A Climate Risk Platform at the Frontier

EnergyEcoLab and AFS Research teams

Climate risk has gained increasing importance in the realm of economic activity. The world economy could experience a GDP loss of up to 18% by 2050 if no climate action is taken to mitigate climate change (with a projected 3.2°C increase), whereas meeting the targets of the Paris Agreement (limiting the increase below 2°C) could reduce the loss to 4% (Swiss Re Institute, 2023). These findings highlight the urgency of addressing climate risk. **How should climate risk be integrated into policy frameworks and firm's strategies?**

Introduction

Significant efforts have been devoted to integrating climate risk into policy frameworks and decision-making processes. A notable example is the European Central Bank (ECB) initiative to conduct stress tests for banks in 2022, explicitly assessing their resilience to climate-related risks. The results revealed significant challenges banks face regarding methodology and data availability for climate risk assessment. The ECB stress tests emphasize climate risk as a systemic threat that must be considered in financial stability assessments.

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Climate risk assessment and its challenges

Climate risk is commonly classified into two types: physical and transition risks. Physical risk is directly linked to climate-related catastrophic events such as floods, droughts, and earthquakes, among others. In turn, transition risk pertains to the potential risks associated with governmental and international regulations concerning the transition toward a low-carbon economy.

Physical climate risk models typically consist of three key components: a hazard module, an exposure module, and a vulnerability module. The *hazard module* focuses on specific hazards included in the model and their essential characteristics. It provides datasets containing information about the intensity and frequency of hazard events, represented by suitable indicators such as flood depth, wind speed, or earthquake magnitude. The *exposure component* incorporates information about the assets at risk - such as buildings, agriculture, or infrastructure - including their descriptions, precise locations, and estimated values. Finally, the *vulnerability component* serves as a connection between hazard, exposure, and loss, allowing for the estimation of the relative damage to an asset based on a specific hazard level. In many cases, vulnerability models are structured as a set of damage functions, which facilitate mapping hazard intensity to estimated damage as a ratio of the total value.

One of the primary challenges of physical risk assessment is the availability and quality of data. Often, there is a lack of

comprehensive and up-to-date data on hazards and vulnerabilities, or the resolution of available data may be inadequate, hindering precise risk analysis at localized levels. Methodological challenges also arise, including the selection and application of appropriate models and tools, as well as the integration of complex interactions among various risk components. Overcoming these challenges is crucial to enhance the accuracy and reliability of physical risk assessments and improve the effectiveness of risk management strategies.

Our objectives

At EnergyEcoLab (in partnership with AFS and UNED), we are engaged in a project aimed at developing a comprehensive software platform that will act as a one-stop solution for physical climate risk assessment. The platform will be particularly valuable for small and medium-sized financial institutions that usually do not have the resources to address climate risk-related problems on their own.

The main tools of the platform will include:

1. **Data**: We will collect relevant data related to climate risks, encompassing hazard, exposure, and vulnerability levels.
2. **Risk metrics**: We will develop a tool that generates risk metrics and reports for banks and financial institutions, focusing on their asset portfolios.
3. **Stress testing**: We will provide a tool for conducting internal stress tests specifically tailored to assess climate risks for banks and financial institutions.
4. **Transition risk**: We will incorporate tools to evaluate and address transition risks associated with climate change.
5. **Portfolio alignment**: We will offer functionalities to assess and align asset portfolios with climate risk factors.

Current results

So far, the project's main results can be grouped as follows:

Methodology

In climate risk research, there are two main approaches to risk assessment. The first approach, known as the probabilistic approach, relies on return period maps. The second approach, the event-based approach, involves a set of simulated events using climate models or stochastic methods. We have adopted the first approach which, in short, comprises the following steps:

1. Select a set of assets for which we want to make physical risk analyses.
2. Choose return period maps for the specific hazard under consideration.

3. Select the appropriate damage function for the given hazard and asset.
4. Calculate risk measures using suitable software tools.

While the risk assessment scheme remains consistent across different hazards, each hazard presents its own unique characteristics in terms of available data, dataset construction, climate models used for analysis, and more. Currently, we have developed four comprehensive documents focusing on river floods, coastal floods, windstorms, and wildfires, providing detailed descriptions of each hazard. For example, in the river flood survey, we outline how hazard intensities and frequencies are defined, detail available datasets, and explain their creation process. Our surveys serve as convenient tutorials, explaining the key points of the risk assessment method for each hazard. Looking ahead, our goal is to expand this documentation to cover landslides, subsidence, and water stress.

Our second outcome is related to the output of physical models. In general, our goal is to present the final output of the physical risk models in terms of various risk metrics. However, the output of the vulnerability module is usually expressed as exceedance probabilities for various levels of damage. In simpler terms, if we have multiple return period maps, we can determine, for each asset, the probabilities that the damage will exceed certain thresholds. To establish risk metrics in this context, one must initially build a probability distribution from this data. Currently, our project focuses on developing methods to derive these probabilities from the output of the vulnerability module. In the subsequent phase, we aim to create our own set of risk metrics that will provide relevant information about the portfolio exposed to risk.

Data

Throughout the project, **we have compiled an extensive data catalog comprising datasets essential for our project.** Let us stress that by 'developing,' we mean collecting data from various sources, not creating the datasets ourselves. The collected data can be classified into two main categories. The first category includes hazard datasets, encompassing floods, windstorms, droughts, wildfires, earthquakes, and other hazards. Within this category, we

have two types of datasets. The first type, known as "probabilistic," consists of return period maps that provide information about the likelihood of hazards of varying intensities occurring in Europe or specific regions. The second type includes "deterministic" datasets, which contain scenario-based simulations for different hazards. These datasets consist of sets of events generated through climate modeling or stochastic simulations. The resolution of our datasets ranges from 1 meter to several kilometers. Our data includes historical and scenario-based data, with the data adjusted to various climate change scenarios, such as different global temperature changes.

The second part of our data catalog comprises information related to damage functions for different types of assets. We have gathered data for various hazards and asset types, including buildings, infrastructure, agriculture, etc. It is worth emphasizing that all the data we utilize is open source and obtained from reputable institutions and research centers, such as the Joint Research Center of the European Commission, the Copernicus Programme, the Inter-Sectoral Impact Model Intercomparison Project, and various governmental sources from EU member states just to mention a few of them. The data sources encompass climate models, satellite imagery, numerical simulations, and other relevant sources.

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Technology

The third component of our project revolves around the technological tools within our platform. Since the beginning of the project we are utilizing open-source tools provided by platforms such as CLIMADA and the OS-climate community. By leveraging both platforms, we have developed workflows that load the data we collected and generate output in the form of impact maps containing information about each asset damage. As we continue to develop risk metrics, these workflows will incorporate this aspect as well •