RECIPE

REINFORCING CIVIL PROTECTION CAPABILITIES INTO MULTI-HAZARD RISK ASSESSMENT UNDER CLIMATE CHANGE

Visualizer tool for managing emergency situation in case of high avalanche risk

ENGLISH SUMMARY

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1. Introduction

This report is part of the deliverables of the RECIPE Project (Reinforcing Civil Protection capabilities into multi-hazard risk assessment under climate change) and corresponds to the Deliverable 4.5 of Task 4.3.

RECIPE is a two-year Prevention Project (January 2020 – November 2021) founded by the Civil Protection Mechanism of the European Commission (call identifier UCPM-2019-PP-AG), with the participation of 8 institutions from 5 EU countries:

- Forest Science and Technology Centre of Catalonia (CTFC), Spain (Project coordinator).
- Pau Costa Foundation (PCF), Spain.
- Civil Protection General Directorate of Catalonia (DGPC CAT), Spain.
- Forest Research Institute Baden-Württemberg (FVA), Germany.
- CIMA Research Foundation (CIMA), Italy.
- Austrian Research Centre for Forest Natural Hazards and Landscape (BFW), Austria.
- Institute of Cartography and Geology of Catalonia (ICGC), Spain.
- Higher Institute of Agronomy (ISA), Portugal.

The RECIPE Project seeks to develop operational recommendations and tools to reinforce Civil Protection capabilities into emergency management and risk planning of different natural hazards across Europe to address climate change impacts, by using an integrated risk management approach and the exchange of lessons learned and best practices.

By means of putting together multi-hazards' expertise from science and practice on wildfires, floods, storms, avalanches, rockfalls and landslides, main impacts of climate change in risk management will be identified. The potential scenarios of unprecedented multi-risk events will be considered. The interactions between prevention-preparedness-response-recovery actions in projected climate change scenarios will be analysed with an active participation of practitioners and other users. Accordingly, Civil Protection requirements to face new risk management challenges about climate change impacts will be identified.

Based on the above, transferable guidelines will be edited to incorporate the projected multi-risk impacts of climate change into operational decision support systems (DSS) that are used for risk management. Complementary, specific operational tools will be developed at pilot site level for each natural hazard to reinforce Civil Protection capabilities. Participation of public agencies will be promoted from the beginning to achieve an end-user oriented focus. Results will be actively disseminated into Civil Protection systems.

Furthermore, the project's workshops will promote the knowledge exchange in the existing networks to reinforce European landscapes' resilience to natural hazards.

The project is divided in 5 work packages (WP) as follows:

- WP1 Management and coordination of the action.
- WP2 Framing Civil Protection requirements for integrated multi-hazard risk management.
- WP3 Impacts of climate change projections on multi-hazard risk management.

• WP4 Guidelines and decision support tools to integrate climate scenarios into risk assessment and planning.

• WP5 Publicity and project outcomes transference.

Task 4.3 is part of the work package 4. This WP is composed by three tasks. On the one hand, in task 4.1 an analysis of existing decision support systems and the operability to include projected climate change impacts identified in previous WP3, is developed. In the second task (4.2), a description of the risk attributes and data requirements to be included into the DSS to address climate change impacts on multi-hazards risk management is done. Finally, the taks 4.3 includes a set of support tools for civil protection which will serve to address a specific need, taking into account all the work done in the previous WP.

As expected, each support tool will be edited in the local language of the territory of applicability (Italian, Catalan, German and Portuguese), and will be also a summary in english available, which is this document.

2. Visualizer tool for managing emergency situation in case of high avalanche risk

The RECIPE project has provided the opportunity to learn about the risk management needs of the General Directorate of Civil Protection (DGPC) and the Risk Managers of the Cartographic and Geological Institute of Catalonia (ICGC). The ICGC, as coordinator of the Nivo-meteorological Assessment Group of the Special Avaluation Plan for Avalanches in Catalonia (ALLAUCAT[1]), has detected the need to incorporate the synoptic patterns that trigger episodes of large avalanches and the records of major avalanches with their main characteristics (aspect, length, effects and/or damage) into the prediction of avalanche danger.

2.1 Objectives and scope

The main task of the Avalanche Warning Service of the ICGC (UPA) during the winter season is the avalanche forecasting. Daily the UPA carries out the avalanche bulletin according to the European avalanche danger scale of 5 degrees (from 1 low up to 5 very high). In case of esteemed danger such as level 4 high or 5 very high the UPA carry out special warnings (APA) addressed to Civil Protection exclusively as established in the special civil protection plan ALLAUCAT.

The two main objectives in the frame of the project are: 1) improvement of the forecasting issues in critical situations which involves risk and the attainment of APA and 2) supply a tool to help in the process of decision making.

The analysis and the assessment of major avalanches occurred in the past and the prediction of new scenarios will allow to refine the APA fulfilment and risky scenarios. Thus, the participation in the project will allow to update the major avalanche scenarios in the Pyrenees of Catalonia in the frame of climate change. A special focus on vulnerable sites will be done in order to increase the safety and to improve the forecasting for critical situations and the issue of APA.

On the other hand, there is a tool for the process of avalanche forecasting that allows the assessment of the snowpack stability in a systematic risk based workflow. The Platform of information of Avalanche Hazard called PIPA is a tool that enables the daily forecasting by using the conceptual model to asses snowpack stability. The platform is made up of different levels that are defined as follows. Levels 10 and 11 make up the tool.

First level: access into the application using a user and password for each forecaster, selection of the snow-climate zone to be assessed, date of realization and date of validity of the forecasting.

Second level: definition of the scope and the scale of forecasting.

Third level: input of the main snow and weather data.

[1] The ALLAUCAT Plan is the Special Plan for Avalanche Emergencies in Catalonia of the General Directorate of Civil Protection of Catalonia (DGPC). This plan defines the structure and organisation of the action groups involved. It also establishes the measures and actions to be performed in situations with an avalanche danger level of 4 and 5 (very high danger). The ALLAUCAT Plan is activated in the pre-alert phase when the degree of danger is equal to 4. On the other hand, a danger level of 5 means that the plan is activated in the alert or emergency phase (level 1 or 2) depending on the impacts and/or damage caused by avalanches.

Fourth level: definition and ranking of the snowpack layers that have the main role in the stability.

Fifth level: Definition of the avalanche situation (problems) associated with the layers defined in the previous stage.

Sixth level: Definition of avalanche triggering probability according to the spatial distribution (elevations, orientations and spots in danger) and the sensitivity to triggers for each one of the problems defined in the previous stage.

Seventh level: danger diagram showing the avalanche triggering probability in relation to the expected avalanche size.

Eighth level: stage where each predictor writes additional comments to monitor the avalanche situation.

Ninth level: forecasted danger degree for the next 24 hours and its trend for the 48 and 72 hours. It includes the level of confidence level according to the number of data, level of experience, level of reliability of weather forecasting, among others.

Tenth level: outline of the situation with the visualization of the most relevant features of the previous levels. This summary is used as a communication tool for the different stakeholders: civil protection, observers and forecasters prior to the issue of APA or BPA.

Eleventh level: definition of the critical situation that would rely on the outline and the most similar major avalanche pattern and the forecasted avalanche activity with a map (figure 1).

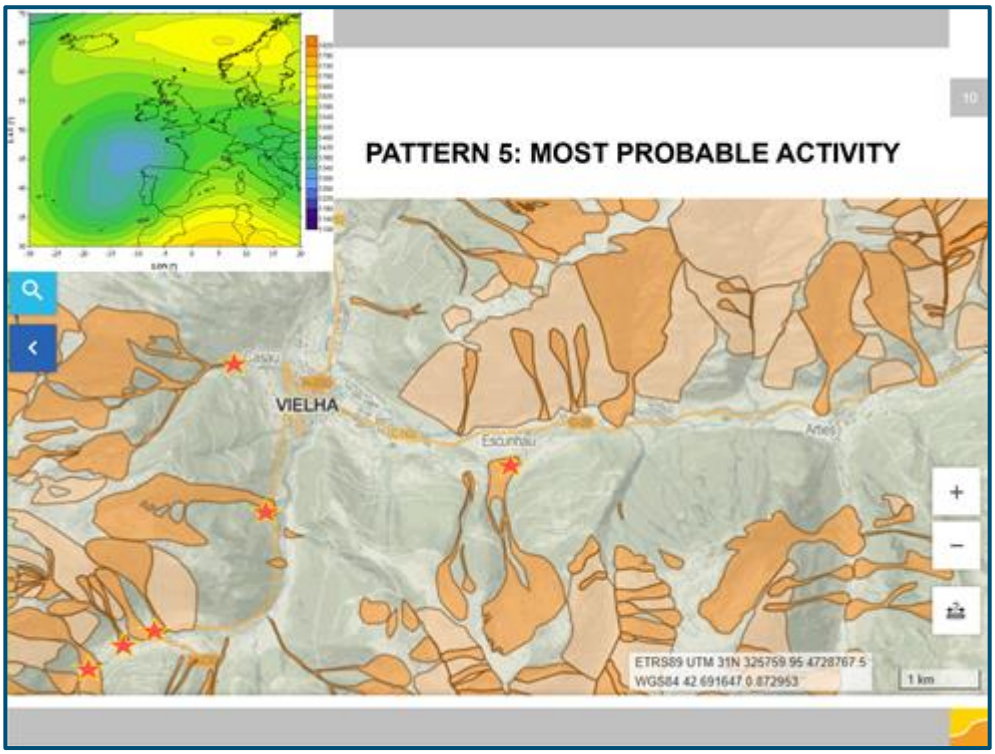


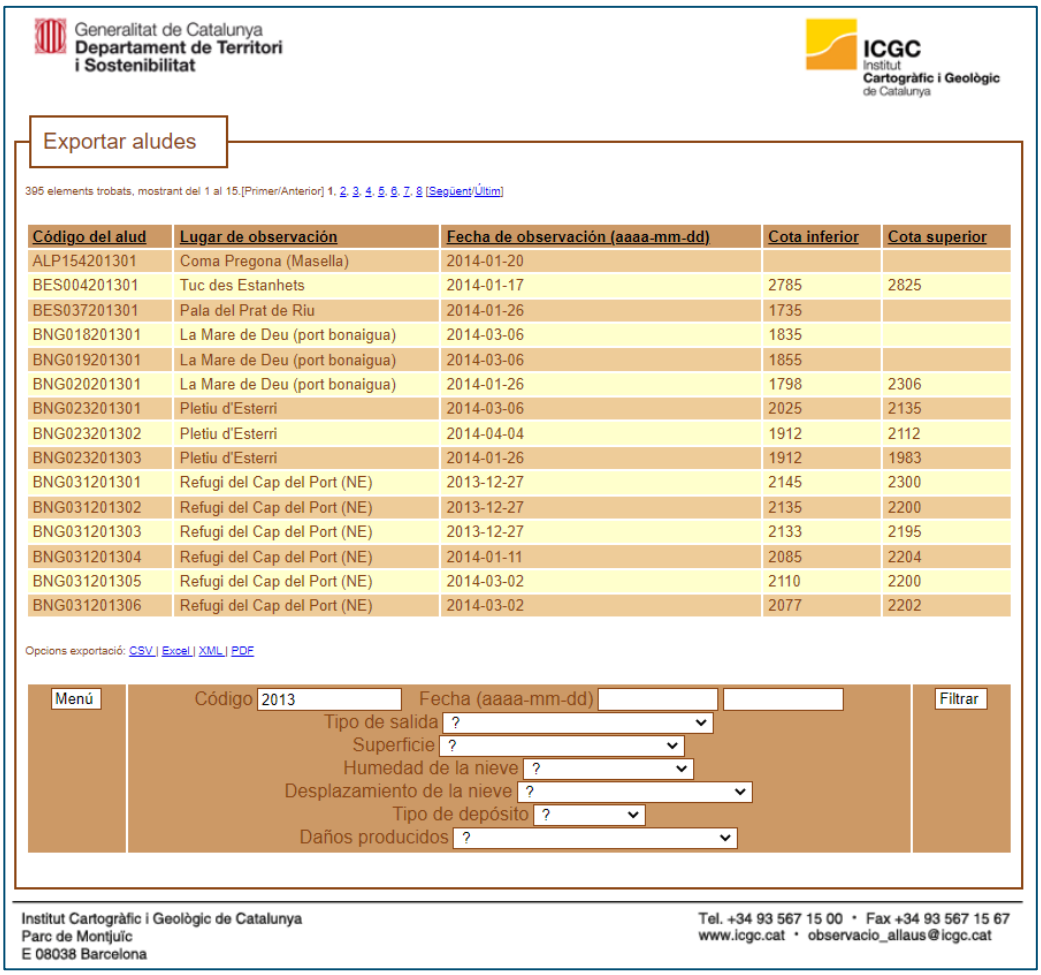
Figure 1. Map of the forecasted avalanche activity (pointed with an orange symbol) according to an specific synoptic pattern.

2.2 Description of the tool

The decision support tool (DSS) developed by the ICGC (Visualizer tool) has the main function of enhancing the Avalanche Hazard Information Platform (PIPA) and assists in decision making when the Avalanche Hazard Degree is 4 or 5 (high and very high).

On these conditions linked to pre-alert, alert and emergency situations, the Visualizer tool will show which are the most susceptible areas for triggering major avalanches based on the definition of major avalanche episodes and nivo-climatic zones. So, for each synoptic atmospheric pattern and nivo-meteorological zone, the avalanche zones likely to trigger large avalanches will be identified.

To develop this tool requires extracting all the topographic information on major avalanches in the Catalan Pyrenees. The main source of information used to develop the Visualizer Tool is the Avalanche Database of Catalonia (BDAC) (Figure 2). This database collects information about avalanche zones (susceptible areas where avalanches can occur), avalanche observations (avalanches observed during the winter season) and avalanche surveys (avalanche information from surveys to the older population living in risky areas). Other sources of information that have been analysed are the historical documentation and some scientific publications (Garcia, C. 2017; Oller, P. 2015).


Generalitat de Catalunya
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Exportar aludes

395 elements trobats, mostrant del 1 al 15.[Primer/Anterior] 1, 2, 3, 4, 5, 6, 7, 8 [Següent/Últim]

Código del alud	Lugar de observación	Fecha de observación (aaaa-mm-dd)	Cota inferior	Cota superior
ALP154201301	Coma Pregona (Masella)	2014-01-20		
BES004201301	Tuc des Estanhets	2014-01-17	2785	2825
BES037201301	Pala del Prat de Riu	2014-01-26	1735	
BNG018201301	La Mare de Deu (port bonaigua)	2014-03-06	1835	
BNG019201301	La Mare de Deu (port bonaigua)	2014-03-06	1855	
BNG020201301	La Mare de Deu (port bonaigua)	2014-01-26	1798	2306
BNG023201301	Pletiu d'Esterri	2014-03-06	2025	2135
BNG023201302	Pletiu d'Esterri	2014-04-04	1912	2112
BNG023201303	Pletiu d'Esterri	2014-01-26	1912	1983
BNG031201301	Refugi del Cap del Port (NE)	2013-12-27	2145	2300
BNG031201302	Refugi del Cap del Port (NE)	2013-12-27	2135	2200
BNG031201303	Refugi del Cap del Port (NE)	2013-12-27	2133	2195
BNG031201304	Refugi del Cap del Port (NE)	2014-01-11	2085	2204
BNG031201305	Refugi del Cap del Port (NE)	2014-03-02	2110	2200
BNG031201306	Refugi del Cap del Port (NE)	2014-03-02	2077	2202

Opcions exportació: CSV | Excel | XML | PDF

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Figure 2. Avalanche Database of Catalonia (BDAC)

A systematic search was carried out based on these sources of information in order to identify major avalanches. A major avalanche is characterised by a length of more than 1,000 metres, by exceeding the expected arrival zone of the avalanche zones and/or by causing damage to the exposed and vulnerable elements of the territory. More than 6.000 avalanche records have been reviewed and analysed, due to lacks of information in the BDAC. This analysis has allowed us to extract the most accurate information on large avalanches according to various selection criteria (length, arrival zone, damage, etc.).

Once the major avalanches have been detected in the BDAC, a date of major avalanche cycle has been assigned to them. A major avalanche episode is defined as the occurrence interval of time (minimum one day is considered) of at least one major avalanche registered.

In total, 78 episodes of large avalanches (with a specific date) have been identified. They contain 418 records of large avalanches with the information related to the triggering synoptic pattern, its identifying code, length, orientation, arrival height, type of avalanche, origin, and damage and/or effects. Nevertheless, 629 records of large avalanches have not been associated with an episode of major avalanches since it was not possible to be dated at daily resolution. This extracted information has been used to generate a new exclusive database about major avalanches in the Catalan Pyrenees. Also, avalanches affecting vulnerable zones, but not being large ones, which belong to episodes of large avalanches have been added to the Visualizer tool.

From the 78 episodes, a total of 9 synoptic patterns triggering major avalanche have been detected applying a Principal Components Analysis (PCA). The identified synoptic patterns are north-westerly and northerly advections, trough, Mediterranean ridge, Atlantic ridge, cold-core low, low centred on the southern half of the Iberian peninsula, zonal circulation and south-westerly advection (Figure 3).

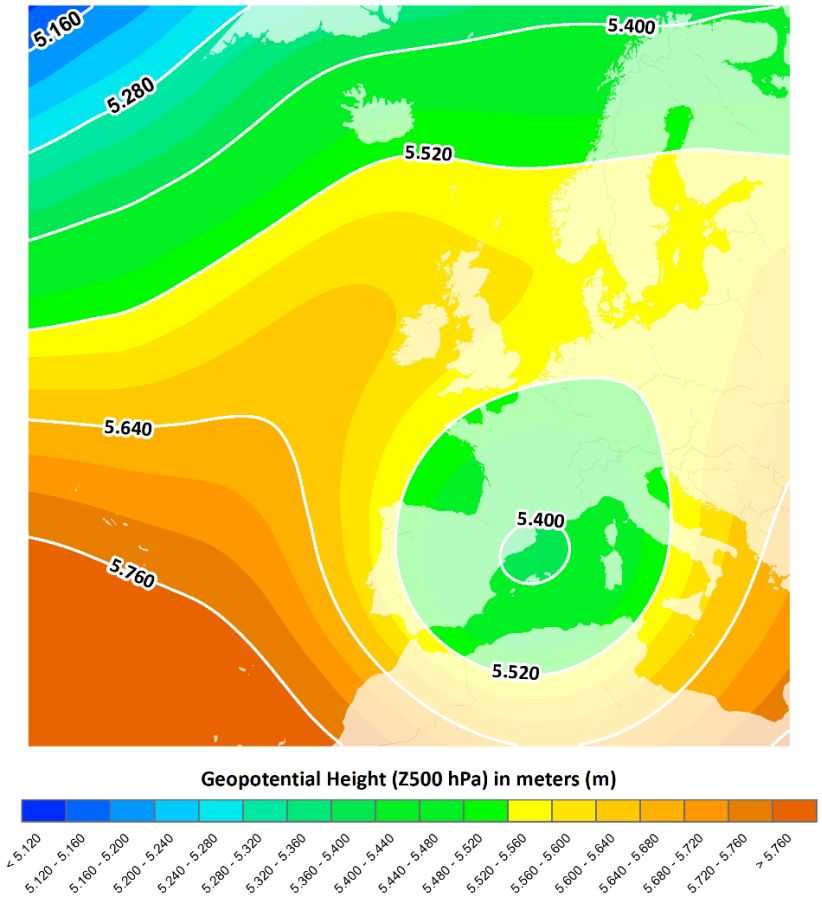

Figure 3. Synoptic Pattern “Cold-core low”.

Once the synoptic patterns triggering large avalanches have been defined, an exclusive forecasting tool (Visualizer tool) with two modules has been developed. **Module 1** shows the **likely major avalanches** for the current day, which are those observed so far. It contains three levels of information:

- **Level 1:** According to the synoptic pattern, the **major avalanches** are visualised.
- **Level 2:** According to the synoptic pattern, **avalanches that have affected exposed and vulnerable elements and that are not classified as large avalanches** are visualised.
- **Level 3:** The **maximum arrival zone observed** for each avalanche zone is visualised, regardless of the synoptic pattern.

Module 2 shows the **possible avalanches**. According to the topographical features of the major avalanches observed for each synoptic pattern, avalanche zones sharing common features with the observed ones are visualised as possible major avalanches. Information on the possible effects on exposed and vulnerable elements is indicated.

3. Recommendations for the EU scalability of the support tool

The Visualizer tool for managing emergency situations in case of high avalanche risk is a decision support tool (DSS) that can be applied in other countries around the world. In Catalonia, the Visualizer Tool is part of the Avalanche Danger Information Platform (PIPA). This kind of platform used in avalanche danger forecasting is also developed in other countries; so, the analysis of large avalanche episodes could be included in their respective platforms and thus improving avalanche risk management. In addition, the analysis carried out for forecasting large avalanches in Catalonia depending of the atmospheric conditions is also applicable to other complex climate contexts. It is applicable for risky situations and extreme events, such as floods. The aim is to forecasting natural risks (avalanches, floods, wildfires, etc.) using the information registered in a database where all the events can be found and taking into account the particularities of local climates and geographical conditions. These events must be extracted, analysed and organised using search criteria. In this way, we have defined several scenarios of major avalanches and avalanches affecting vulnerable zones that improve the forecasting outputs.

The Avalanche Database of Catalonia (BDAC) began to be developed more than 30 years ago. This source of information has gone through various stages and administrations. This fact has complicated the extraction of information on large avalanches in the Catalan Pyrenees. For this reason, 10 search criteria were used in the Avalanche Database of Catalonia (BDAC), in order to define precisely which are the major avalanches in the Catalan Pyrenees and their characteristics. The aim is to file systematised and homogenised data and information, avoiding inconsistences depending on the evolutive stages. Therefore, a well-developed, structured, consolidated and worked database will allow Civil Protection to achieve this approach to natural hazards in a more efficient way.