The HuT

Modelling activities to be developed in the Demonstrators

Deliverable D4.5

DEVELOPED WITHIN
WP4 Science and Technology, T4.3 Innovative Nexus Modelling

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1. Technical references

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* PU = Public

PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

CO = Confidential, only for members of the consortium (including the Commission Services)

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1.1. Document history

Version	Date	Lead contributor	Description
0.1	30.06.2023	Michele Calvello (UNISA)	First draft
0.2	10.07.2023	Jo-Ting Huang-Lachmann (HEREON)	Critical review and proofreading
1.0	14.07.2023	Michele Calvello (UNISA)	Final version

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2. Table of contents

2.1. List of Tables

2.2. List of Figures

None

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3. Purpose

Several modelling approaches will be adopted for risk characterization in the ten demonstrators, leveraging the existing expertise of the project partners and using different open data sources (e.g., C3S datasets or EMS services from COPERNICUS initiatives). The modelling activities to be undertaken in the demonstrators' arena have been defined considering "modeling and risk analysis needs" explicitly expressed by the main stakeholders in each Demonstrator. Specifically, these needs are associated with improvements in weather and climate modeling for DRR/CCA purposes at the local scale, and with advanced predictive tools for assessing the risk and associated impacts (i.e., hazard, exposure, vulnerability).

The main envisioned innovations concern: i) improvement in the assessment of weather and climate forcing at different time scales by exploiting cutting-edge approaches (e.g., machine learning) and new monitoring data; ii) the adoption of dynamic exposure mapping approaches, currently available for seismic risk, within a hazard agnostic framework; iii) improvement in parametrizations and parameters of predictive tools used for warning or climate change impact assessments.

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4. Innovative Nexus Modelling

The modelling activities that will be carried out by the project partners within Task 4.3 “Innovative Nexus Modelling”, address three different issues: weather and climate, exposure, and impact. Table 1 reports the plan of such activities in each demonstrator for these issues. Considering that the starting point of each case study is very different, some demonstrators will be able to boost already existing consolidated expertise in these activities (also available for cross-transferring elsewhere), while in other demonstrators The HuT will serve as a means of importing the best practices from other partners or more developed demonstrators.

Table 1: Modelling activities in the Demonstrators [DLead=Demonstrator’s leader, FF=Forest Fires, D=Droughts, H=Heatwaves, L=Landslides, F=Floods, S=Storms]

ID (DLead)	Site, Country (Events)	Weather and climate	Exposure	Impact
DEM1 (UPV)	Valencia city, Spain (D, H)	Yes	No	Yes
DEM2 (UPC)	Val d'Aran region, Spain (F, L, S)	Yes	maybe	Yes
DEM3 (CMCC)	Lattari mountains, Italy (F, FF, L, S)	Yes	Yes	Yes
DEM4 (VU)	Vilnius city, Lithuania (F)	Yes	No	Yes
DEM5 (HEREON)	Schleswig-Holstein state and harbour cities, Germany (H, S, F)	No	Yes	No
DEM6 (IMO)	East fjords, Iceland (L, S)	Yes	No	Yes
DEM7 (KOTIVIZIG)	Hungarian Tisza River basin, Hungary (F)	No	No	Yes
DEM8 (CMCC)	Ogliastra province, Italy (F, L, S)	No	No	Yes
DEM9 (BGS)	Dorset county, UK (F, L, S)	Yes	maybe	Yes
DEM10 (UNIGE)	Bern canton, Switzerland (F, L, S)	Yes	Yes	Yes

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4.1. Weather and climate

Weather and climate forecasting activities will be carried at different temporal and spatial scales, in relation different variables, and considering the main gaps currently affecting model estimations in the areas of interest. The main overall objective of these activities is to device models that improve weather and climate forecasting for DRR/CCA purposes at local scale, and whose results can feed advanced predictive tools for risk assessment and associated impacts. To this aim, the specific characteristics of the demonstrators, and of the climate extremes and weather-induced hazards addressed in those areas, will also be taken into account.

4.2. Exposure

One of the partners, GFZ, is specifically in charge of improving and using an existing tool called "Global dynamic exposure model", which was originally developed to provide building-specific exposure data globally for seismic risk assessment, to address risks related to climate extremes in some of the demonstrators. This model combines engineering knowledge from existing classical exposure models with open data, predominantly OpenStreetMap, to characterize every building as precisely as possible. It provides these exposure data in a fully open fashion, including the software system to generate it. The model is discretized to approx. 100m x 100m tiles of a global grid while still preserving the information for each building separately. These data are immediately processed and the exposure at the building locations is updated. Each building is represented by one or more assets describing in a probabilistic way what is known about this building. The tiles are used to approximate building counts in case where OpenStreetMap data is incomplete. To preserve privacy, the publicly available data is aggregated to these tiles such that information about single buildings cannot be derived.

The model input data and the codes will be updated and adapted in The HuT, in cooperation with the leaders of relevant demonstrators, to profitably use this approach in the estimation of exposure data for the assessment of risks associated with climate extremes.

4.3. Impact

In The HuT the possible impacts of extreme climate events are addressed by adopting a trans-disciplinary "all-hazards" approach, connecting the sectoral silos associated with individual events and enabling a joint and coordinated planning and adoption of multi-hazard disaster risk reduction. To this aim, both existing and novel procedures will be used across the demonstrators. In some demonstrators, the modelling activities will specifically aim at improving some predictive tools and approaches that forecast the potential impacts of extreme climate events. In such cases, these activities will necessarily deal with the specific hazards affecting the area of interest. The improvement of such tools/approaches will be related to either one or both of the following: short-term preparedness actions to be used in warning systems, medium and long-term estimates directing adaptation solutions to climate change.

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5. Activities in the Demonstrators' Arena

5.1. DEM1 - Valencia city, Spain

The modelling activities related to weather and climate in the area of the demonstrator are aimed at: improving the forecasting capacities within the basin, downscaling the results, and trying new forecasting models/products. Some details follow.

- Variables of interest: rainfall and temperature.
- Time horizon of interest: 1 week, 2-3 months.
- Main gaps currently affecting the estimation: Rainfall prediction not as precise as needed. Temperature predictions not downscaled at the city scale.
- Expertise: internal, support from partners not needed (new ideas are welcome).

Dynamic exposure mapping activities will render 3D models of the Valencia demonstrator which will be used as a starting point for the digital twin simulating heat stress mitigation measures. This is the initial point for a collaboration with GFZ exploring the use of their 3D city models in Europe for dissemination of the proposed digital twin heat stress impact assessment at EU level.

In this demonstrator, improvements of tools/approaches that forecast the potential impacts of extreme climate events are addressing the following:

- drought and water resource management for the simulation of long-term climate scenarios with the aim of estimating the impact of climate change to the water availability and the raw water quality for the city of Valencia;
- urban morphology algorithms forecasting heat maps and urban heat island maps for the city of Valencia at a 90m resolution, downscaled from surface temperatures at 5km.

5.2. DEM2 - Val d'Aran region, Spain

The modelling activities related to weather and climate in the area of the demonstrator are aimed at: improving rainfall and soil moisture input for early warning systems addressing rainfall-induced landslides, debris flows and flash floods. Some details follow.

- Variables of interest: rainfall and soil moisture.
- Time horizon of interest: not defined yet.
- Main gaps currently affecting the estimation: scarcity of monitoring data, especially rain gauges.
- Expertise: internal for monitoring and rainfall-runoff modelling.

Dynamic exposure mapping approaches in the estimation of exposure data may be adopted in this demonstrator, yet an action plan to develop this activity in cooperation with GFZ has not been set up yet.

In this demonstrator, improvements of tools/approaches that forecast the potential impacts of extreme climate events are addressing the following:

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- flood-landslide coupling model aimed at addressing cascading-compounding events simulations in Val d'Aran.

5.3. DEM3 - Lattari mountains, Italy

The modelling activities related to weather and climate in the area of the demonstrator are aimed at: improving the understanding about the simulation chains currently adopted for weather forecast; testing the usefulness of information freely available from Copernicus Services or NASA (SMAP, GPM); developing nowcasting approaches to cover time scales not adequately considered by the regional early warning system. Some details follow.

- Variables of interest: rainfall and soil moisture.
- Time horizon of interest: nowcasting, projections.
- Main gaps currently affecting the estimation: spatial resolution on highly complex orographic areas, mainly for short term forecasting.
- Expertise: internal for long term projections, support needed for nowcasting.

Dynamic exposure mapping approaches in the estimation of exposure data will be adopted in this demonstrator, yet an action plan to develop this activity in cooperation with GFZ has not been set up yet.

In this demonstrator, improvements of tools/approaches that forecast the potential impacts of extreme climate events are addressing the following:

- use of climate data and land use/cover changes to direct land use planning at municipal level.

5.4. DEM4 - Vilnius city, Lithuania

The modelling activities related to weather and climate in the area of the demonstrator are aimed at: improving rainfall nowcasting and short-term forecasting. Some details follow.

- Variables of interest: precipitation intensity.
- Time horizon of interest: nowcasting, 2-3 days weather forecasts, climate change projections.
- Main gaps currently affecting the estimation: insufficient resolution of historical extreme precipitation data (precipitation intensity); precipitation intensity forecasts not accurate due to urban microclimate and complex orographic conditions; low reliability climate projections data for extreme variables, which makes it difficult to use them for accurate adaptation measures to stormwater systems.
- Expertise: support needed.

Dynamic exposure mapping activities will not be conducted in this demonstrator.

In this demonstrator, improvements of tools/approaches that forecast the potential impacts of extreme climate events are addressing the following:

- expert assessment and numerical modelling of the impact of rainfall on the stormwater drainage system of the city of Vilnius, in coordination with the municipality and its in-house technical company UAB "Vilniaus Planas".

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5.5. DEM5 - Schleswig-Holstein state and harbour cities, Germany

Modelling activities related to weather and climate will not be conducted in the area of the demonstrator.

Dynamic exposure mapping activities will be conducted in this demonstrator. To this aim, HEREON and GFZ have already started cooperating to deal with exposure data in the municipal area of Glückstadt.

In this demonstrator, only existing tools/approaches that forecast the potential impacts of extreme climate events will be used.

5.6. DEM6 - East fjords, Iceland

The modelling activities related to weather and climate in the area of the demonstrator are aimed at improving the forecasting capabilities in the area of interest, which is characterized by steep high valley mountains in narrow fjords. Some details follow.

- Variables of interest: precipitation, temperature, wind.
- Time horizon of interest: nowcasting, weather forecasting.
- Main gaps currently affecting the estimation: inaccuracy in precipitation forecasts due to different factors, e.g., complex terrain conditions, lack of high-resolution radar data.
- Expertise: internal, support and cooperation with other partners desirable.

Dynamic exposure mapping activities will not be conducted in this demonstrator.

In this demonstrator, improvements of tools/approaches that forecast the potential impacts of extreme climate events are addressing the following:

- regional forecasting of landslides based on modelling of precipitation thresholds and soil moisture;
- local forecasting of landslides and avalanches based on improved precipitation forecasting on a small scale as well as analyses of weather leading up to former events.

5.7. DEM 7 - Hungarian Tisza River basin, Hungary

Modelling activities related to weather and climate will not be conducted in the area of the demonstrator.

Dynamic exposure mapping activities will not be conducted in this demonstrator.

In this demonstrator, improvements of tools/approaches that forecast the potential impacts of extreme climate events are addressing the following:

- warning scenarios in the mobile application called “water24”, which is used to share flood warning information with institutional stakeholders in the Hungarian Tisza River.

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5.8. DEM8 - Ogliastra province, Italy

Modelling activities related to weather and climate will not be conducted in the area of the demonstrator.

Dynamic exposure mapping activities will not be conducted in this demonstrator.

In this demonstrator, improvements of tools/approaches that forecast the potential impacts of extreme climate events are addressing the following:

- adaptation and mitigation pathways reducing the impacts of fire events and related costs, analyzed in the short- and medium-term under a changing climate considering different management and adaptation scenarios;
- catastrophe model aiming at capturing how disasters related to fires unfold and impact insurable assets using sophisticated simulation methods.

5.9. DEM9 - Dorset county, UK

The modelling activities related to weather and climate in the area of the demonstrator are aimed at reviewing how to improve the pull-through of meteorological data from a range of timescales (nowcasting, NWP, sub-seasonal) to enhance impact-based forecasting. This will involve identifying which models are most appropriate for which hazards, and user-purposes and then looking across the warning value chain to identify where they could be used more effectively to convey upcoming high-impact events to users. Some details follow.

- Variables of interest: precipitation at various intervals; antecedent conditioning variables (both meteorological and environmental); mean sea level pressure; variables which convey likelihood of convection (e.g., CAPE); wind speed, gust & direction; temperature; dry-spells.
- Time horizon of interest: nowcasting, weather forecasting, sub-seasonal. Some of the variables will also be considered for the climate time horizon to understand how they might change under different scenarios.
- Main gaps currently affecting the estimation: lack of harmonization of information across timescales utilizing the skill of models effectively to provide the best possible messaging and advice to users (this work aims to close this gap); linking datasets more seamlessly with non-meteorological data to convey potential future risks.
- Expertise: internal, willing to learn from others and open to collaboration.

Dynamic exposure mapping approaches in the estimation of exposure data may be adopted in this demonstrator, yet an action plan to develop this activity in cooperation with GFZ has not been set up yet.

In this demonstrator, improvements of tools/approaches that forecast the potential impacts of extreme climate events are addressing the following:

- ensemble forecasts leading to different risk scenarios for improved decision making and warning communication.

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5.10. DEM10 - Bern canton, Switzerland

The modelling activities related to weather and climate in the area of the demonstrator are aimed at improving forecasts across all temporal scales. Some details follow.

- Variables of interest: precipitation, runoff.
- Time horizon of interest: from nowcasting to projections.
- Main gaps currently affecting the estimation: downscaling to local impact, for advective and convective events.
- Expertise: internal expertise, collaboration welcome.

Dynamic exposure mapping approaches in the estimation of exposure data will be adopted in this demonstrator, yet an action plan to develop this activity in cooperation with GFZ has not been set up yet.

In this demonstrator, improvements of tools/approaches that forecast the potential impacts of extreme climate events are addressing the following:

- pathway schemes of cascading effects for the Zulg valley.

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