Project EX310

Forest Fire in Sweden 2014
Field Report

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1. Introduction

This document is a brief report of the activities that were carried out during the Expert Exchange project that was carried out in Ramnäs from 21 to 23rd April 2015 to analyse the large forest fire that occurred in the region of **Västmanland** in 2014.

The objectives of this Project were the following:

- Contact with ongoing research on forest fire risk in Sweden
- Visit the area of the large fire to learn about its development and about the factors that affected it.
- Contact with local fire managers to better understand their methodologies and procedures.
- Exchange information, knowledge and experience on fire management aspects and to seek for opportunities for future collaboration.

Members of the Group of Participants in the Project. From left to right: C. Apelquist, A. Hoglund, D. Caballero, C. Seielstad, M. Cruz, H. Olson and D. Viegas.

2. Description of the mission

21st April

The mission started on the 21st April 2015 with a visit to the Airport of Vasteräs where we visited the company HeliAir that operates several types of Helicopters and was active during the fire of 2014.

We were received by Anders Nilsson the head of HeliAir who explained us the operation of the company and how it was involved during the fire of 2014. It was clear that helicopters

were not involved during the initial attack. In spite of the availability of various aerial means during the initial stages of the fire their involvement was limited apparently due to budget concerns. At certain stages there were helicopters form various private companies and from the Air Force operating in the area. Coordination was provided by a fixed wing plane form the Swedish Navy.

The Group of Participants during the visit to HeliAir in Vasteras.

We were shown a heli-torch system that was locally built following an USA design and saw one video on its use to ignite fires in the context of a prescribed burn project.

After checking in at the Conference Hotel in Ramnäs we had a dinner during which each participant in the Workshop was introduced informally to the others.

The persons who attended the sessions were:

Ref.	Name	Institution	Country
1	Leif Sandahl	MSB	Sweden
2	Anna Höglund	MSB	Sweden
3	Anna Johansson	MSB	Sweden
4	Anders Granström	SLU	Sweden
5	Håkan Olsson	SLU	Sweden
6	Carl Apelquist	S. Forest Service	Sweden
7	Carl Seielstad	Univ. Montana	USA
8	D. Xavier Viegas	Univ. Coimbra	Portugal
9	Miguel Cruz	ANPC	Portugal
10	David Caballero	Meteogrid	Spain

22nd April

In the morning a welcome address was made by Leif Sandahl and each participant made a brief presentation of his work and interest in the Workshop.

Afterwards Leif Sandahl made a presentation on the **Organization of forest fire suppression in Sweden** and on the **Role of the municipality, county, MSB, and forest owners –** followed by discussion with the participants.

After a break Anders Granström made a presentation on **Fuel structure of Swedish forests**. This presentation was actually made in the field near the Hotel to illustrate typical examples of fuel types in the area of the large fire of 2014.

After lunch Anna Höglund made a presentation on **SMHI/MSB fire risk prognosis system** and on **Weather effect on forest and grass fires conditions in Sweden.**

After the coffee break we travelled to the local municipal Fire Station in Södra Dalarnas Räddningstjänstförbund where we attended a presentation of equipment and initial response organization at the local municipal fire station.

We were presented to the various hand and mechanical tools that are available to the local fire fighters stations and a description of the intervention of the various local forces during the fire was made. Situations of fire entrapment involving fire fighters and civilians were described. Evacuation of some villages on the 4th August that was performed with the support of the Police and of the Fire Fighters was described.

During this trip we travelled through the area burned by the fire especially in its Northern part. We passed by the site of the fatal accident but did not have conditions to stop and visit with more detail.

23rd April

During the morning the formal representations of specific topics was continued with the following lectures:

Prospects of fuel classification using remote sensing - by Professor Håkan Olsson**,** Land Survey of Sweden, Metria.

An overview of large and problematic fires in recent years and **Fire behaviour and suppression activities during the 2014 Västmanland forest fire -** Dr Anders Granström.

Portugal's training of fire fighters in the topic of fire behaviour and fire safety and short courses – by Professor Viegas and Miguel Cruz.

After the coffee-break the following lecture was given:

Forest Fires and the Urban Interface by David Caballero, Head of Forest Fire Department at MeteoGRID, Spain

Then we departed for a very interesting Field Trip to the area of the **Vastmänland fire of July/August 2014.**

During the visit the following issues were analysed and discussed:

- Failure of the initial attack.
- Variation in fuel structure and its effects.
- Fire behavior reconstructions.
- Weather conditions and impact
- Effects of lakes and other fire barriers.
- Fire refuges at different scales.
- Wildland-urban interface.
- Suppression efforts.
- Entrapment situations.

The visit was very useful to have a better knowledge of the scale of the fire and of the conditions of fire spread and fire suppression from its beginning till it's very rapid evolution on the 4th August 2014.

The difficulties found near the fire origin during the initial attack, the problems with a counter fire on an East-West forest road and the difficulty in stopping the fire at the shore of Lake Öjesjon on the 31st July were assessed directly during this visit.

During this visit most attention was paid to the Southern part of the fire as the Northern par had been visited on the previous day.

Observing typical forest fuels in the area around the fire.

Visit to the location of the fire start.

3. Recommendations and future work:

From the visits and meetings that we made we would like to highlight some aspects that are related to our expertise and interest that can be the object of common attention and remain open for future collaboration.

i) **Fire behaviour** – Domingos Viegas

Fire risk assessment

Fire risk assessment in Sweden is done on the basis of the Canadian System that is used extensively in Europe namely in Portugal. In the analysis of fire risk conditions during the 2014 fire the FWI was used but apparently it required better calibration to differentiate the regional conditions. In Sweden the same threshold values are used to distinguish the fire danger conditions of the whole country; a suggestion was made to perform a calibration for each region: North, Centre and South. It was mentioned that there are six levels of risk: besides the five usual ones a sixth class that is designated as 5E (Extreme) was created in analogy to the class 6 (Catastrophic) that was created in Australia. I assume that the conditions to differentiate classes 5 and 5E need to be better studied.

Fuel assessment

In the area of the 2014 fire vegetation cover and potential fuels are quite different from those that are found in Southern Europe. This aspect is a challenge to produce adequate fuel models and to assess accurately their relevant parameters in order to describe their fire ignition and fire spread properties.

The presence of peat, humus, moss and liquens near the forest ground is a specificity of the fuel in this area. The presence of water bogged areas or of forest management activities can produce important spatial variability of fuel cover in an otherwise homogeneous area.

The assessment of water content of the fuel components (fuel moisture content (FMC)) as a function of meteorological and soil parameters is a challenge as well. The work that has been done at ADAI (University of Coimbra) in the modelling of FMC of fine fuels based on the concept of equilibrium moisture content can be extended to some of these fuels.

The production of a guide of forest fuels applicable to Sweden can be useful for practical assessment of potential fire behaviour and needs of fuel management.

Fire modelling

The excellent work performed by Dr. Anders and his team to reconstruct the fire was appreciated. It provides a very good description of the fire advance during its spread that can be correlated with meteorological condition, fuel cover and fire suppression activities in order to check the main factors affecting its behaviour and to assess the effectiveness of fire suppression capabilities.

These data can also be used as input for fire behaviour modelling systems in order to assess their performance. D. Viegas presented a simulation of the fire spread on the 4th August using as input the perimeter given by the satellite image obtained at 12.10h and assuming average fuel and weather conditions. This simulation was performed using the FireStation® simulator developed by ADAI. Although the overall shape of the fire was similar to the observed situation the average rate of spread was lower than the observed in real conditions.

The simulation of the fire spread can be made with more accurate input parameters for the entire duration of the fire. The fire spread on the afternoon of the 4th August is a challenge to current models that do not take into account the interaction between the fire and the atmosphere. Based on the analysis of some fires that spread in similar conditions – practically flat terrain with constant wind direction – the hypothesis of a “wind eruption” is advanced to interpret the very rapid fire advance during this period. In order to explore this hypothesis more details on the fire advance at intermediate time steps are required.

Fire safety

During this fire an accident with one fatality and one wounded person occurred on the 4th August and several other incidents in which Firefighters and Civilians were endangered by the fire were reported as well. In our opinion it is very important to analyse each one of these cases in order to learn lessons and to identify aspects that need improvement.

During our visit we obtained some information about these incidents but this is not sufficient to express any opinion about them. We are aware that there are ongoing investigation about these accidents that will provide important information about them.

We understand that exchange of information on fire safety training and on the use of protective equipment could be useful to improve the situation that we perceived in Sweden.

ii) **General Aspects and Urban wildland fires** - David Caballero

Some general ideas and reflections:

Large forest fires in Sweden are possible. Despite of their low return frequency, large forest fires, when they happen, are very destructive.

Climatic conditions are changing and this entails the appearance of a clear forest fire risk period during late winter and spring, which has not existed before so clearly. In this risk period cured grass of the previous year is available to burn, and the abundant moss in the floor is exposed to drying conditions. These two factors favor new fire outbreaks, particularly from forestry machinery producing sparks in their operation in areas with surface rocks and stones.

A seen, the existing forest fuel structure, with large amount of fine fuel in the ground, existence of litter and slash, fuel load in the shrub layer, presence of ladder fuel in the trees and relatively dense forested areas is favoring the initiation and consolidation of forest fires. The fuel continuity, particularly in the surface, favors the consolidation and spread of large fires.

Despite the notable presence of water masses, water availability for ground forest fire fighting is unclear, mainly due to the inexistence of appropriate access points and roads to the lake shores and other water points. This can give a false sense of safety. Aerial means can take water from the lakes and other water masses, but their firefighting efficiency is diminished due to the lack of aerial means co-ordination in fighting operations.

Road and forest road network does not allow efficient access to several point in the territory. This is due, mainly, to the relatively poor forest road density and the lack of network structure: frequently forest roads drive to a dead end, not connecting to other roads.

The road network is not conditioned to allow fire containment and fire extinction operations, such as fire line anchoring, back fire etc. Given that a noticeable part of the fire propagation is performed in the surface, fuel treatments at both sides of the roads could help greatly in firefighting operations.

The firefighting organization is based in a municipality-oriented structure, which is very efficient for local small fires but does not allow the organization and deployment of a large fire-fighting capacity for large and more destructive fires.

The type of forest fires, particularly in the incipient phase, and the presence of water masses, is indicating that a first, quick attack by heli-crews should be very efficient, especially in the high-risk days with potential of developing large fires. Currently there is no such capacity.

There is a clear need of designing, training and applying of strategic protocols and firefighting crews and resources management, based in the knowledge of the fire potential and behavior, the establishment of objectives and the application of tactical methods. As seen in the 2014 fire, several fire control opportunities were missed while at the same time dangerous situations for firefighters and other personnel were observed.

Some comments on the Wildland Urban Interface

What we have seen in the visit is that not large towns are potentially exposed to the fire. Instead many isolated houses or small groups are located near to or inside the forest.

House sidings and structure are made mainly of wood, which is treated with a compound of iron giving the characteristic red tone and preventing wood degradation. Maybe that this compound in the wood provides some resistance to fire ignition, but this point has not been tested.

Windows are medium size and do not present any type of shielding (shutters, etc.). In this sense, frames and window glasses are directly exposed to the potential effects of a forest fire (radiation, flame contact etc.)

Houses in general are very simple in construction, presenting just few or no horizontal elements such as decks or terraces.

Roofing is made of clay tiles mainly. Roof slope is moderate and in some cases flat roofing has been observed.

Surrounding of the houses are mainly patches of short grass or lawn, at a distance of the forest. This is more evident in the group of houses. Accessibility in general is good, through roads or directly crossing the field. Gardening is not very patent, and fences are infrequent. No green hedges have been observed.

In some cases other type of flammable materials and objects have been observed near or even touching the house, although this is not frequent.

Some of the houses have been destroyed in the fire of Vastmänland, although no detailed research on the causes and circumstances of such destruction has been carried out. It is likely that sustained combustion of the structure took place.

In general several isolated houses are more exposed to a wildland fire as they are located in the very vicinity or within the forested lands.

Although in general there is a clear opportunity of an efficient defense of such houses, particularly by cleaning vegetation and other surrounding fuels, no specific prevention measures have been observed. In the case of forest fires, no planned evacuation was in place nor identified safe meeting points.

In light of what we saw in the visit, it is not clear that a shelter-in-place operation could be performed efficient and safely given that not house conditioning was observed to act as shelters, nor basic fire defense installations and equipment.

It was identified a real need to cope with this type of forest fire emergencies affecting houses and infrastructure. In this sense is recommended to design and implement a national strategy for the defense of housing areas against fires. This should include:

- Self-protection measures for isolated and disperse houses
- Awareness and education campaigns aimed at population living in the forest
- Design of specific fire defense and civil protection operations and protocols

It is suggested to proceed with a specific study on the potential risk in the WUI areas, following these steps:

- Risk identification, characterization and mapping
    - Factors driving fire potential, fire scenarios
    - Potential sources of danger (flame front, smoke, firebrands etc.)
    - Identification of domino emergencies
    - Characterization and mapping of house vulnerability
    - Characterization and mapping of road vulnerability
    - Risk functions, calculation and mapping
- Zoning and prioritization
- Prevention measures planning
    - Actions on fuels
    - Actions on road and street network
    - Actions on houses and gardens
    - Actions on infrastructure for defense, installations
    - Improvement of communication channels
- Self-protection Plan, protocols, good practices
- Education, training and awareness activities

As in other European countries, the figure of the Municipality is a keystone in the implementation phase.

It is also recommended to count with tools and channels to inform population in the high fire risk days and remind good practices

It is recommended to perform an in detail research activity in order to understand the processes and factors entailing houses destruction.

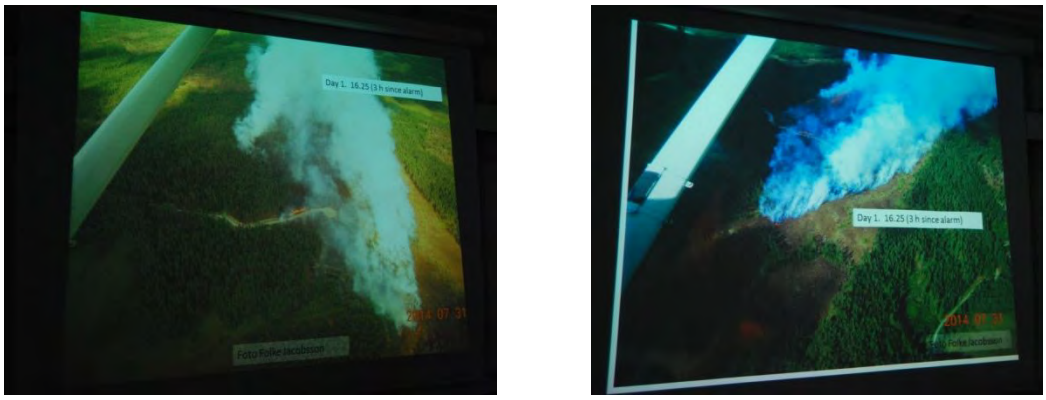
As a final recommendation, it is suggested to connect to the WUIWATCH network in order to:

- Share experiences
- Identify common problems
- Adopt common solutions
- Contribute with knowledge of houses affected in real fires

WUIWATCH is an European network for the creation and use of a knowledge base on forest fires affecting houses in the interface in Europe (www.wuiwatch.com)

iii) **Organization of fire suppression** – Miguel Cruz

The fire suppression system is fully responsibility of each local municipality, and of the fire brigades that are present in each of those municipalities. Considering the information provided, regarding the initial dispatch, we can conclude that, considering the FWI condition's at the ignition moment, the initial attack, should have been done with more resources, provided on the initial phase, from the neighbour municipalities, and also including the possibility of use of light helicopters, in order to prevent the fire spreading.



Aerial photography (taken 3 hours after fire ignition)

Considering the fire spreading and the specific terrain characteristic's with the presence of great quantities of stones in the forest combined with a very low road network density, the establishment of hose lines and the exclusive use of water, on fire suppression efforts, is a strategy very difficult to implement, that reduces efficiency of the teams progression in the ground, considering the initial fire rate of spread. An improvement that could be taken in consideration is the possibility to reintroduce in the firefighting training process (because there was in the past) the use of hand sapper tools for line construction operations and combined that use with the hose lines establishment, not only in direct firefighting but also, in mopping-up operations. According the information provided, the initial strategy established was to try to stop the left fire flank from the fire back to the fire head, but the fire back was not fully contained and anchored allowing that the fire became very active at the left flank after a wind direction change, occurred in the second day, which is a very common situation in wildfire fighting.

Fire area (visible the large amount of stones)

The establishment of specific wildfire behaviour training programme for the fire fighters can also be improve and boost their fire behaviour capabilities, providing them tools to better understand the opportunities for adjust the adequate fire suppression techniques and strategy's considering the type of vegetation and it´s structure, and its interactions with the meteorological conditions, specially wind speed and direction changes.

Regarding strategic overall coordination, at the county level, the use of specific and technical experience provided by the universities and the forest service, regarding the composition of the forest fuels and its characteristics, presented in a certain forest area can also be important to support the decision making of the incident commander (IC). Also the availability of different aerial images taken by several municipalities should be centralized and made available for the IC, because they are an extreme important decision making tool.

Regarding wildfire fighting resources, the availability of initial attack aerial means (helicopters) is a steep that should be consider for the future and to be managed and prepared at county or national level, instead of being a municipal responsibility. This will allow creating a national contract to insure the availability of these resources, on a pluri-annual base, beyond determined high levels of FWI, and using the remaining flight contract hours for other uses like, power line break maintenance or prescribed burning in important conservation areas.

Other lessons learn from the Vastmänland Fire, considering the average forest property dimension in Sweden (around 45 ha) and the climate change threat, is the need to establish an global approach for a more wildfire resilient forest, in a close cooperation between forest administration, associations and owners, though some adjustments on the forest species intermixed patterns, taking advantage of autochthonous species like the spruce and birch, but also taking in account the natural barriers that the lakes, the marshy and the agricultural areas, can contribute to wildfire rate of spread reduction and suppression opportunities.

4. Conclusion.

In our opinion this Expert Exchange Project was very useful and important for us. It provided us a unique experience and possibility to learn directly from eminent researchers and elements of the operational community at National and at local levels on the conditions of forest fire management in Sweden and in particular in the area of the large fire of 2014.

We are very grateful to the EU Expert Exchange program for providing us this opportunity and for our host for the excellent organization and hospitality during our entire stay.

The organization of the Workshop was excellent in all its details. The program was very well balanced and the chosen topics and events were most relevant. The extension of the problem and of the 2014 fire did not allow sufficient time to deal with all problems in the two days of our stay. We expect to overcome this difficulty with correspondence and future exchanges.