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IMPETUS Project – Risk analysis through Impact Chains related to the agricultural sector

Results of the workshop of 27 March 2025

The IMPETUS project

The IMPETUS project, whose English acronym stands for "Dynamic Information Management Approach for the Implementation of Climate Change Adaptation Solutions in European Regions," is part of the European strategy for climate change adaptation and aims to translate climate commitments into tangible actions. The project is funded by the European Research and Innovation Program "Horizon 2020," has a duration of four years (2021-2025), and seeks to support the European Union's goal of becoming the world's first climate-neutral continent by 2050. The project consortium consists of 32 organisations from 9 European countries and is coordinated by the Spanish foundation EURECAT.

The general objective of IMPETUS is to develop and validate multi-scale and multi-sectoral adaptation measures to accelerate the transition toward a sustainable and climate-neutral economy and society. To account for all climate systems, present in Europe, several demonstration sites have been identified in seven distinct biogeographical regions (continental, coastal, Mediterranean, Atlantic, Arctic, boreal, and mountainous), where solutions for climate change adaptation will be developed, tested, and validated to enhance long-term resilience.

The co-creation and development of innovative measures involve integrating the digital and human dimensions through the establishment of *Resilience Knowledge Boosters* (RKBs). RKBs are spaces, both digital and physical, where acquired information is managed and processed. End-users then utilise the resulting insights to enhance decision-making for climate change adaptation.

The Valle de Laghi has been selected as a representative geographical unit for the mountainous region, where an Impact Chain was developed through a participatory workshop, which was further enriched by expert interviews. Following the development of the Impact Chains, adaptation measures were proposed and assessed through the adaptation pathways framework.

Due to the relevance of the mountain biogeographical region in Europe, there was interest in replicating the workshop on climate risk analysis for the agricultural sector in a comparable setting. The Carpathian Convention Secretariat recommended the White Carpathians, specifically the Zlín region in the Czech Republic, as a suitable location given its similarities to the Italian demonstration site, such as the presence of apple orchards and vineyards, and its rural character with small villages.

The workshop was organized as part of the HORIZON2020 IMPETUS Project "Dynamic information management approach for the implementation of climate resilient adaptation packages in European regions," funded by the European Union under grant agreement no. 101037084.

Hostětín was proposed as the venue for its accessibility and the presence of an active local partner, the Veronica Centre, which could support the workshop through its established stakeholder network and provide moderation in the local language.

The replication workshop in Hostětín

The replication workshop was held on 27 March 2025 in Hostětín (Czech Republic), co-organised by the Veronica Centre and Eurac Research. The workshop was made possible through the collaboration of local and international experts (Mountain Research Initiative, Carpathians Convention) who provided funding and connections to their international networks. Following the recommendation of the Carpathian Convention Secretariat, the White Carpathians and specifically the Zlín region in the Czech Republic were selected as a suitable replication site due to their similarities with the Italian demonstration area, including the presence of apple orchards, vineyards, and a predominantly rural landscape with small villages. Hostětín was chosen as the venue for its accessibility and the support offered by the local partner, the Veronica Centre, which contributed through its established stakeholder network and capacity to provide moderation in the local language.

Figure 1 The Impact Chain replication workshop organised in Hostětín at the Veronica Centre.

The aim of the workshop was to identify, through a participatory approach, the primary risks to the agricultural sector in the context of climate change in the Zlin region.
The workshop agenda was structured to balance theoretical input with hands-on application.

The **morning session** focused on providing a conceptual foundation, with opening remarks from the organizing institutions followed by an introduction to the IMPETUS project, climate change adaptation, the risk concept, including risk assessment. This set the stage for a shared understanding among participants. The **afternoon session** shifted to a more practical format, with a participatory exercise conducted using the Impact Chains method, developed by Eurac Research. The day concluded with a discussion on next steps and a guided tour of ecological projects in Hostětín, offering participants a tangible example of local sustainability initiatives.

The workshop brought together a diverse group of participants, including local stakeholders from the Zlín region, such as farmers, environmental NGOs, and local authorities. The event also benefited from the presence of two international observers, in order to further transfer the approach within the mountain biogeographical region. This diverse mix enabled a rich exchange of perspectives and supported the co-creation of context-specific insights on climate risks to agriculture.

In total, 16 participants attended the event (see Table 1). The experts were divided in two groups, one working in English and one in Czech.

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Table 1. Participants to the workshop in Hostětín. Source: Eurac

Stakeholder Category	Number of stakeholders per group	Gender
Academic System	6	4 F, 2 M
Industry and Economic System	4	2 F, 2 M
State, government and political System	6	3 F, 3 M
Total	16	9 F, 7 M

The workshop was conducted in a combination of English and Czech, facilitated by the presence of an interpreter, who also supported the process as a co-moderator. During the interactive sessions, participants were divided into two working groups: one conducted in English, including international observers and local experts, and the other in Czech, enabling full participation of all.

The Impact Chain Methodology

The workshop applied the Impact Chain methodology, a conceptual framework developed by Eurac Research to support climate risk assessments (Zebisch et al. 2023). Impact Chains allows for a graphical and intuitive representation of the complex cascade of impacts triggered by climate events, focusing on various risk components, including exposed elements and vulnerabilities. The conceptualization of hazards, cascading impacts, and susceptibility, as well as the lack of capacities, also enables the identification of potential areas for improvement in risk management and the development of specific adaptation measures for the sector under consideration. Overall, the visual and participatory nature of the method fosters a shared understanding of local risks and potential areas for adaptation action.

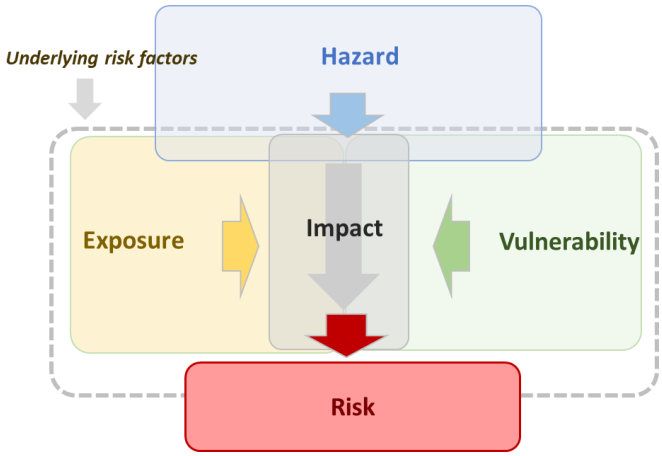

Figure 2 The risk components and the basic structure of the Impact Chain. Source: Eurac.

Table 2. Main definitions of the components of risk used within the Impact Chains. Source: Pittore et al. 2025

Risk	Combined impacts, exposure elements and vulnerabilities that describe potential risks highly relevant in the scope of the Impact Chain.
Hazard	Climatic influence, climatic or non-climatic event or trend that may constitute a hazard to the exposed assets and systems and result in an impact and possibly a risk (with damage or loss)
Exposure	The (presence of) people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected (IPCC 2021).

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Vulnerabiliy	Vulnerability refers to the predisposition/propensity of exposed elements such as human beings, their livelihoods, and assets to be adversely affected by a natural hazard. This element contributes to and encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and/or lack of capacity to prevent, prepare, respond, cope and/or adapt (IPCC, 2021).
Impacts	Effect or consequence caused by a hazard or another impact. Within the Impact Chain, Impacts relate to adverse (negative) consequences that can be considered as potential materializations of risks.

Further details on the Impact Chain methodology and its integration within a comprehensive climate risk assessment framework are available in existing reports and guidance documents (UNDRR 2022; Zebisch et al. 2023).

Results

(I) Scoping. The first step involved identifying and defining the context that would guide the following phases of the workshop. Geographically, the focus was placed on the Zlín region in the Czech Republic, with particular attention to the Bojkovice area. From a sectoral perspective, the analysis concentrated on orchards and pastures, which are key components of local agricultural activity. The temporal frame was set in the near future, aiming to understand the imminent scenarios and implications of climate change.

(II) Identification of the main risk factors. During this part of the interactive discussion, participants identified the main risk components (hazards, exposure, and vulnerabilities).They aimed to explore the interconnections among these components and their subsequent cascading impacts, as well as to outline the potential negative consequences for both human and ecological systems. The identified components are listed in Table 3.

Table 3. Risk factors related to the agricultural sector, with a focus on orchards and pastures, identified by the participants during the workshop.

Hazard	Exposed elements	Impacts	Vulnerability
Increasing temperature	Food production/local use	Flash floods	Lack of diversification in big farms
Heatwaves	Groundwater	Wind/water erosion	Lack of long-term thinking and planning (due to politics and electoral cycles)
Changes in precipitation patterns	Orchards (apples, plums and pears)	Increase in landslides	Lack of insurance products targeted to the local needs
Hail	Farmers	Changes in phenology	Poor soil quality (lack of organic/matter humus in the soil)
Spring Frost	Big Agriculture/holding	Increase in evaporation	Need for local plans/strategies for CCA (Bottom-up approach)
Increase in heavy precipitation	Meadows/Pastures	Larger periods of drought/decrease of water availability	Unsustainable practices: Groundwater pollution
	Consumers	Decrease groundwater levels	Unsustainable local varieties for the market
	Processing Industry	Decrease of available food for livestock in the farms	Reliance on traditional varieties

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	Livestock	Increase on pests and diseases	Artificial changes to river flow
		Damage to plants/crops	Lack of water harvesting/ reuse practices
		Economic losses for agriculture sector	Lack of pollinators
		Reduction in the quality/quantity of agricultural products	
		Insufficient supply for the consumers	

(III) Development of an Impact Chain.

The main climate-related risk identified during the workshop was the reduction in both the quality and quantity of crop yields and agricultural products, particularly in orchards and pastures. The elements identified in Phase (ii) which were related to this risk where placed into an Impact Chain.

The workshop discussion highlighted the increasing challenges that climatic hazards pose to agriculture, particularly shifts in temperature and precipitation patterns. Participants identified several key hazards affecting the sector, including rising temperatures, heat waves, changes in precipitation patterns, hailstorms, spring frosts, and heavy rainfall events. These hazards were linked to a range of exposed elements, including food production and livestock, orchards, meadows, and the food processing industry.

The potential of cascading impacts of these hazards on the agricultural sector drove the discussion in the workshop. Both discussion groups emphasized that rising temperatures and changing rainfall patterns trigger multiple secondary impacts. These include an increase in pests and diseases, increased water evaporation, disrupted plant growth cycles (phenology), and soil erosion caused by water runoff. These resulting impacts damage plants, reducing both the quality and quantity of harvests, ultimately resulting in significant crop losses.

Beyond the physical hazards, the workshop highlighted the role of vulnerabilities that exacerbate these risks. Participants highlighted a lack of diversification in large farms, inadequate insurance products tailored to local needs and limited long-term planning due to the influence of political and electoral cycles. Poor soil quality, groundwater pollution, and unsustainable agricultural practices were also identified as key factors that exacerbate the impacts. Additionally, reliance on traditional crop varieties, while valuable for cultural identity, was seen as a potential limitation in adapting to changing climate conditions.

The discussion emphasised the need for locally driven adaptation strategies, including improved soil and water management, better insurance mechanisms, and a shift toward sustainable agricultural practices. Participants stressed the importance of developing climate change adaptation plans through a bottom-up approach that considers the specific needs of local farmers, consumers, and the agricultural industry. Without proactive measures, the increasing frequency and intensity of climate-related hazards could have economic, environmental, and social consequences for the region's agricultural sector.

The Impact Chains developed through post its during the workshops were merged and mapped subsequently by Eurac Research using Draw.io, an online tool to better visualise the Impact Chains (Figure 2). Moreover, the Impact Chain was transfer in KUMU (https://kumu.io/impetus/impetus-impactchains-ds7) an online software that allows for the creation of Impact Chains in a structured

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environment, considering not only the graphical representation but also the content associated with all elements and connections.

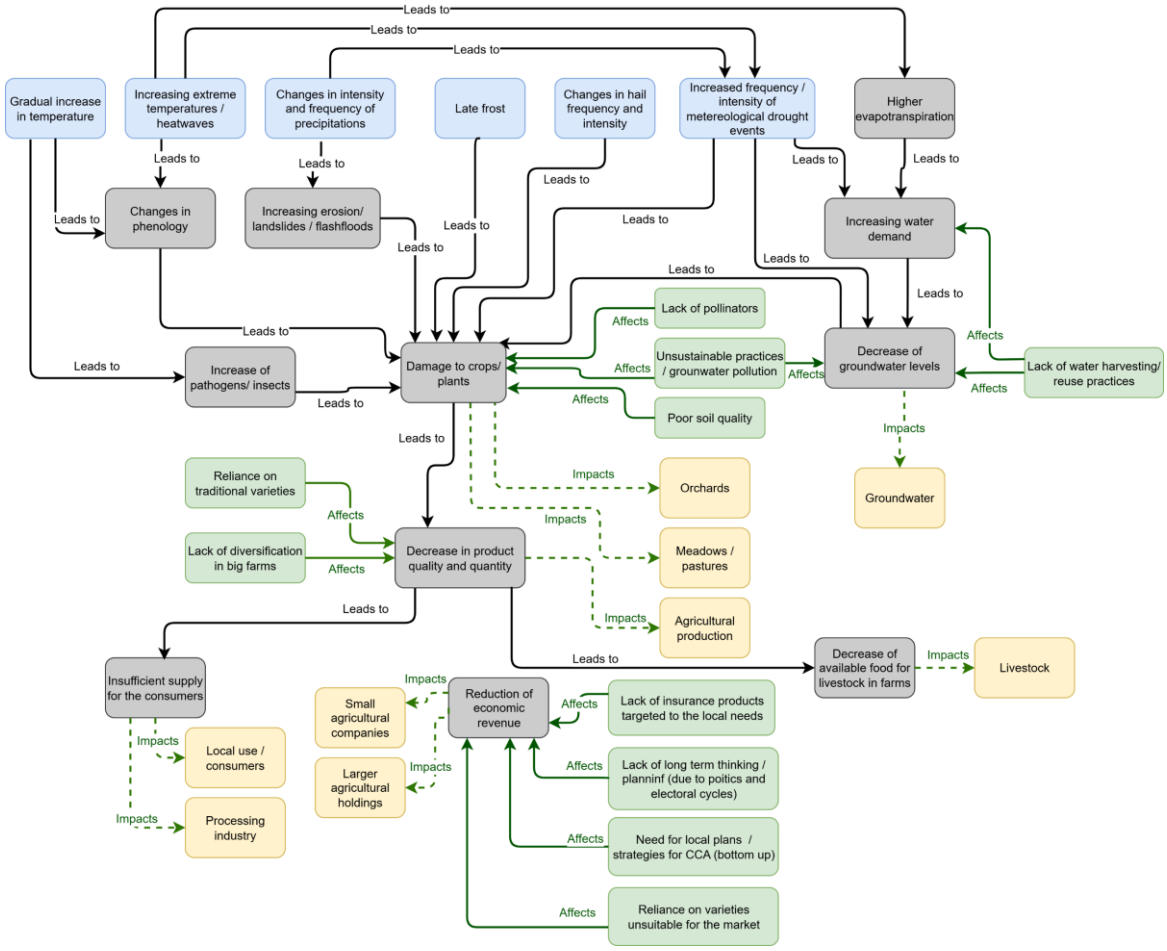

Figure 1. Impact Chain for the Agricultural Sector/orchards in Zlin region in Czech Republic developed in Draw.io developed in the Hostětín workshop. Source: Eurac.

Commonalities and differences with the Valle dei Laghi Mountain Demonstration Site

The Impact Chain developed for the Valle dei Laghi Mountain Demonstration Site is also available on Kumu: https://kumu.io/impetus/impetus-impactchains-ds7. The impact chains created for Valle dei Laghi and the Zlín region share a common core structure, as both focus on the agricultural system and identify rising temperatures, shifting precipitation patterns, hail, and frost as the primary climate-related hazards. They also converge on key impact themes, including reduced crop quality and yields, increased pests and diseases and economic losses.

However, important contextual differences emerged. In Valle dei Laghi, water scarcity stood out as a dominant concern, with competing demands from agriculture, hydropower, and tourism. Participants highlighted rapid shifts in hydrological cycles and increasing tensions between irrigation, domestic water supply, and energy production. This issue was less pronounced in the Hostětín (Zlín region) impact chain, where concerns around local food security, livestock production, and community-level resilience were more prominent.

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The Impact Chain of Valle dei Laghi also reflects region-specific vulnerabilities linked to viticulture, such as the need for early harvesting, reliance on single water sources, and demographic challenges in farm succession and management. In contrast, the Hostětín Impact Chain emphasized more systemic issues, including soil degradation, groundwater pollution, and the need for bottom-up climate adaptation planning.

In Valle dei Laghi, the results of the workshop were enriched through semi-structured interviews conducted as part of another activity focussing on Cultural Heritage, which provided additional insights into traditional agricultural practices, local knowledge, and institutional constraints. These inputs helped to refine the Impact Chain and introduce new vulnerability factors. Furthermore, a set of adaptation options targeting water scarcity was co-identified with stakeholders, forming the basis for the development of adaptation pathways to support long-term planning and decision-making.

Conclusion and next steps

The workshop successfully demonstrated the potential of Impact Chains as a valuable tool for conceptualising climate risk in a structured and participatory way. By enabling the elicitation of expert knowledge, the integration of diverse data sources, and the combination of both quantitative and qualitative information, Impact Chains provide a flexible yet consistent method for capturing the complexity of climate-related cause-effect relationships. They place particular emphasis on the role of vulnerability, highlighting entry points for adaptation and risk reduction. In the short term, the workshop enhanced local awareness and understanding of climate risks, strengthened stakeholder engagement, and supported more informed adaptation planning through participatory workshops. In the longer term, this activity can contribute to building local capacities for climate risk assessment, promoted the institutional uptake of participatory risk governance, and reinforced regional and transnational cooperation among local institutions, researchers, and civil society actors.

Looking ahead, the goal is to develop a Library of Standardised Impact Chains, which can serve as references for future climate risk assessments across sectors and regions. This process treats Impact Chains as a knowledge engineering tool, where the development of each chain includes detailed descriptions of elements and their connections. Users will be able to query and filter these chains based on geographical or sectoral scope, and importantly, they will no longer need to start from scratch but can build upon an existing, validated structure.

To support this process, KUMU, an online visualisation tool, is being used to build Impact Chains within a structured environment of pre-defined element and connection types. This enables not only the visual representation of risks, but also the documentation of rich content associated with each component. Impact Chains can be exported and shared in formats such as Excel, facilitating collaboration and integration into other workflows. The Replication Workshop Impact Chain resulting from the replication workshop is available on KUMU.The KUMU Impact Chains will ultimately be made accessible via the IMPETUS Resilience Knowledge Booster (https://impetus.mantisims.gr/knowledge-boosters/mountains/), supporting wider dissemination and usability across the community.

In parallel, the development of a set of Guidelines is underway, aimed at ensuring a systematic yet efficient approach to creating Impact Chains. These guidelines will be made available through the IMPETUS Marketplace (https://climate-impetus.eu/solutions/marketplace/). Moreover, an ad hoc tool is being designed to further facilitate the creation and visualisation of Impact Chains.

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Authors contacts

Silvia Cocuccioni- silvia.cocuccioni@eurac.edu

Liz Olaya Calderon - liz.olayacalderon@eurac.edu

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