frontiers | Frontiers in Climate

TYPE Original Research
PUBLISHED 08 December 2025
DOI 10.3389/fclim.2025.1719404

OPEN ACCESS

EDITED BY
Phoebe Koundouri,
Athens University of Economics and Business, Greece

REVIEWED BY
Ramazan Sari,
Technical University of Denmark, Denmark
Bruce Currie-Alder,
International Development Research Centre (IDRC), Canada

*CORRESPONDENCE
Cristóbal Reveco
✉ cristobal.reveco@hereon.de

RECEIVED 06 October 2025
REVISED 14 November 2025
ACCEPTED 17 November 2025
PUBLISHED 08 December 2025

CITATION
Reveco C, Cortekar J, Trozzo C, Vokral M, Kotova L, Kuntsi-Reunanen E, Galluccio G and Korhonen N (2025) Integrating value systems and place-based characteristics in climate risk assessments.
Front. Clim. 7:1719404.
doi: 10.3389/fclim.2025.1719404

Integrating value systems and place-based characteristics in climate risk assessments

Cristóbal Reveco[1,2]*, Joerg Cortekar[1,2], Chiara Trozzo[3], Martin Vokral[4], Lola Kotova[1,2], Eeva Kuntsi-Reunanen[5], Giulia Galluccio[3] and Natalia Korhonen[5]

[1]Climate Service Center Germany (GERICS), Hamburg, Germany, [2]Helmholtz-Zentrum Hereon, Geesthacht, Germany, [3]Centro Euro-Mediterraneo Per I Cambiamenti Climatici Sede di Bologna, Bologna, Italy, [4]ASITIS s r.o., Prague, Czechia, [5]Ilmatieteen Laitos, Helsinki, Finland

This article examines how value systems and place-based characteristics shape the ways in which local communities define, represent and prioritise climate risks in urban and rural settings. Drawing on 10 climate impact-chain assessments—co-developed through participatory processes with stakeholders in demonstration regions across Europe within the EU project VALORADA—we explore four hazard domains: urban warming, heatwaves, droughts and extreme precipitation. Building on previous literature and based on our observations, we show that the identification, definition and prioritisation of climate risks extend beyond biophysical aspects or existential threats and are also influenced by locally salient values, including sustainability, security, safety, identity, human health, cooperation and trust. These values can, at times, come into tension—particularly where the management of scarce resources (e.g., water) is contested, or where policy goals such as environmental conservation and economic development intersect within the same decision arena. We conclude by suggesting that addressing the challenge of integrating value-based and place-specific characteristics into climate risk assessments may benefit from illustrating how climate hazards influence local value frameworks and shape meaningful societal participation.

KEYWORDS

climate risk assessment, place-based characteristics, value-based approaches, climate impact chain, climate change adaptation

1 Introduction

Over the past two decades a well-developed body of literature has matured and recognised the relevance of integrating value systems and place-based perspectives into climate risk assessments (O'Brien and Wolf, 2010; Tschakert et al., 2017; Menk et al., 2022). In contrast to traditional approaches to climate risk assessment focusing on biophysical and economic metrics, value and place-based approaches highlight the significance of local values, cultural heritage, and social dynamics in shaping risk perceptions and adaptation strategies (Kythreotis et al., 2024; Brown, 2018), and advocate for participatory and co-creation methods for ensuring legitimacy and relevance in adaptation planning (Nörstrom et al., 2020; Lejano et al., 2013). A value and place-based characteristic approach acknowledges that societal groups interpret risk differently and perceptions of risk are framed by unique social, cultural, political and historical aspects inherent to the places in which they are experienced (Van den Hurk et al., 2018; Kythreotis et al., 2024).

In this article, we argue that integrating value-based and place-specific characteristics into climate risk assessments requires a deeper understanding of how climate hazards can

exacerbate underlying tensions within social, cultural, economic, political, and environmental circumstances that render human life inherently vulnerable. Drawing on key case studies, we contend that rapidly changing climatic conditions risk not only intensifying these tensions but also accelerating shifts in value frameworks. Such shifts may undermine the effectiveness of established normative structures in guiding societal agency for adaptation and weaken the relational capacities necessary to address climate risk constructively.

Our contribution to addressing this gap focuses on examining how value systems and place-based characteristics shape the prioritisation of climate risks across 10 European demonstration regions. A central objective of this research is to characterise local climate risk in ways that resonate with stakeholders' perceptions. Accordingly, the study seeks to identify and represent what matters to local stakeholders—who or what is at risk, to what extent, and what thresholds are considered tolerable—while exploring how stakeholders interpret climate risks and collectively define and depict these risks. Ultimately, we argue that integrating value-based and place-specific characteristics into climate risk assessments requires reflecting to local actors how climate hazards can influence the local value frameworks that guide human action and potentially affect their meaningful participation in society.

Specifically, we are guided by the questions: How do value systems and place-based considerations influence the definition, representation, and prioritisation of climatic risks? Which values and worldviews are expressed in the selection of these risks? How do institutional cultural values and worldviews impact risk perception?

To address these questions, we employ participatory Climate Impact Chain (CIC) assessments across 10 European regions. CICs serve as analytical tools for understanding and prioritising the drivers of climate risk by incorporating local experiences, values, and perceptions, while exploring specific risk-transmission pathways and socio-economic sensitivities to climate events (GIZ and EURAC, 2017). The co-development process explicitly integrates scientific, normative, and cultural knowledge (Lejano et al., 2013), ensuring that assessments reflect both empirical evidence and stakeholder perspectives.

This article is conducted within the Horizon Europe project VALORADA ("Validated Local Risk Actionable Data for Adaptation," 2023–2026), which aims to strengthen data governance and management for local climate adaptation planning. Given the nature of this project, the EU Mission Adaptation initiative provides a policy framework where the goal is to accelerate climate resilience in European regions through collaborative approaches. Supporting this goal requires a nuanced understanding of how communities act and change their ways of acting in the face of climate risk. This research aims to support this endeavour by critically engaging with risk assessments and their connection to local values and place-based characteristics.

The structure of the article is as follows: Section 2 presents a literature review moving from a more general review on social values down to the critic to risk assessments. Section 3 details the CIC methodology; Section 4 presents the general results of the climate impact chains and provides a deeper account of the value frameworks identified through the CICs; Section 5 discusses these results; and Section 6 outlines the main conclusions.

2 Conceptual framework: value-based approaches and place-based characteristics

It is widely recognised that while climate impacts can threaten people's survival and security, climate impacts also affect the critical social values that constitute society and upon which people's lives are built (Tansey and Riordan, 1999; van Schie et al., 2024). Climate change is intimately connected to social values. Responses to risk are linked to people's political choices, actors' perceptions of what matters, and what works where (Runhaar et al., 2018; Brown, 2018; Wardekker et al., 2010).

Social values represent "what is valued or what is of value in everyday material realities" (Tschakert et al., 2017). Social values lead the criteria to guide judgement, evaluation, argument, attribution of causality, and choice (O'Brien and Wolf, 2010; Gorddard et al., 2016). Social values include identity, self-actualisation (O'Brien and Wolf, 2010), social bonds, local knowledge, cultural heritage and habitats that support ecosystem services (van Schie et al., 2024; Padin-Dujon, 2023) among others.

Valuations made by individuals or as part of a group are intimately linked to space and place (Tschakert et al., 2017); i.e., valuations are made based on what is important in people's lives and the places they live (Graham et al., 2013; Graham et al., 2014). What people consider valuable or worth protecting in the context of climate change is defined by unique cultural and place-specific contexts (Tschakert et al., 2017; Renn et al., 1990; Schmidt, 2004). Place in turn gives meaning to people's lives (Hess et al., 2008) and "a way of seeing, knowing and understanding the world" (Cresswell, 2004). In this context, Krauß and Bremer (2020) emphasise that place-based understandings of climate extremes and responses require capturing a cultural dimension to how climate change is experienced by the people living in these places. It also requires understanding how climate impacts are transforming people's lives (O'Brien et al., 2015). Capturing a place-based understanding of climate change involves engaging with people's histories, recognising culturally derived values as meaningful (Turner et al., 2008; Gorddard et al., 2016), and illuminating how climate risks are embedded within local value systems and lifestyle structures (Kasperson, 2014; Ensor et al., 2019).

Climate impact assessments should reveal how people perceive climate change affecting what they value (ibid) and should aim to protect things that people value (Tschakert et al., 2017). Krauß and Bremer (2020) contend that many places experience a persistent mismatch between predominantly science-based and technical framings of climatic risk on the one hand, and the place-based understandings of climate extremes and responses of people living in these places on the other.

Critiques of climate risk assessments highlight their tendency to focus on physical, socio-economic, and ecological aspects, often overlooking the social and political dimensions that define "place-based" risk (Kythreotis et al., 2024), and thereby neglecting subjective factors, such as the acceptable level of risk for individuals and organisations, or how people perceive and respond to climate risks (Brown, 2018). Others emphasise that by framing climate change as a technical problem, these assessments frequently prioritise management and technical approaches (O'Brien and Selboe, 2015), resulting in technical solutions to inherently complex problems (GIZ and EURAC, 2017). O'Brien and Wolf (2010) argue that climate change impacts cannot be fully assessed through objective, scientific means or economic analyses.

10.3389/fclim.2025.1719404

3 Methodology

Ten Climate Impact Chains were co-developed in this research. A climate impact chain describes how a hazard evolves into a risk by considering exposure, potential intermediate impacts and associated sensitivity factors, and response/adaptation capacity (resilience) that reduces vulnerability (GIZ and EURAC, 2017).

The research takes a qualitative and participatory approach, and group discussions were the basis for co-developing each CIC. Ten demonstration regions, referred to as "demonstrators" were involved in the project. The regions include Prerov and Mlada Boleslav (Czech Republic), Molise (Italy), Toulouse and Sicoval, Occitanie (France), Evoia (Central Greece), and Burgas and Gabrovo (Bulgaria).

Demonstrator regions were selected based on a typology of cities most vulnerable to climate change, using the ESPON territorial-development approach (2013) focused on compound risks and cascading effects. Four indicators guided selection: vulnerability/adaptive capacity, aggregated climate impact, heat vulnerability (2019 index), and flood-related mortality (1991–2015). Final choices also considered EU Mission Adaptation signatories (Table 1).

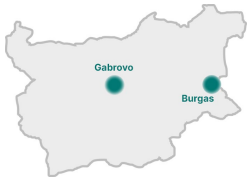
3.1 Development of a climate impact chains

Our approach to developing the CIC followed the principles of co-creation and participatory action research as outlined by the Adaptation Research Alliance (2021). In alligning with this, we sought to emphasise collaborative knowledge production, inclusivity, and iterative learning, and to provide a space for local stakeholders to be actively involved in defining and addressing climate risks.

In preparation for co-developing each CIC and to help local demonstrators identify key challenges in managing and integrating climate and local data crucial for understanding climate risks, a self-assessment tool, the so-called Local Climate Information Profile (LCIP), was developed and sent to each demonstration region. The information gathered served as input for the co-development of the CICs. The LCIP consists of three sections:

a Visualising the Climate Adaptation Context: Focused on documenting past climate impacts, the consequences of extreme events, and the responses developed in each region.
b Data Management and Governance: Identified policies, processes, actors, and infrastructure involved in managing

TABLE 1 List of demonstrators.

City/region		Territorial definition	Risk attended	Climate hazard represented in CIC
Prerov (Czech Republic)		Urban	Degradation of urban ecosystems due to urban heat and droughts	High temperature and drought
Mlada Boleslav (Czech Republic)		Urban	Extreme high temperatures on people's health in the context of urban transport	High temperature
Molise (Italy)		Rural	Floods affecting agricultural livelihoods and rural infrastructure	Extreme precipitation
Toulouse (France)		Urban	Urban warming affecting people's health	High temperature
Sicoval, Occitanie (France)		Rural	Drought affecting agricultural production and rural livelihoods	Drought
Central Greece (Evoia) 1		Urban–Rural	Wildfire affecting infrastructure	High temperature and drought
Central Greece (Evoia) 2		Urban–Rural	Extreme precipitation affecting the agricultural sector	Extreme precipitation
Burgas 1 (Bulgaria)		Urban–Rural	Urban warming on people and ecosystems	High temperature and drought
Burgas 2 (Bulgaria)		Urban–Rural	Flash floods on urban and surrounding rural areas	Extreme precipitation
Gabrovo (Bulgaria)		Urban–Rural	Drought and wildfires affecting ecosystems and urban areas	High temperature and drought

climate-related data, providing insight into local data governance structures for addressing climate risks.

c Assessment of Local Data Governance Maturity: Offered a self-assessment of the maturity level of each demonstrator's data governance systems.

3.2 Co-generation workshop

A 2-day workshop was conducted in each demonstrator region, aiming to facilitate a participatory process for developing CICs tailored to local contexts. During a dedicated 5-h session, stakeholders worked with a pre-developed CIC template. Stakeholders participating in these workshops considered public servants within municipalities, both head of departments (e.g., Environmental Department, Emergency department, Road and Transport Department), technical officials (supporting administrative and technical tasks, such as data collection, project supervision), elected representatives, as well as representatives from NGOs, academia, and the private sector. Efforts were made to capture a diversity of perspectives, including differences in professional background, experience with climate risks, and demographic characteristics. VALORADA consortium partners included a range of enterprises working in each of the demonstrator regions. Officials were recruited based on their previous participation in related climate adaptation initiatives led by these VALORADA's consortium partners. This approach facilitated identifying key informants and stakeholders and facilitated their active participation throughout the project (Table 2).

Our stakeholder engagement primarily focused on municipal officials. We aknowledge that this focus brings considerable influence over local climate adaptation strategies—the perspectives gathered from this group may be shaped by institutional biases or political agendas (O'Brien and Wolf, 2010). To mitigate the risk of a narrow or skewed viewpoint, we deliberately broadened our engagement to include representatives from national agencies, academic institutions, and non-governmental organisations. This multi-actor approach enabled a wider spectrum of expertise. To further enhance the credibility and legitimacy of our findings, we triangulated stakeholder insights with publicly available documents, such as municipal and regional adaptation plans. This triangulation not only validated the perspectives obtained through workshop experience and one-to-one interviews, but also provided a more balanced foundation for interpreting the results within the broader policy context.

To bridge the gap between technical terminology and local stakeholders' understanding of climate risks, a fictional story of a town called Valuatu was created. The fictional story facilitated illustrating climate hazards while covering all needed conceptual aspects involved in climate risk assessments. This narrative helped contextualize risk concepts and align them with the priorities identified previously in the LCIP.

Overall, each workshop aimed to reach a consensus among participants on the most pressing types of risk. For this, a set of questions was proposed to orient participants to discuss climate risks and to link these risks to personal experiences and place-specific features. Overarching questions included:

- Which major climate impacts and risks do affect your system of concern?
- Which attributes of the system contribute to the risk?
- What is valuable and at stake in your system of concern?

Resulting from these workshops, 10 CIC diagrams depicting the cause-effect relationships of climate hazards, vulnerabilities, and potential consequences for each demonstrator were created. After a first draft of each CIC was generated during the workshops, a literature review was undertaken to complement each draft with additional examples on hazard sequences, exposure, and vulnerability factors.

TABLE 2 Number of stakeholders participating in the co-generation workshop.

Demonstrator region	Number of stakeholders participating in the co-generation workshop	Number of stakeholders participating in the evaluation workshop
Prerov (Czech Republic)	7	3
Mlada Boleslav (Czech Republic)	6	3
Molise (Italy)	18	4
Toulouse (France)	11	3
Sicoval, Occitanie (France)	6	2
Central Greece (Evoia) 1	14	3
Central Greece (Evoia) 2		
Burgas 1 (Bulgaria)	9	4
Burgas 2 (Bulgaria)		
Gabrovo (Bulgaria)	16	3

3.3 Evaluation workshop

A preliminary version of each CIC was delivered to each respective demonstrator region to collect feedback on it. The feedback was structured around the following questions:

- Does the climate impact chain represent climate risks accurately?
- Are there additional risk factors that need to be included/taken out of the impact chain?
- Is the information clear?

Addressing these issues, a concise summary document was generated. This document was used as input for the evaluation process. The evaluation process was organised around a 2-day workshop in Brussels, which gathered 25 civil servants (technical and administrative) and elected representatives from the demonstrator regions. The workshop[1] aimed to review results from each CIC, focusing on key

1 The management of personal data associated with the workshop adhered to EU ethical guidelines, ensuring no personal data was collected and informed consent was obtained.

issues and areas for improvement. During the workshop, participants worked on a physical map and made drawings of the different impact sequences presented in the climate impact diagram, thereby allowing them to specify the areas, activities, assets and (sometimes) the people that were affected by specific events, and why, and to identify key factors responsible for the system of concern being at risk or to fail.

3.4 Identifying values in connection to representations of climatic risks

The collective and consensual development of each CIC provided valuable insights into the socio-environmental histories of climate risk within each demonstrator. This process also illustrated how local stakeholders drew on their diverse experiences to co-construct a shared understanding of specific climate risks. Ultimately, our research used the process of creating a CIC both, as a method for collecting data, and as a lens for understanding how people collectively make sense of climate risk. In this context, Climate impact chains complement narrative approaches (Bremer et al., 2020) by offering a structured way to map cause–effect relationships while integrating local perspectives and values. While CIC help to identify specific drivers and pathways of risk, narratives and storylines remain essential for contextualising risks (Krauß and Bremer, 2020; Marschütz et al., 2020).

In reflecting on the method previously outlined, it is important to acknowledge, however, that qualitative methodologies—including interviews and focus groups—are inherently limited in terms of generalisability (Barnett et al., 2010). Our intention was not to propose universal value dimensions, but rather to illuminate the ways in which risk perceptions are linked to locally salient values and contexts. By foregrounding the diversity of stakeholder perspectives and situating our findings within documented policy frameworks, we aimed to provide nuanced understanding of the interplay between values and climate risk, while recognising the contextual specificity of our results.

Building on these insights, we conducted a content analysis of each CIC using established coding methods to explore how climate risks connected to local values and place-based considerations across the demonstrators. Drawing on established typologies of social values from Graham et al. (2013), Tschakert et al. (2017), and Menk et al. (2022), coding tags were developed (as summarised in Table 3). These coding tags were used for analysing the content of the CICs together with insights provided by local stakeholders during the workshops described above.

The analysis involved reviewing the CICs for descriptions aligned with the predefined value categories and coding relevant segments accordingly. In some cases, references to specific values were absent or the available information was too limited to allow for detailed interpretation. In other cases, descriptions were more comprehensive and supported by official documentation. Here, we only report on the values and place-based considerations that could be endorsed by the collected information.

TABLE 3 Values used as codes.

Menk et al. (2022)	Tschakert et al. (2017)	Graham et al. (2013)
*Physical and mental health *Material living standards *Functioning ecosystems *Cultural heritage and identity *Knowledge and education *Governance and participation *Self-determination and time-use *A desirable future	*Identity *Health *Place *Community	*Health *Safety/security *Belongingness *Esteem

4 Results

This section begins by presenting a consolidated overview of the key factors shaping climate risk across the studied regions. Analysis of 10 climate impact chains identified 34 consistent sequences, most frequently affecting human health (12 sequences) and ecosystem services (7 sequences). Due to the detailed nature of each CIC, comprehensive descriptions of individual risk factors are available in VALORADA's public Deliverable 1.1. This synthesis integrates climate hazards, impact sequences, and the three interrelated dimensions of exposure, sensitivity, and adaptive capacity.

The second part of this section provides a detailed account of the values and place-based characteristics observed across the study regions (Table 4).

4.1 Values and place-based characteristics observed across the study regions

Four overarching value domains were identified through the research: health and wellbeing, environmental values, economic values and institutional values.

Health and wellbeing—understood here as the capacity to maintain physical functioning, perform daily activities without undue fatigue or stress, and experience life satisfaction (Menk et al., 2022)—emerged as a recurrent concern across Prerov, Mlada Boleslav, Toulouse, Eovia, and Burgas, particularly in relation to high temperatures.

Across all cases, high temperatures were acknowledged as disproportionately impacting vulnerable groups. Stakeholder accounts agreed on that vulnerable groups (e.g., older adults, children, and pregnant women) face heightened risks during heat events. In Prerov, outdoor workers, commuters, and individuals engaged in physically demanding activities were reported to be under considerably higher risk to heat since they currently experience substantial heat stress due to prolonged exposure. In Mlada Boleslav, concerns about worsening physical and mental health were linked to commuters' exposure to high temperatures and limited mobility options, which currently constrain their ability to avoid peak heat. In Toulouse, dense housing, extensive hard surfaces, and limited access to cooling amenities were noted to trap heat—especially at night—potentially compounding physiological strain and affecting residents' mental wellbeing. In

10.3389/fclim.2025.1719404

TABLE 4 Overview of climate risks experienced in each demonstrator region.

Hazard	Factors increasing exposure	Factors increasing sensitivity	Factors increasing adaptive capacity
Urban heat and drought (water scarcity in cities caused by prolonged heat and insufficient rainfall)	The effects of urbanisation on amplifying heat islands and disrupting critical services were associated with increasing health risks during heatwaves in Toulouse, Přerov, and Mlada Boleslav. Přerov emphasised potential water conflicts	Social factors increasing sensitivity related to heat: Extreme high temperatures disproportionately affect the elderly, infants, and people with cardiovascular, respiratory, or renal conditions. Ageing populations heighten vulnerability to heat events. Socio-economic conditions (poverty, unemployment, social isolation) and behavioural factors (alcohol, medication use) further increase sensitivity.	Relevant for Prerov, Mlada Boleslav, Toulouse, Eovia, Burgas, and Gabrovo. Key determinants: Financial resources—Availability and equitable distribution of funds for adaptation. Spatial planning—Integration of green spaces and thermal regulations in urban design. Public policies—Health interventions and transport sector adaptation. Education and engagement—Training officials and fostering cross-sector collaboration.
Heat and drought in rural areas	Exacerbated by soil erosion, salinisation, and water scarcity, reducing agricultural productivity and intensifying competition for water (Sicoval).	Agricultural dependence, crop choices, and limited market access make rural livelihoods highly sensitive. Remoteness and outmigration reduce governance capacity, increasing risks of wildfires and hydrogeological hazards. Institutional neglect exacerbates these vulnerabilities (Molise and Sicoval).	Key determinants: Agricultural and livestock practices—Adjusting schedules, resilient crops. Forestry management—Enhancing ecosystem resilience and reducing fire risk. Knowledge and coordination—Monitoring, disease surveillance, and institutional collaboration for wildfire prevention (Sicoval and Molise).
Wildfire exposure	Wildfire occurrence depends on topography, fuel availability, and location. Terrain shape, wind regimes, solar exposure, and moisture influence ignition and spread. Vegetation load and dead biomass increase fuel, while proximity to fire fronts determines exposure to flames, smoke, and secondary impacts like soil erosion (Eovia and Gabrovo)	Species homogeneity, urban expansion and lack of planning intensify wildfire risk were highlighted in Eovia (Greece).	Shaped by agricultural and forestry management, ecosystem monitoring, and wildfire prevention networks (Eovia, Molise)
Floods in rural areas	Linked to geomorphology and infrastructure vulnerability. Geomorphology amplifies susceptibility, and infrastructure failures (e.g., dam overflow) can flood towns, agricultural, and industrial zones, spreading pollutants and chemicals (Molise).	Agricultural dependence, limited markets, and outmigration heighten sensitivity to drought and floods, as documented in Molise and Sicoval	Relevant for Central Greece and Molise. Key determinants: Access to land, technology, and markets—Supporting adaptation investments. Policies and networks—Promoting collaboration and behavioural change for resilience.

Toulouse, extreme heat particularly affects resource-limited communities—especially the elderly—due to financial constraints (e.g., energy costs for air conditioning), limited mobility, and reduced social networks. In considering future climate projections, local stakeholders emphasised that these impacts raise important questions about equity and fairness in climate adaptation.

Overall, these observations align with a value framing in which protecting health, supporting daily functioning, and sustaining life satisfaction are treated as salient priorities alongside the objective of adapting to high temperatures.

Environmental values—understood here as commitments to and stewardship of ecosystem functions (supporting, provisioning, regulating, and cultural)—recur across all CICs and often intersect with values related to health and wellbeing, recognising that ecosystem services provide essential benefits to society. At the same time, environmental values bring to the forefront the perceived erosion of values associated with trust in institutions, especially when people's and environmental safety are not guaranteed.

In this value framework, pollution control becomes a critical aspect associated with wellbeing and security, as illustrated in Molise. Past flood events raised concerns when chemical pollutants from nearby industrial sites were washed into agricultural lands. Such incidents not only triggered environmental and public health alarms but also eroded public trust in institutions due to perceived failures in pollution control, setting a precedent for concerns about future environmental mismanagement and worsening trust in institutions.

These insights reveal that climate risks not only intensify concerns about values linked to healthy environments—beyond human wellbeing—but also expose structural tensions between competing value domains. For instance, in Přerov, risks from extreme heat, urban warming, and drought are associated with ecosystem degradation through factors such as the proliferation of foreign pests, shifts in disease patterns, and the modification of ecological interaction networks. Yet, stakeholders identified the most critical concern as the declining institutional capacity to maintain and monitor these ecosystems. While ecosystem degradation is a central issue, efforts to protect trees and expand green spaces in the historic centre have encountered obstacles due to the imperative of preserving cultural heritage. This case illustrates the challenge of reconciling priorities where environmental quality, heritage conservation, and community uses converge within limited space and resources. In sum, climate hazards raise concerns about ecosystem resilience, but declining trust in institutional management is compounded by conflicts between conservation and heritage preservation, creating governance challenges that hinder effective adaptation and amplify tensions over resource allocation and community priorities.

In another example, Přerov and Sicoval illustrate conflicts over water access during heatwaves, which are projected to become more frequent and intense. Rising demand, coupled with declining water quality and availability, is likely to intensify tensions between environmental and sanitation needs, leading to stricter water restrictions and limited irrigation options. The growing likelihood of water-related disputes foregrounds critical sustainability values—ensuring long-term environmental and societal wellbeing—and cooperation values, which are essential for resolving resource conflicts. Cooperation, recognised as a core principle of sustainable systems (Mrabti et al., 2022), is perceived to be under threat as communities struggle to pursue shared goals related to water management under stress, raising concerns about diminishing trust and dialogue.

In the same line, yet another example, in Eovia (Greece), underscore tensions between environmental protection and tourism development in the context of wildfire risks. Greece suffers from chronic underfunding and inadequate forest fire management, with 80% of resources allocated to firefighting and only 20% to prevention (Almeida et al., 2023). For decades, the national forestry service has lacked sufficient funding and a robust wildfire prevention plan (Greenpeace, 2023; Almeida et al., 2023). Tourism expansion—particularly the construction of holiday homes built with light materials near monoculture forests—has significantly increased exposure to wildfires. The case of Eovia exemplifies the tension between the drive for economic development and the preservation of sustainability values, highlighting how short-term growth imperatives can undermine long-term environmental resilience.

4.2 Economic values

Economic values surface across cases at the interface of climate risks, ecosystems and economic activity. In Molise, Burgas, and Central Greece, the risk of flooding has been associated with damage to roads and bridges that disrupts mobility, communication, and social activities, with potential isolation of rural communities and interruptions to land-based livelihoods, which is associated with reduced *security and sense of community.*

In Burgas and Mladá Boleslav, extended periods of heat have been linked to several critical impacts: accelerated degradation of roads and railways, increased maintenance costs, and mounting pressure on transport systems and emergency services. Additionally, risks to workers performing summer repairs under extreme temperatures may intensify. These heat-related impacts are closely associated with values such as physical and mental health, as well as safety and security.

In Molise, alternating periods of drought and extreme precipitation have reduced land productivity and triggered economic shifts from agriculture to tourism. This transition reflects a broader revaluation of rural landscapes—from production-based identities toward amenity values tied to recreation, forests, and ecosystem services—creating, for some, a sense of decline in traditional farming structures and diminished community cohesion.

Additionally, cycles of drought and heavy rainfall have further reduced agricultural productivity, contributing to outmigration and land abandonment, which in turn weakens territorial governance and increases the risks of wildfires and hydrogeological instability (Region Molise, 2022). The case of Molise illustrates the complex ramifications of changing rainfall patterns on socio-economic structures. In this context, outmigration is associated with impacts on place-based values such as identity and belonging, which foster social harmony, community dynamism, and a sense of mutual support among individuals within a group.

In rural contexts, heat and drought risk to exacerbate soil erosion, salinisation, and water scarcity. In Sicoval (Occitanie), stakeholders noted that these processes have coincided in the past with reduced agricultural productivity and heightened competition for water among agricultural, tourism, and industrial users, increasing the risk of affectation on values associated with material living standards, safety, and security.

In Gabrovo, wildfires were described as threatening key ecosystem services—including timber supply, carbon storage, pastures, and recreation—which can directly affect employment in the forestry sector. These impacts raise concerns about job security and potential declines in service provision, thereby undermining values linked to material living standards, functioning ecosystems, cultural heritage, and identity.

Economic values also emerge in connection with adaptive capacity. The cases of Sicoval and Molise suggest that the ability to buffer economic losses is shaped by agricultural and livestock management, forestry management, and complementary mechanisms such as ecosystem monitoring, disease control, and cooperation in wildfire prevention. In flood-prone areas such as Central Greece and Molise, adaptive capacity also appears linked to economic enablers—access to land, technology, and markets—as well as institutional networks that facilitate collaboration, information exchange, and behavioural change for preparedness. These insights suggest that an adaptive capacity lens is closely intertwined with an economic value framing centred on access to material living standards, which underpin resilient livelihoods and security.

4.3 Institutional cultures and values

The demonstrators emphasise a suite of values that guide institutional preferences and attention to specific risks. And in many instances, the risks highlighted in the CICs correspond to those already recognised in official management approaches.

For example,: Přerov's adaptation plan targets risks associated with high temperatures during heat waves and underscores ecological stability via green infrastructure, energy-saving measures, and cycle-path development; Mladá Boleslav's Sustainable Urban Mobility Plan addresses infrastructure and fleet improvements to enhance thermal comfort in summer, alongside mechanisms for rapid reconstruction of transport assets after natural disasters; Molise coordinates its Municipal Adaptation Plan with national strategies (e.g., Hydrogeological Zoning Plan; National Rural Development Programme) to reinforce rural policy coherence; Sicoval's Territorial Food Project (PAT) seeks to address economic, environmental, and social objectives through initiatives such as reducing food waste, supporting organic production, advancing food education, and improving financial accessibility; and in Central Greece, adaptation efforts align national and regional flood-management strategies (e.g., the National Strategy for Adaptation to Climate Change (ESPKA), the Regional Plan for Adaptation to Climate Change, and Water Basin Management Plans). In the context of wildfire management, enforcement of the National Forestry Strategy prioritises reforestation with biodiversity objectives and the promotion of fire prevention and suppression.

The notable alignment between risks identified in the CIC and those outlined in the aforementioned documents suggests that institutional cultural values and normative frameworks do not merely inform organisational priorities but also shape underlying assumptions about what constitutes risk and how it should be managed.

5 Discussion

This research set out to deepen our understanding of how value systems and place-based characteristics shape the ways in which local stakeholders define, represent, and prioritise climate risks. Our goal was not only to explore these dynamics but also to identify key requirements for integrating values and contextual characteristics into climate risk assessments, making them more meaningful and actionable at the local level.

Through this work, several insights provide an account of the complex interplay between local perceptions and cultural norms that influence risk prioritisation. These insights are organised around four overarching value dimensions, each encompassing a series of specific values, as summarised in Table 5. We draw on these dimensions to highlight key findings and reflect on their implications for recognising and embedding local values and place-based characteristics approaches into climate risk assessments.

Overall, our findings on the role of social values and place-based characteristics in shaping climate risk perception align with Tschakert et al. (2017) and others. However, we also find that people deliberately choose which risks to prioritise and address. Consistent with Graham et al. (2013), this selection is not random but guided by criteria that weigh what is most valuable and what is perceived to be at stake. The remainder of this section explores these three perspectives—value influence on risk perception, selection, and prioritisation criteria—while highlighting nuanced differences drawn from our documented insights.

First, regarding how prioritisation of climate risks occur, our research points more specifically to the role of institutional and social and memory as a key driver in the selection process. Across the demonstrator regions, the selection of hazards represented in the CICs appears to reflect prevailing political and institutional values, established worldviews, and management traditions within local government. As documented in previous research, local authorities often operate within a "risk logic" shaped by national legislation, political discourse, and administrative instruments (Karlson et al., 2023). Our findings suggest that this logic typically frames climate risks through the lens of past events. Regions and cities design policies based on territorial characteristics, prioritising hazards that are most prominent locally. The strong alignment between risks identified in our climate impact chains and those highlighted in official publications indicates a broad consensus among local administrations on which climate risks require attention.

This has important implications for stakeholders' ability to recognise less obvious risks. Because risk perceptions are often anchored in the consequences of past events, potential risk scenarios tend to replicate previous trajectories. While this focus ensures attention to familiar hazards, it also narrows the scope of consideration, leaving limited capacity to anticipate risks from other climate hazards that have not yet manifested locally.

Linking specific hazards to value domains revealed several important insights. Heat emerged as the only hazard directly affecting values related to health—both mental and physical—and overall wellbeing. In contrast, when drought and heat occur together, concerns shift strongly toward economic values. The heightened risk of wildfires and potential damage to infrastructure and livelihoods creates cascading effects across multiple dimensions, including material living standards, functioning ecosystems, cultural heritage and identity, and safety and security. In essence, drought and heat jointly threaten a broad spectrum of values tied to the loss of material assets and economic stability. Unsurprisingly, such risks evoke heightened anxiety among stakeholders, as the prospect of losing livelihoods—whether recalled from past experiences or imagined in future scenarios—resonates with particular clarity.

Precipitation alone appears to have a less pronounced influence, primarily affecting values of security and sense of community. However, when cycles of drought and extreme precipitation combine,

TABLE 5 Summary of value domains and specific values within each domain.

• Health and wellbeing • (protecting health, supporting daily functioning, sustaining life satisfaction)	• Heat: Physical and mental health and safety linked to ensuring daily functioning without undue stress or fatigue (*Prerov, Mlada Boleslav, Toulouse, Eovia, and Burgas*). • Heat: Physical and mental health linked to commuters' exposure to high temperatures and to limited mobility (*Prerov and Mlada Boleslav*) • Heat: Protection against physiological strain and affecting mental wellbeing of residents (*Toulouse*) • Heat: Fairness (heat affecting vulnerable groups disproportionately) (*Toulouse*)
• Environmental values (Stwardship of Ecosystems)	• Heat: Strong association between "healthy" ecosystems and values *of health and wellbeing* (across all CICs) • Precipitation: Failure to control pollution is associated with erosion of *public trust* in *institutions* (*Molise*) • Balancing biodiversity *conflicting with cultural heritage and community uses* (*Prerov*)
• Economic values (*surface across cases at the interface of climate risks, ecosystems and economic activity*)	• Drought and Precipitation: Livelihood security (agriculture, forestry, tourism) (Gabrovo) • Precipitation: Losing economic resilience and discontinuity of services (transport, infrastructure) affecting *security and sense of community* (*Molise, Burgas,* Mladá Boleslav *and Eovia*) • Drought and Precipitation: Triger new values, such as amenity values tied to recreation and rural landscapes (Molise). • Drought and Precipitation: revaluation of rural landscapes eroding place-based values like *identity and belonging, Symbolic and emotional meanings attached to landscapes.* (*Molise*) • Heat and drought: *Wildfires: Losing ecosystem services and* affecting employment, linked to eroding values of *Material living standards, Functioning ecosystems, Cultural heritage and identity* • Heat and drought: Exhacerbated water scarcity trigers conflicts in water use. Affecting values of *Material living standards, safety and security, sustainability and cooperation* (*Sicoval, Prerov*) • Values linked to adaptive capacity: linked to *Material living standards that produce resilient livelihoods and security* (*Sicoval, Molise, Eovia*)
• Institutional values	• Risk logic shaped by legislation, political discourse, and administrative routines. • Normative orientations toward valued objects (territory, human security, ecological integrity). • Preference for strategies aligned with official plans and bureaucratic traditions.

the range of affected values expands significantly. These interactions can erode deeply rooted place-based values such as identity, belonging, and the symbolic and emotional meanings attached to landscapes.

A key observation from this analysis is the multiple pathways through which climate hazards disrupt what people value and seek to preserve. This underscores the need to examine how hazards interact over time, creating compound effects and new forms of impact that only become evident after prolonged cycles—such as alternating periods of drought and extreme precipitation.

Moving from hazards to impacts, our observations suggest that even when hazards are similar, the criteria used to evaluate impacts can vary significantly within communities, with notable differences across generations. The case of Molise illustrates this dynamic: alternating periods of drought and extreme precipitation have reduced land productivity and driven economic transitions from agriculture to tourism, prompting migration. Local stakeholders reported that younger generations are more inclined to migrate and pursue new economic opportunities, whereas older generations tend to remain, experiencing shifts in identity. Attachment to place and tradition is perceived differently by these groups—land abandonment signifies an erosion of community cohesion for some, while others view new employment prospects and entrepreneurial ventures as opportunities for advancement. This observation reinforces Tschakert et al.'s (2017) argument that values vary within social groups and that cultural values do not necessarily reflect consensus on individual priorities.

Another complexity lies in the overlap between values. Our findings suggests that value dimensions are rarely isolated; rather, they are deeply interwoven. Environmental values, for example, are closely intertwined with social and economic values because their evaluation criteria depend on elements shared across multiple domains. Health and wellbeing for instance, cannot be fully depicted without considering economic security, environmental quality, and both physical and mental health. This interdependence is critical for climate risk assessment and underscores the need to avoid treating value domains in isolation.

Another insight that we draw from our study is that while our results highlight a consensus across all demonstrator regions regarding the relevance of all values, tension and conflicts can arise between different values within the same community and around the same climate hazard. The examples of Prerov (degrading ecosystems and insuficient institutional capacities, compounded by little progress on greening the city vis-à-vis the need for preserving cultural heritage), fire hazard in Eovia (bringing conflicts between economic development and sustainability values) and water conflicts in Prerov and Sicoval (affecting values of sustainability and a sense of lack of cooperation and community cohesion) shed light on some valuable insights about conflicting values. As noticed by Krimsky and Golding (1992) and later by Thompson and Rayner (1998), while there can be a broad agreement on the threat posed by specific hazards, disagreements can persist on how to manage them. Risk conflicts frequently originate from divergent framings, even when fundamental values are aligned. Such divisions are further exacerbated by variations in institutional cultures and contrasting interpretations of what constitutes an acceptable level of loss (ibid). Our interpretation of the documented value conflicts are in light with this view. Indeed, the previous cases suggest that while local actors recognized the hazards presented by changing climate conditions (e.g., heat, drought, and risk of wildfire), yet, they expressed reservations about specific adaptation

measures when these were perceived to conflict with locally salient priorities—such as economic objectives (Sicoval), heritage preservation (Prerov), or environmental (Eovia and Molise).

However, what becomes particularly concerning from the cases documented here is the perceived erosion of trust in the ability of institutions to navigate through conflicting interests and value frames pertaining the environment, economic development and people's safety. Our view is that the tensions emerging between environmental values and other priorities are reflections of struggles between broader competing value frameworks. Our epistemological stance adopts a post-modern perspective, recognising that local values are contingent on historical and discursive contexts rather than fixed or universal principles. Yet, the cases also reveal that local values are not immune to global forces such as capitalism and institutional neoliberalism—the latter emphasising a reduction in state size and institutional influence. This dynamic is illustrated by the case of Molise. Understanding how cycles of drought and extreme precipitation trigger a revaluation of rural landscapes—and prompt shifts in criteria for assessing their significance—requires examining the interplay between economy and labour, and how agricultural production systems respond to market dynamics of supply and demand.

We challenge the notion that values are persistent, stable frameworks providing enduring orientation for communities. Our findings show that values evolve—and sometimes fade—creating unintended consequences for how communities perceive change and prioritise what matters. Climate risks often amplify pre-existing tensions between value frameworks, while global forces further reshape perceptions and criteria for assessing risk. This dynamic makes it necessary to revisit and reassess value frameworks continually. These insights call for closer attention to how economic, social, and environmental tensions drive shifts in the valuation and prioritisation of climate risks.

6 Conclusion

Our analysis suggests that climate risk perceptions and answers are shaped by underlying value and place-based characteristics. More broadly, our observations align with the view that effective risk assessment entails understanding what communities value, how they perceive risk, and how they envision risk reduction action.

Although hazards such as flooding or heatwaves are often framed as technical problems, stakeholder perspectives across the demonstrator regions suggest that risk is often interpreted through the lens of locally salient values—such as ecosystem integrity, human health, cultural identity, and social justice—rather than through purely technical considerations.

Tensions between values were evident in how risk is perceived, and risk responses devised. Such tensions show that while risks deemed technically credible and broadly acknowledged may nevertheless be socially misaligned. While this can be portrayed as deficits in climate awareness; however, they may be more appropriately understood as value-laden disagreements over response options and associated trade-offs.

Based on the cases documented in this article, we argue that integrating value-based and place-specific characteristics into climate risk assessments requires making explicit how climate hazards can influence local value frameworks that guide human action and shape meaningful participation in society. One practical way to achieve this is by openly discussing competing value claims—such as environmental sustainability versus economic growth—early in the assessment process. Bringing these tensions to the surface helps reflect the diversity of stakeholder priorities and fosters more inclusive and context-sensitive approaches to climate risk governance.

Finally, while our findings are grounded in the specific contexts of the 10 demonstration regions, many of the observed dynamics—such as the influence of local values on risk prioritisation—are likely to be relevant in other European settings. Nevertheless, differences in institutional structures, cultural norms, and climate hazards mean that adaptation strategies must be tailored to local circumstances.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

CR: Methodology, Conceptualization, Validation, Supervision, Data curation, Funding acquisition, Writing – review & editing, Project administration, Writing – original draft, Formal analysis, Resources. JC: Data curation, Validation, Supervision, Writing – review & editing. CT: Supervision, Methodology, Writing – review & editing. MV: Writing – review & editing, Supervision, Formal analysis. LK: Writing – review & editing, Supervision, Formal analysis. EK-R: Validation, Writing – review & editing. GG: Formal analysis, Writing – review & editing, Methodology, Supervision. NK: Writing – review & editing, Formal analysis.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research has received funding from the Horizon Europe Framework Programme under Grant Agreement No 101112837.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy,

including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fclim.2025.1719404/full#supplementary-material

References

Adaptation Research Alliance (ARA). (2021). Adaptation research for impact principles. Available online at: https://southsouthnorth.org/wp-content/uploads/2021/07/ARA-Principles_2021.pdf (Accessed November 14, 2025).

Almeida, M., Ribeiro, L. M., Alves, D., Viegas, D. X., et al. (2023). Analysis of critical wildfire events in the Mediterranean region. Luxembourg: Publications Office of the European Union.

Barnett, J, and O'Neill, S. (2010). Maladaptation. *Global Environmental Change*, 20, 211–3.

Bremer, S., Johnson, E., Fløttum, K., Kverndokk, K., Wardekker, A., and Krauß, W. (2020). Portrait of a climate city: how climate change is emerging as a risk in Bergen, Norway. *Clim. Risk Manag.* 29:100236. doi: 10.1016/j.crm.2020.100236

Brown, I. (2018). Assessing climate change risks to the natural environment to facilitate cross-sectoral adaptation policy. *Philos. Trans. A Math. Phys. Eng. Sci.* 376:20170297. doi: 10.1098/rsta.2017.0297

Cresswell, T. (2004). "Defining place" in Place: a short introduction. ed. T. Cresswell (Malden, MA: Blackwell Ltd).

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and EURAC (2017). "Risk supplement to the vulnerability sourcebook" in Guidance on how to apply the vulnerability sourcebook's approach with the new IPCC AR5 concept of climate risk (Bonn: Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH).

Ensor, J., Wennström, P., Bhatterai, A., Ensor, J. E., Nightingale, A. J., Eriksen, S., et al. (2019). Asking the right questions in adaptation research and practice: seeing beyond climate impacts in rural Nepal. *Environ. Sci. Pol.* 94, 227–236. doi: 10.1016/j.envsci.2019.01.013

Gorddard, R., Colloff, M. J., Wise, R. M., Ware, D., and Dunlop, M. (2016). Values, rules and knowledge: adaptation as change in the decision context. *Environ. Sci. Pol.* 57, 60–69. doi: 10.1016/j.envsci.2015.12.004

Graham, S., Barnett, J., Fincher, R., Hurlimann, A., and Mortreux, C. (2014). Local values for fairer adaptation to sea-level rise: a typology of residents and their lived values in lakes entrance, Australia. *Glob. Environ. Chang.* 29, 41–52. doi: 10.1016/j.gloenvcha.2014.07.013

Graham, S., Barnett, J., Fincher, R., Hurlimann, A., Mortreux, C., and Waters, E. (2013). The social values at risk from sea-level rise. *Environ. Impact Assess. Rev.* 41, 45–52. doi: 10.1016/j.eiar.2013.02.002

Greenpeace. (2023). (checked on 10th January 2024). Available online at: https://www.greenpeace.org/international/story/61166/greece-burning-5-insights-greek-fires-crisis/ (Accessed March 28, 2024).

Hess, J. J., Malilay, J. N., and Parkinson, A. J. (2008). Climate change: the importance of place. *Am J Prev Med* 35: 468–478.

Karlson, C., Morsut, C., and Engen, O. (2023). Politics of climate risk management in local government: a case study of the municipality of Stavanger. *Front. Clim.* 5. doi: 10.3389/fclim.2023.1136673

Kasperson, R. (2014). Four questions for risk communication. *J. Risk Res.* 17, 1233–1239. doi: 10.1080/13669877.2014.900207

Krauß, W., and Bremer, S. (2020). The role of place-based narratives of change in climate risk governance. *Clim. Risk Manag* 28:100217. doi: 10.1016/j.crm.2020.100221

Krimsky, S., and Golding, D. (1992). *Social theories of risk*. New York, NY: Praeger.

Kythreotis, A., Hannaford, M., Howarth, C., and Bosworth, G. (2024). Translating climate risk assessments into more effective adaptation decision-making: the importance of social and political aspects of place-based climate risk. *Environ. Sci. Pol.* 154:103705. doi: 10.1016/j.envsci.2024.103705

Lejano, R. P., Tavares-Reager, J., and Berkes, F. (2013). Climate and narrative: Environmental knowledge in everyday life. *Environ. Sci. Policy* 31, 61–70.

Marschütz, B., Bremer, S., Runhaar, H., Hegger, D., Mees, H., Vervoort, J., et al. (2020). Local narratives of change as an entry point for building urban climate resilience. *Clim. Risk Manag.* 28:100223. doi: 10.1016/j.crm.2020.100223

Menk, L., Schinko, T., Karabaczek, V., Hagen, I., and Kienberger, S. (2022). What's at stake? A human well-being-based proposal for assessing risk of loss and damage from climate change. *Front. Clim.* 4:1032886. doi: 10.3389/fclim.2022.1032886

Mrabti, N., Hamani, N., and Delahoche, L. (2022). A comprehensive literature review on sustainable horizontal collaboration. *Sustainability* 14:11644. doi: 10.3390/su141811644

Nörstrom, A., Cvitanovic, C., Löf, M. F., West, S., Wyborn, C., Balvanera, P., et al. (2020). Principles for knowledge co-production in sustainability research. *Nat. Sustain.* 3, 182–190. doi: 10.1038/s41893-019-0448-2

O'Brien, K., and Selboe, E. (2015). "Climate change as an adaptive challenge" in The adaptive challenge of climate change. eds. K. O'Brien and E. Selboe (Cambridge: Cambridge University Press).

O'Brien, K., and Wolf, J. (2010). A values-based approach to vulnerability and adaptation to climate change. *WIREs Clim. Change* 1, 232–242. doi: 10.1002/wcc.30

O'Brien, K., Eriksen, S., Inderberg, T., and Sygna, S. (2015). "Climate change and development: adaptation through transformation" in Climate change adaptation and development: Changing paradigms and practices. eds. T. H. Inderberg, S. H. Eriksen, K. L. O'Brien and L. Sygna (Oxon and New York: Routledge), 273–289.

Padin-Dujon, A. (2023). What is 'non-economic' loss and damage (NELD)? Explainer. London: London School of Economics.

Region Molise. (2022). Region Molise Strategia Regionale per lo Sviluppo Sostenibile. Available at https://www.gse.it/normativa_site/GSE%20Documenti%20normativa/MOLISE_DGR_n248__26_07_2022.pdf (Accessed December 10, 2023).

Renn, O., Burns, W. J., Kasperson, J. X., Kasperson, R. E., and Slovic, P. (1992). The social amplification of risk: Theoretical foundations and empirical applications. *Journal of Social Issues*, 48, 137–160. doi: 10.1111/j.1540-4560.1992.tb01949.x

Runhaar, H., Wilk, B., Persson, A., Uittenbroek, C., and Wamsler, C. (2018). Mainstreaming climate adaptation: taking stock about what works from empirical research worldwide. *Reg. Environ. Chang.* 18, 1201–1210.

Schmidt, M. (2004). "Investigating risk perception: a short introduction. Chapter 3" in Loss of agrobiodiversity in Vavilov centers, with a special focus on the risks of genetically modified organisms (GMOs) (PhD thesis). ed. M. Schmidt (Vienna: University of Vienna, Institute of Risk Research).

Tansey, J., and Riordan, T. (1999). Cultural theory and risk. A review. *Health Risk Soc.* 1, 71–90. doi: 10.1080/13698579908407008

Thompson, M., and Rayner, S. (1998). "Cultural discourses. The societal framework" in Human choice and climate change. eds. S. Rayner and E. L. Malone, vol. 1 (Columbus: Battelle Press), 265–343.

Tschakert, P., Barnett, J., Ellis, N., Lawrence, C., Tuana, N., New, M., et al. (2017). Climate change and loss, as if people mattered: values, places, and experiences. *WIREs Clim. Change* 8. doi: 10.1002/wcc.476

Turner, N. J., Gregory, R., Brooks, C., Failing, L., and Satterfield, T. (2008). From invisibility to transparency: identi-fying the implications. *Ecol. Soc.* 13:7.

Van den Hurk, B., Hewitt, C., Jacob, D., Bessembinder, J., Doblas-Reyes, F., and Döscher, R. (2018). The match between climate services demands and earth system models supplies. *Clim. Serv.* 12, 59–63. doi: 10.1016/j.cliser.2018.11.002

van Schie, D., Jackson, G., Serdeczny, O., and van der Geest, K. (2024). Economic and non-economic loss and damage: a harmful dichotomy? *Glob. Sustain.* 7:e42. doi: 10.1017/sus.2024.40

Wardekker, A., de Jong, A., Knoop, J., and Van Der Sluijs, j. (2010). Operationalising a resilience approach to adapting an urban delta to uncertain climate changes. *Technol. Forecast. Soc. Change* 77, 987–998.