The FireHub Tool: NOA EO- based Fire Related Services in the framework of BEYOND

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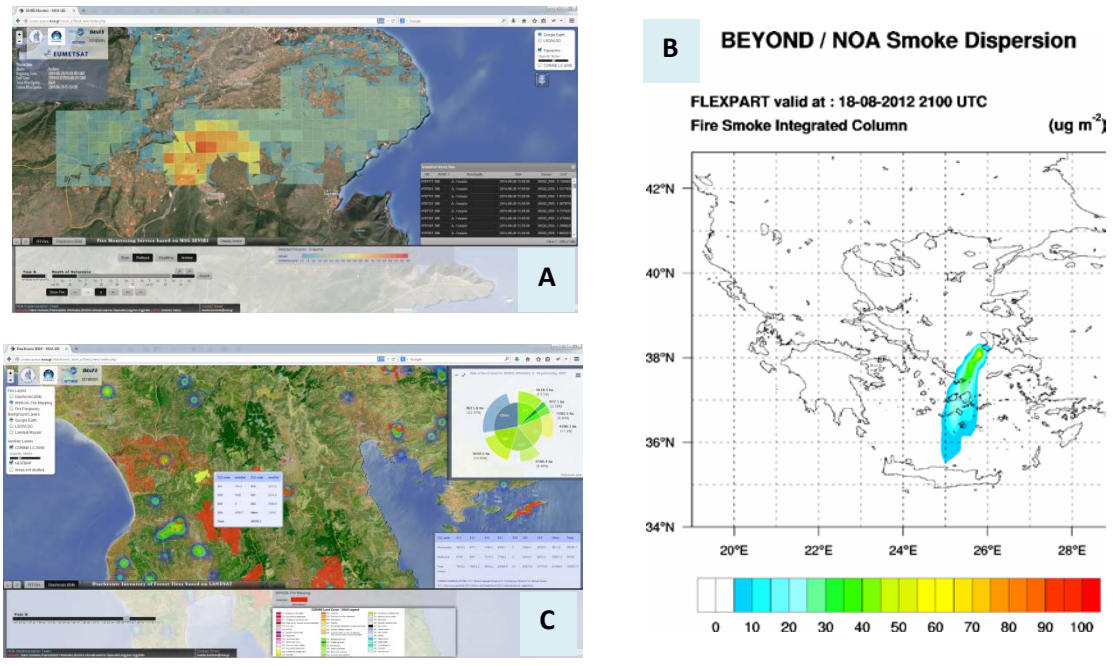
Firehub is a novel, multidimensional, highly robust and efficient WebGIS platform that aims to provide the best support in the Disaster Risk Management (DRM) and Emergency Response (ER) disciplines regarding the wildfires phenomena. It is the result of a laborious and multiyear, research and development effort in the fields of remote sensing (RS), topography, forestry, meteorology, geographic information systems (GIS) and computer engineering that evolved during several projects in which National Observatory of Athens (NOA) and specifically the Institute of Astronomy, and Astrophysics Space Applications and Remote Sensing (ISAARS) was a counterpart. It was recently honored with the high award of the first prize of Best Challenge Service in the 2014 Copernicus Masters Awards competition and it is already recognized by the Greek Fire Brigades and Civil Protection authorities as an effective and stable wildfires DRM and ER platform, currently utilized by them to a large extent, especially during the challenging Summer season; a season (in Greece) that is highly vulnerable to wildfires which are causing devastating effects in both the biosphere and the economy.

Firehub is characterized as a multidimensional platform due to the fact that it is comprised of three modules that provide valuable DRM and ER information regarding the wildfires in the Greek terrain, through different perspectives. The three modules are: a) the Real-time Fire Monitoring module which provides continuous information on active fires detected from the MeteoSat Second Generation (MSG) SEVIRI satellite with a 5-minutes fire spots monitoring frequency, b) the Smoke Dispersion Forecast which provides smoke dispersion assessments based on a Lagrangian model, and c) the Burn Scar Mapping and Damage Assessment module which is capable to depict the results of the diachronic burnt area mapping over Greece for the last 32 years (1984 to 2015) by implementing a fully automated processing chain for burnt area mapping, which is based on the exploitation and analysis of the full USGS archive of Landsat TM images, since the first satellite image was ever recorded over Greece.



Figures 1.A, 1.B and 1.C: 1.A - the Real-time Fire Monitoring module, 1.B - the Smoke Dispersion Forecast module and 1.C - the Burn Scar Mapping and Damage Assessment module

Here we describe the greatest novelty of Firehub which stems from its ability to accommodate both the needs for high space resolution data and monitoring frequency, with the least possible processing cost. It's been a long time since the scientific fire community is trying to address the wildfire phenomena using RS techniques and GIS to effectively support the decision-making process. Although, RS is a powerful tool for generating and visualizing situation awareness pictures in DRM, its limitations in performing complex near real time data analysis at fine spatial resolution scales, requires powerful downscaling methods, integration of multisource spatial data and robust web based dissemination. For example a fine grained and real-time fire monitoring system like the corresponding module in Firehub has to cope with a specific trade-off which is consisted from the following dilemma: either receive high resolution satellite images or receive more frequently but of a lower resolution satellite images for a specific Area of Interest (AOI). Such a system is bound to choose the frequency offered by low and medium resolution satellite sensors, and alleviate the resolution problem by applying a downscaling methodology, that is improving the spatial resolution or the raw satellite observation. Firehub achieves to provide real time fire monitoring, every five minutes, and in the same time to improve the spatial resolution of the MSG SEVIRI satellite images by about 50 times, namely returning fire occurrence information in cells of 500m x 500m wide, without compromising the system's response time (i.e. it provides a new observation every 5 minutes).

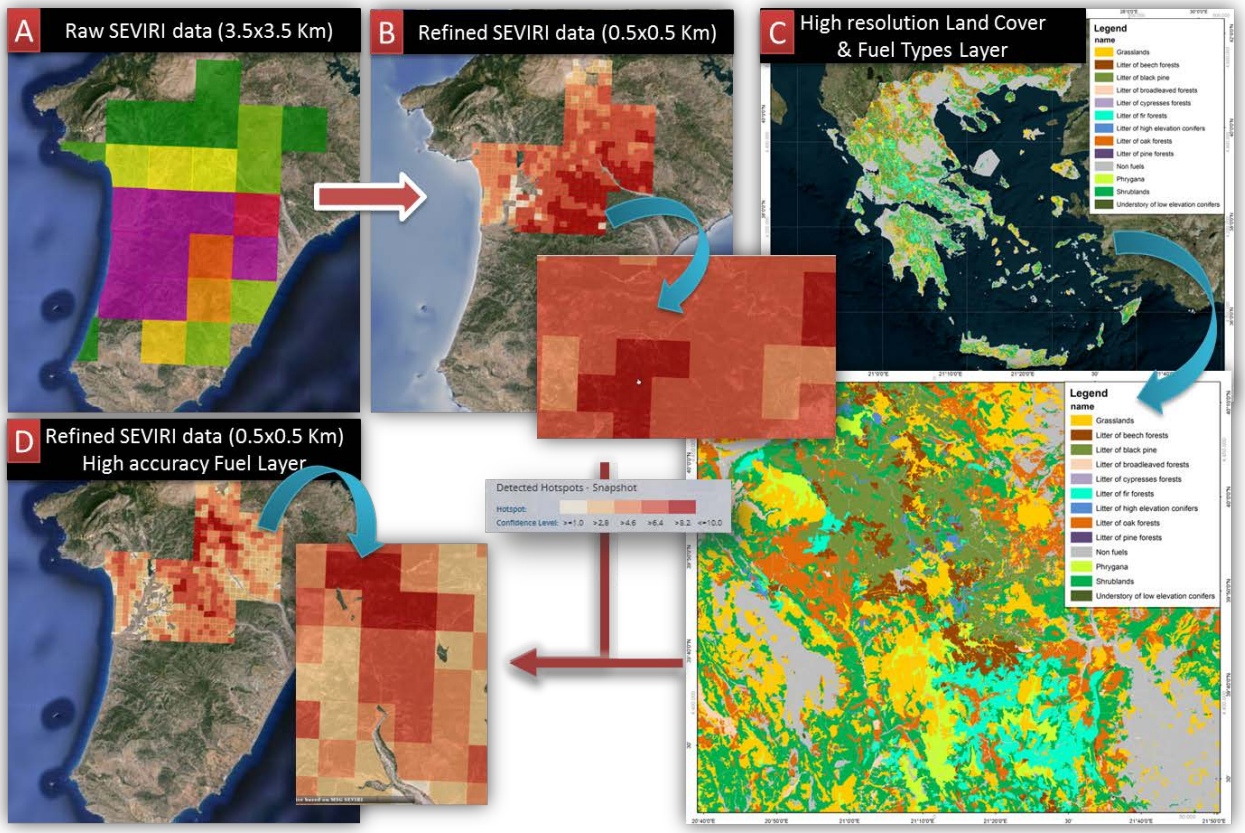


Figure 2: On-line Fire Services dissemination through NOA's dedicated web interface

Firehub, in order to achieve the aforementioned downscaling, is using auxiliary thematic and GIS information with higher space resolution, which subsequently combines with the ingested raw images of MSG SEVIRI. Firehub integrates three geo-spatial layers:

a) A novel fuel map which contains information about the type and density of any fuel type, generated through the combination of forest/ecosystem vegetation geo-spatial layers with expert knowledge on fuel modelling using fuel physical and chemical properties. To this end, specific fuel proneness to fires data, resulted from the long term analyses (more than 30 years of analyses) of fire regimes conducted by the IAASARS/NOA team are used.

b) A topography layer created using Digital Elevation Map (DEM) data either from the ASTER Global DEM, and/or any other existing DEM available for use at national/regional level, extracting the necessary buffers of altitudinal zones, along with slope magnitude and slope direction (aspect) data for the forested zones affected and/or threatened by the occurring fires

c) A meteorology layer ingesting to the system dynamic meteorological forecasts for the next hours of up to a couple of days relevant to wind speed and wind direction in the AOI, so as to escalate the resolution of the raw observations.

Exploiting these geo-spatial ancillary data in conjunction with the satellite observations through complex modelling the system succeeds in providing on a 5-minute basis, and with a time interval of less than 6 seconds after the satellite image acquisition, a first level classification of the fire / non-fire pixels, but also a much finer grained classification of fire occurrence in sub-pixels of 500mx500m wide, improving that way the raw MSG SEVIRI observation by about 50 times (to be noted that the raw spatial resolution of MSG/SEVIRI over SE Europe is approximately 3.5km).

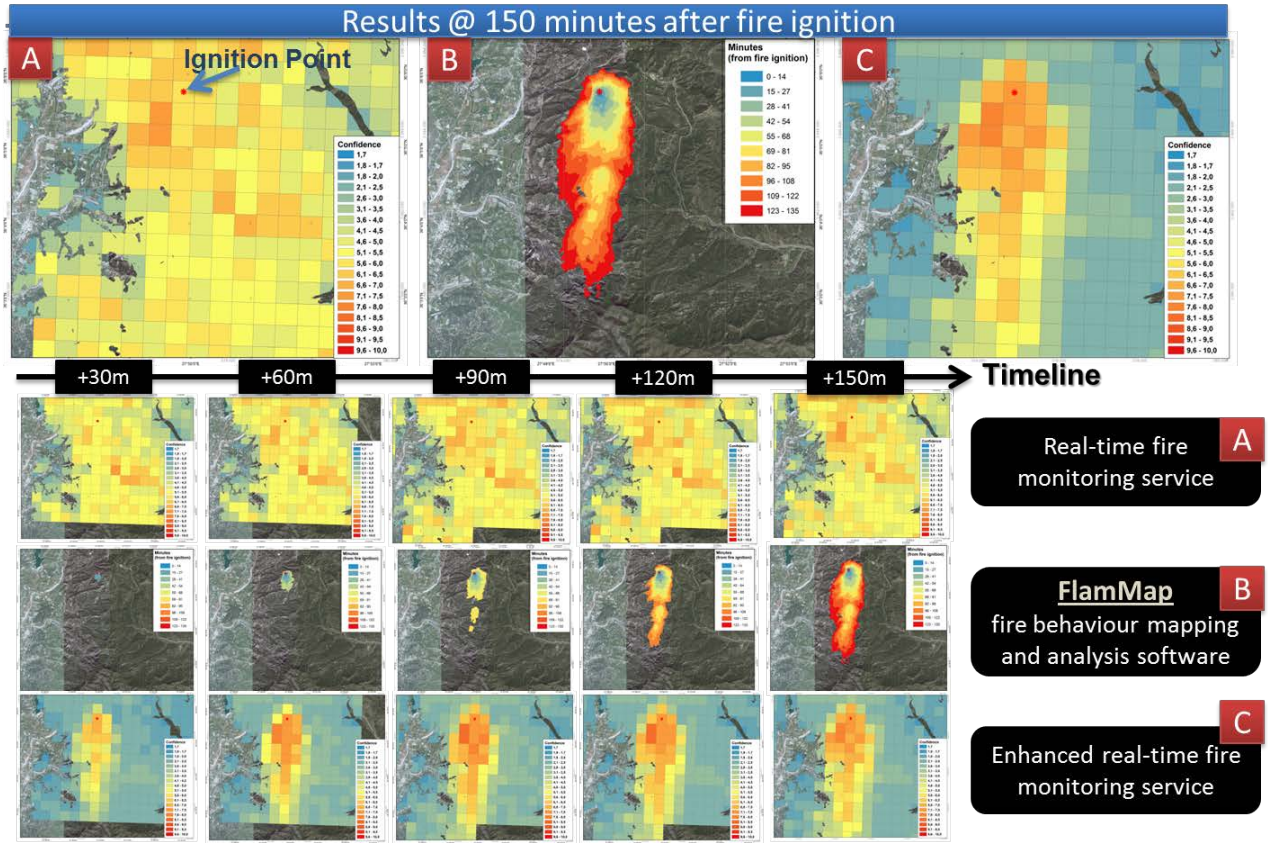


Figure 3: Model driven real-time service: On-line Fire Services dissemination through NOA‘s dedicated web interface

To be noted that in the framework of BEYOND much attention has been also given to further evaluate and improve the effectiveness, and reliability of the Firehub tool. A large number of Earth Observation (EO) images of different spectral and spatial resolutions are systematically being processed to derive thematic products that cover a wide spectrum of fire management applications in the pre-, during- and post-fire crises, ranging from fire detection, fire monitoring and rapid mapping, up to damage assessment. The X-/L-band station recently acquired and operated by the BEYOND Center of Excellence receives medium and high resolution images from a multitude of satellite missions as MODIS, NPP, MetOp, NOAA/AVHRR, FY. At the same time the first mirror site (Collaborative Data Hub) of the Sentinel missions established at the premises of NOA allows direct access in nearl real time to all Sentinel data acquired over SE Europe, North Africa, and Middle East. With these new observational capacities and the relevant image products generated on a routine basis, new assimilation techniques, and validation mechanism for the Firehub tool have become available for a more credible fire spots detection and fire evolution assessments time during crisis.

The improvement of the Firehub platform and the ongoing development is expected to contribute substantially to judicial wildfires management. Countries with climate similar to that of Greece (e.g. Mediterranean countries) which suffer from wildfires phenomena, especially during the summer season, may benefit a lot from a system that is fully operational and can function autonomously, namely without further processing and with the minimum human intervention. The local and civil protection authorities will be able to design and apply finer disaster management plans and thus to minimize or even to eliminate the risk of human losses and its social impact, as well as to protect the economy and the environment. For example, by using the Burn Scar Mapping module of Firehub the local authorities are able to map each area's proneness to fire and thus to generate a more sophisticated contingency plan depending on each area's risk, but even better to preempt a disaster according to that plan. In the same way the responsible authorities may exploit the other modules of Firehub in order to refine their decision making process and provide qualitative services to the civilians.

FireHub URL: http://ocean.space.noa.gr/FireHub