European Union Civil Protection Mechanism

European Commission

Mission to the Republic of Chile

In the field of emergency response – Forest fires

TECHNICAL REPORT

Forest fires situation in Chile between January – February 2017

February 2017

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Front page:

Overview of the forest fires situation in Chile

Forest affected by the fire.

Photo credits: EUCP Team, CONAF.

EXECUTIVE SUMMARY

Highlights

- During January – February 2017, Chile has experienced an episode of forest fires that can be described as an **extreme firestorm** with **rapid spreads** up to 8,200 ha/hour and **massive heat dissipation** with linear density of more than 60,000 kW/m.
- The underlying causes of the event are the extreme meteorology and high water stress of the vegetation resulting from the long drought. As an added circumstantial factor, the anticyclonic blocking situation between the high pressure of the Pacific and the Andes mountain range during the preceding days may have accumulated energy to trigger events in the evening of 25-26 January 2017.
- By weighing all the factors, **this resulted into a situation of a magnitude far beyond the capacity of any extinguishing operation**. The situation should not only be understood as an accumulation of simultaneous meteorological circumstances, but also taking into consideration that it is framed in a context of high water stress and anomalous conditions.
- **This exceptional forest fire event** and night firestorm from 25 to 26 January 2017 is an **extraordinary event that requires further studies** in order to be able to understand it in a comprehensive manner. Furthermore, such knowledge and eventual lessons are of a **great added value for the entire global forest fire community** and should be disseminated accordingly.

Target group, aims and structure

This technical report is addressed primarily to the national authorities of the Republic of Chile but also to the entire global forest fire community.

The first objective of this report is to make an analysis of the situation from the point of view of fire behaviour regarding multiple fires burning simultaneously in Chile.

The second objective, in respect of emergency response, is to draw some preliminary findings on the possibility that similar events (s) may occur in the future also in other parts of the world. To this end, the largest fires of this wave have been studied and analysed in more detail, which have occurred in the Maule and Biobío regions. Within the Maule region, the study has been focusing on the “Las Máquinas” fire complex and within the Biobío region, the study has been focusing on the “San Antonio” fire complex.

The report is presenting some preliminary findings based on available data and existing information at the moment of the assessments, as well as experts knowledge. Derived from this process the experts are making a series of recommendations which should not be considered exhaustive given the limited timeframe of the mission.

Any further follow up should be framed within the national legal, regulatory and planning framework that allows regulating and rationalizing the specific recommendations to be implemented, prioritizing them in time and space, and quantifying them in costs and benefits.

BACKGROUND

Due to the wave of forest fires in Chile at the end of January 2017 and the state of emergency declaration in several regions of the country, the Civil Protection Mechanism of the European Union was activated following a request for assistance from the National Authorities of Chile. Through **European Commission's Emergency Response Coordination Centre (ERCC)**, within hours, three operational ground firefighting modules were mobilized from France, Spain and Portugal, together with a EU Civil Protection team which included technical experts in the analysis of fire behaviour and forest fires dynamics.

The overall EU response consisted of:

- **177 European firefighters** deployed from France (voluntary pool), Spain and Portugal.
- **14 experts** EU Civil Protection Team deployed: 2 ERCC Liaison Officers, 1 DG ECHO Regional Information Officer, 11 experts.
- **In-kind assistance** from Austria, Spain and Sweden (protective and firefighting equipment).
- **EU Copernicus Satellite** mapping service activated for the Los Rios region: 4 satellite maps produced showing the extent and data about the forest fires.

The technical forest fires experts have been supported and integrated into a larger EU Civil Protection team deployed to Chile between 28.01 – 18.02.2017 composed of:

Julian MONTERO CABALLERO, **Team Leader**

Raphël LE GALL, **Deputy TL**

Maja KAMCEVA, **ERCC LO**

Maria PALACIOS VALDECANTOS, **ERCC LO**

Hilaire AVRIL, **Information and communication**

Mats LJUNG, **TAST**

Sam Lars Christian BACK, **TAST**

The main objective of the European Civil Protection Mechanism is to facilitate cooperation in disaster prevention, preparedness and response among its 34 participating States (EU-28 and the former Yugoslav Republic of Macedonia, Iceland, Norway, Serbia, Montenegro and Turkey).

With the support of the European Commission, the participating States pool resources and expertise that can be made available to countries affected by disasters throughout the world, as well as possible prevention and preparedness operations. The Mechanism, through its Emergency Response Coordination Center (ERCC), also monitors global risks and emergencies 24/7 and serves as an information and coordination center in emergency situations.

METHODOLOGY

The following methodology was used for data collection and analysis:

- A compilation of the basic data of the fire episode with the Fire Analysis Technical Unit that owns the National Direction of CONAF in Santiago of Chile.
- A compilation of field data, and more specific fire data with the CONAF Regional Office in Maule and Biobío. For this, the team of experts was subdivided in two teams and performed field assessments in Maule and Biobio regions and had extensive consultations with regional and national authorities
- A subsequent joint analysis of all data by the whole team together with the Fire Analysis Technical Unit of CONAF in Santiago.
- Specific technical consultations on meteorology with experts in Europe from the GRAF Bombers Units, the PCA Analysis Group (Pau Costa Foundation), the CFOA (Fire Chiefs Association in UK and Ireland) and de UNAP in Castilla-La Mancha.

The external sources consulted to obtain data have been the following:

- Meteorological data: GFS model.
- Satellite imagery: METEOSAT and GOES 13.
- Forest fire simulators provided by Tecnosylva S.L., based in León (Spain) and San Diego (USA).
- Expert advice from Al Beaver, Forest Fire Analyst in British Columbia (CA) and Victoria (AU).

EXPERT ANALYSIS AND PRELIMINARY FINDINGS

The episode of forest fires generated gigantic proportions. The fire complex of “Las Máquinas” burned about 187,000 ha, of which 115,000 were burned in a period of 14 hours. This gives an advance of 8,142 ha/hour during the night. This created a huge convective storm of fire that spread a front, which reached the width of 42 kilometres. The length of the run was 21 kilometres long.

Considering that the meteorological conditions in the area do not show extreme anomalies, and that the nearest meteorological stations record winds between 5-20 km/h and relative humidity between 25-30%, only enormous convective conditions can explain the fire behaviour.

In the period between the afternoon of January 25, 2017 and the dawn of day 26, all active forest fires in the Maule and Biobío regions experienced an extreme behaviour, reaching intensities that could exceed 60.000 Kw/m and average propagation speeds exceeding 6 km/h.

The huge simultaneous forest fires during previous days, and the geographical extent in which they occurred, created an event of large forest fires comparable to previous episodes such as Portugal 2003, Galicia 2006, Greece 2007 or Australia 2009. Although, these events are related to the passage of an atmospheric front that generates strong wind gusts that push the propagation of the forest fires and create the well-known phenomenon of firestorm in Mediterranean climate areas. The episode in Chile does not fit in this classification, given that the high-pressure atmospheric conditions.

During this summer season, Chile has suffered severe drought with a long episode of dry weather and record maximum temperatures. During those days there has not been any particularly strong winds at the synoptic level. However, field tests show that, within the forest fire environment, extreme wind speeds were reached, which can only be explained due to convective atmosphere conditions in the fire.

Therefore, it is considered that the amount of surface burning simultaneously in the same zone (coastal mountain range between the regions of Araucanía, Biobío and Maule) and the amount of energy released during the days prior to January 25, caused an extreme situation accumulating hot air and dryness in the atmosphere. This great mass of dry, warm air was enclosed between the Andes and the high pressures of the Pacific Ocean.

It is considered that due to the vorticity of the atmosphere after several days of anticyclonic blockade, a thermal low-pressure area was formed in the Pacific coast. The effect of the simultaneous fires added more energy and intensity to this depression (figure 1). Moreover, the interaction of these forest fires dragged the depression to the south, specifically towards the Maule region, causing extreme behaviour in all active forest fires in the regions from Araucanía to O'Higgins. This depression converged into the largest fire that was burning: “Las Máquinas” fire complex. The convective fire environment created by this complex was aligned with this atmospheric depression and, during the night of January 25 to 26, created a firestorm that altered the atmospheric behaviour of the entire region at mesoscale level, causing an intense flow of South-Southeastern winds in the Biobío region fires and an intense West-Northwestern flow in the fires of the O'Higgins region.

We cannot conclude that the simultaneity of forest fires generated the thermal low-pressure area, but in the mesoscale creation process, huge forest fires altered it and was attracted to its vortex (“Las Maquinas” fire complex), creating a firestorm to the same mesoscale level that lasted all night. This firestorm began to remit once the thermal inversion of the whole area was released. Before that, the high-pressured area was pressuring the surface air layer and it was being directed towards its escape route (the vortex that formed “Las Maquinas” fire complex), where it accumulated the peak of heat energy.

This enormous flow of hot air over the Pacific and over the central valley of Chile also created subsidence with katabatic winds over the Andes, which pushed the column of “Las Casas” fire complex northward. This phenomenon is still under study and reconstruction.

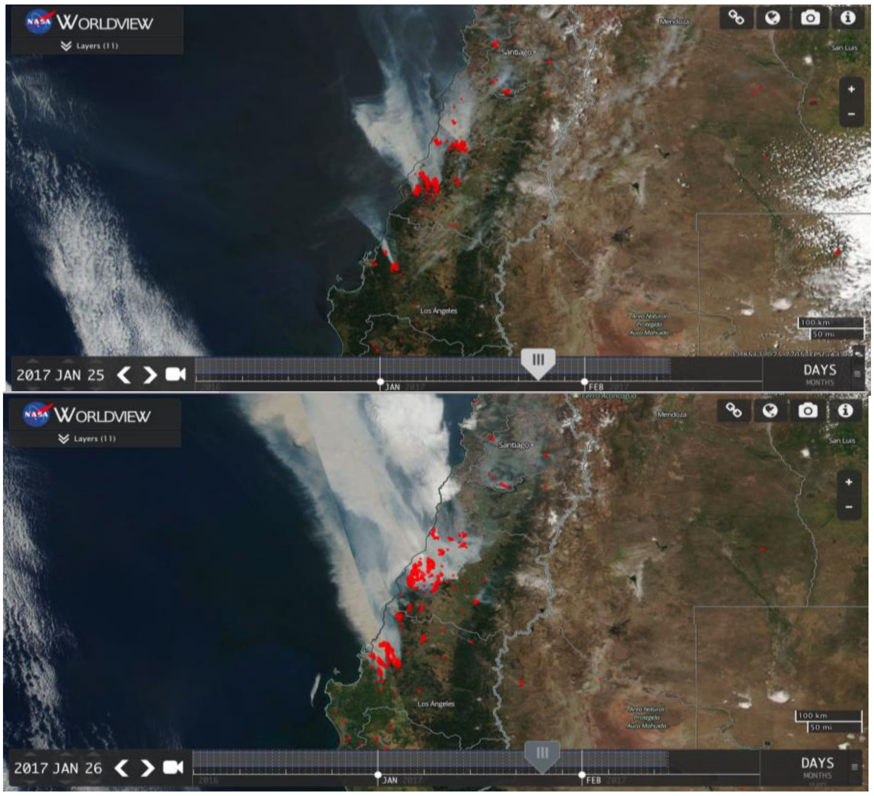

Figure 1. Comparison of the area of study on the morning of January 25 (above) and January 26 (below), where the extreme behaviour of the fires is observed.

This extreme behaviour of the forest fires can be seen in the field with the observation of great runs of crown fire. Their width and the presence of numerous stands of *Pinus radiata* (figures 2 and 3) twisted and crushed by the effect of the fire storm, confirms the extraordinary convection of the vortex fire complex, greatly accelerating the propagation velocities of all the rest of fires affected.

According to experimental simulation data, this propagation would correspond to winds generated by the storm at around 100 to 130 km/h that are much higher than the 20-30 km/h registered by meteorological stations in the area.

Figure 2. Detail of plantation stands of *P. radiata* in the San Antonio (Biobío) fire complex bent and crushed by suction wind currents into the convective cell.

Figure 3. Plantation stand of *P. radiata* has been made to fall by the effect of convective wind currents in "Las Máquinas" fire complex.

<u>Figure 4.</u> Detail of the largest fire run observed in the "Las Máquinas" fire complex. Its width exceeds 2 km.

RECOMMENDATIONS AND GENERAL BEST PRACTICES

NOTE: The mandate of the EUCP team was focused mostly on emergency response. Therefore, the technical experts have limited knowledge and understanding of the national regulatory frameworks and cooperation protocols among different national institutions with responsibilities in emergency situations. Consequently, the recommendations presented below going beyond and not derived from the preliminary findings are based on experts' knowledge and best practices on forest fires encountered within their national and international experience.

General preparedness measures for large scale forest fires with similar characteristics may encompass the following recommendations:

- Identify measures of social fire prevention in order to minimize the occurrence of simultaneity fires.
- Implement measures on vegetation, as well as management of fuels.
- Provide suggestions on forest fire fighting operations.

All measures would be framed within the generation of a legal and planning framework that allows regulating and rationalizing the measures to be implemented, prioritizing them in time and space, and quantifying them in costs and benefits.

Actions to minimize the occurrence of fires

Implement a methodology that allows collecting detailed information on the origin of fires in order to develop social prevention measures.

Actions on vegetation and management of fuels

Generally, the generation of mosaics in the landscape is proposed. The recovery and promotion of traditional agricultural activities, such as extensive livestock farming or agriculture, are very convenient. In the same way, it is considered opportune to advance in the execution of forest fire prevention works considering the opening and maintenance of the network of prevention infrastructures that is defined in the necessary planning documents.

The plantations are the most represented fuel model in the landscape of the regions with the greatest fire affliction. It is therefore proposed to open lines of work aimed at reducing their vulnerability to fires. The management of the forest masses in relation to their impact on the advance of the fires or the increase of the plantation frame to allow a greater flow of wind inside, facilitating the fall of needles to the ground are two examples of possible measures.

Actions on forest fire fighting operations

It is essential to improve the transfer of the work of the technical unit of analysis and planning to the decision-making in the pre-emergency, in the dispatch of means to the possible forest fires and in the operations of fire suppression. These units should provide useful information for the operation at regional and provincial level. Moreover, such information must be integrated into the decision-making process, both at firefighting means deployment and during the development of the fire. There is also a need for continuous feedback between these two parties.

In general, these episodes of forest fires on such a large scale require high levels of preparation and professionalization of the participating personnel, taking into account the capitalization of the experience of the personnel involved and the improvement of the training.

In particular, night operations should be considered. The nights present opportunities of extinction that must be exploited with the pertinent security measures.

Incorporate operations with technical fire as an effective method of extinction in large forest fires. For the implementation of this measure it is necessary that people who are going to execute these actions are properly trained in the matter.

While any air resources with extinguishing capacity is valuable in a scenario of forest fires simultaneity, regarding the management and optimization of resources in the future, it is considered more effective and efficient to use helicopters and aircraft with the capacity of 1500 to 5500 litres rather than large capacity tankers. Since medium and small air resources have greater manoeuvrability and adaptability to the terrain, allow a higher discharge rate and interfere less with the rest of the means working in the fire.