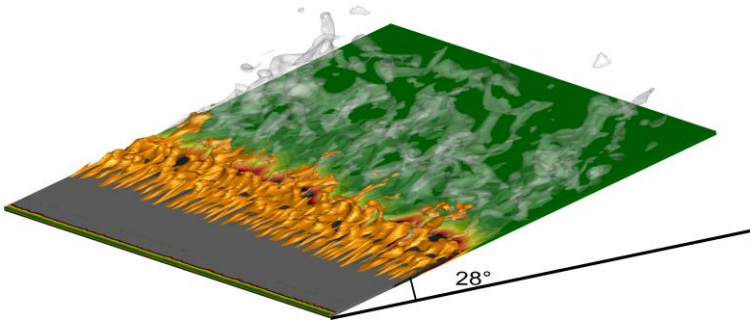

Figure 6- FireStar3D simulation on the Speluncatu experiment

2.3. A geolocation tool for hot spots using UAV images

The geolocation tool answers the needs expressed by the Fire and Safety Services of Corsica. When the fire is stopped, it is necessary to keep an eye on for several days and they need to cover burnt aeras for extinguishing hot spots whom are potential resumption of fire.

Thank to DJI SDK, programs have been developed to automate the pattern of the drone with cameras on board working simultaneously on the UAV and far IR, to detect and to geolocate the hot spots (Fig. 7).

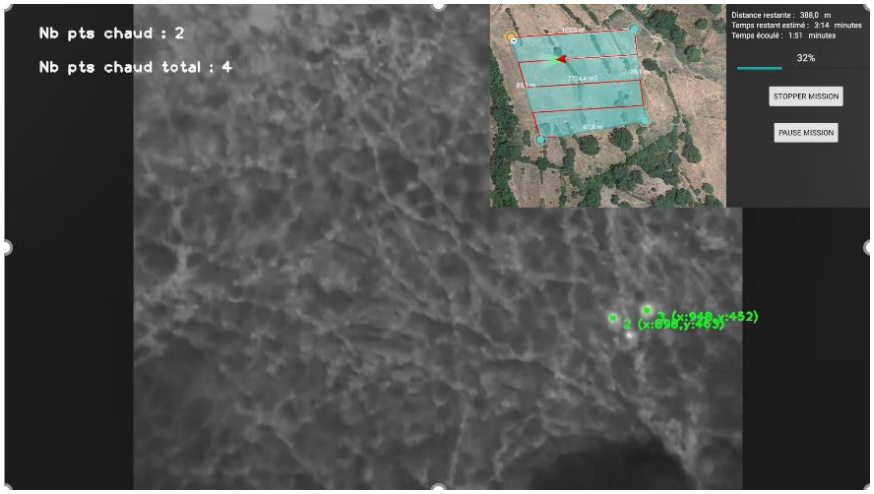

Figure 7- Hot spot software screenshot

2.4. A guide to prescribed burning in the undergrowth

Research works are conducted to improve the knowledge on fire resistance of *Pinus laricio* forests. Undergrowth prescribed fires are carried out (Fig. 8). Samples of vegetation, soil, insects, and pine needles are taking on witness parcels. Sensors for tree growth, sap fluxes, temperatures are located on these parcels.

The analysis of the collected data will allow to give recommendations on undergrowth prescribed fires to minimize impact on *Pinus laricio* forests.

Figure 8- Prescribed fire on a* Pinus laricio *forest in Corsica

3. Conclusion

The GOLIAT project is based on the research developed at the University of Corsica and develops new work to meet the needs for tools, studies and knowledge expressed by firefighting and land-use operators. It allows synergy between academics and fire professionals, technology transfer to build decision support tools: a database of fires occurred in Corsica with a display tool, a behavior and impact simulator for vegetation fires, a geolocation tool for hot spots using UAV images and a guide of good practices to prescribed fires in the undergrowth of *Pinus laricio* forest.

The improvement of knowledge on the phenomenology of vegetation fires will make it possible to increase the effectiveness of the prediction of fire behavior and, thanks to the strong interaction with the operational staff, to develop tools that meet their needs.

4. References

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