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Adapting Intangible Cultural Heritage: Insights and Reflections from Policy and Research Innovations

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Introduction

Intangible Cultural Heritage (ICH) is a critical component of cultural diversity and sustainable development, encompassing the practices, expressions, knowledge, and skills passed down through generations. Unlike tangible cultural heritage, such as monuments, sites, or artifacts, ICH is dynamic, continually reshaped by the environment, history, and social structures, subject to a continuous evolution, interpretation and transmission. The preservation and adaptation of ICH are essential not only for maintaining cultural identity but also for fostering resilience in the face of global challenges, particularly climate change.

Climate change poses unprecedented threats to communities worldwide, altering ecosystems, livelihoods, and cultural practices. For many communities, especially those in vulnerable regions, ICH is deeply intertwined with the natural environment and tangible assets. As climate change disrupts traditional weather patterns, biodiversity, and land use, it also threatens the survival of the cultural practices and knowledge systems that have evolved in harmony with these environments.

The interaction between climate change and cultural heritage has gained attention and momentum in recent years.

Nonetheless, a notable gap is emerging in understanding these interactions due to a disproportionate emphasis on built heritage and heritage sites in discussions about climate change and heritage policies (cf. European Commission, 2022; Morel et al., 2022; Crowley et al., 2021). This reveals a shortfall in achieving a comprehensive and balanced understanding of cultural heritage within risk assessments and discussions pertaining to losses and damages caused by climate change, and climate adaptation. The consequences of climate change on intangible cultural heritage, including indigenous and traditional knowledge and practices related to, for example, nature and the use of natural

resources, have so far been poorly researched and underestimated (Orlove et al., 2022; European Commission, 2022).
Beyond moral obligations to safeguard communities' shared heritage, tapping into traditional knowledge holders and embracing their resilience practices could substantially reinforce climate adaptation and mitigation efforts as much of living heritage holds the potential for imparting lessons from historical climate adaptation practices (Goswami, 2022).
This article draws on case studies on the latest policy and research innovations for adapting ICH to climate change impacts realized in the context of the EU-funded projects SD-WISHEES and Green Heritage[1] to reflect and provide crucial insights into how research and innovation (R&I) and ICH communities can safeguard their heritage while building resilience to environmental changes.

Impacts of climate change on ICH and adaptation options: empirical evidence from Green Heritage case studies

Climate change's effects extend beyond the physical realm to intangible aspects. For example, they disrupt access to traditional foods and longstanding cultural practices like rituals. Climate change can force the displacement of communities from their territories or alter those areas significantly, thereby triggering social and cultural losses (Morel et al., 2022). Such disruptions affect the ability to perform rituals or customary practices, affecting people's identity and sense of belonging, while alteration of specific landscapes resulting from environmental change or climate mitigation measures can result in changes in the sense of place (i.e., the cognitive and emotional experience of places) and in turn place identities and culture (Adger et al., 2013). In essence, due to the interplay between climate change and the social structures, the effects of climate change also put a community's way of life and knowledge at risk. The evidence gathered from European case studies in the Green Heritage project depicts a clear picture of how climate change can influence or potentially disrupt traditional practices and skills deeply intertwined with local ecosystems and weather patterns. Climate change has the potential to result in the depletion or scarcity of natural resources crucial for various traditions, impacting, among other aspects, traditional cuisines, and dietary habits. Additionally, climate change may disturb the timing and conditions of traditional cel-

[1] SD-WISHEES: Supporting and Developing WIdening Strategies to tackle Hydroclimatic Extreme Events: impacts and Sustainable solutions for cultural heritage (https://sd-wishees.irsa.cnr.it/)
Green Heritage: The impact of Climate change on the Intangible Cultural Heritage (https://greenheritageproject.eu/)

ebrations closely associated with seasonal shifts. Events such as agricultural festivals or religious ceremonies that depend on specific weather and seasonal patterns may face disruptions. Furthermore, as climate change can reshape or threaten the cultural landscape through factors like desertification and heavy rainfalls it poses a threat to the continuity of practices dependent on these landscapes.

The relationship between climate change and ICH that emerges from the case studies (N=14) investigated in the Green Heritage project highlights how extreme climatic events and CC-related phenomena, can influence the habits, traditions, and the behaviors of entire communities. On the other hand, many of these cases showcase how ICH can play a key role and be valuable when adapting to climate change and mitigating its risk.

Here we provide a summary - drawn from Green Heritage deliverable D2.3 (Biddau, Galluccio & Trozzo, 2023) - of how changing climatic conditions are affecting such ICH elements (See Table 1) and the type of adaptation measures that have been proposed or implemented (see Table 2). For a detailed account of the case studies, please refer to Green Heritage deliverable D2.2 (Balcare et al., 2023).

Table 1. ICH Elements and Investigated Cases by Green Heritage, along with examples of climate hazards on ICH (drivers and associated Impacts). The numbering of case studies (CS) is codified according to GreenHeritage deliverable D2.2

ICH elements	ICH cases (ID)	Country(ies)	Climate-related hazards (drivers and impacts)
Traditional agriculture and customary practices of food production	Art of Valencian paella (CS14)	Spain	Increasing temperature may cause heat stress and water scarcity, shortening the growing season and yield variability in key ingredients (bean and rice)
	Traditional practice of wild edible plants in Crete (CS6)	Greece	Edible wild plants as a climate-resilient solution to increasing temperatures, heatwaves, and droughts
	Agricultural and dietary tradition of carob in Crete (CS4)	Greece	Carob as a climate-resilient solution to rising temperatures, unpredictable climates, and drought
	Wine culture in the Mosel wine-growing region (CS3)	Germany	Weather extreme phenomena (rainfall and heatwaves) causing droughts or changed freeze /thaw cycles alter soil composition and moisture and in turn the vine productivity, time of ripening and wine taste

Traditional practices of fishing, harvesting, and livestock	Lamprey fishing and preparation skills in Carnikava (CS11)	Latvia	Rising freshwater temperature and changed freeze/thaw cycle affect fish migration patterns and introduction of invasive species and in turn fishing timing and productivity
	Puffin harvesting and hunting (CS1)	Denmark	Increase in ocean temperature and biodiversity loss/decline in the availability of fish as a food source for puffins
	Livestock transhumance in the Cantabrian region (CS13)	Spain	Rising temperatures and changing seasonality cause prolonged droughts and desertification influencing the availability of pasture and the timing of livestock movement
Religious rituals and festive events	Celebrations of the Big Shoulder-borne Processional Structures in the historic cities of Nola, Sassari, Palmi, and Viterbo (CS10)	Italy	Extreme and unpredictable weather events (heatwaves and rainfalls) pose a threat to human safety (extreme heat affecting structure carriers) and tangible assets of outdoor performance (e.g., rain ruining wood and paper structures)
	Madonna Avvocata Festival in the Amalfi Coast (CS9)	Italy	Extreme and unpredictable weather events (heatwaves and rainfalls) pose a threat to human safety and tangible assets of outdoor performance (e.g., landslides altering pilgrimage infrastructure and pathway)
	Feast/Race of Ceri in Gubbio (CS8)	Italy	Extreme and unpredictable weather events (heatwaves and rainfalls) may negatively affect tangible assets or outdoor performance (e.g., heavy rain altering the route and decontextualizing the ritual), with the risk for the event celebration and an impact for its identitarian cultural and social meaning
Traditional craftsmanship shaping the cultural landscape and people-place relationships	The art and technique of dry-stone walls for terraced landscapes in Cinque Terre and Amalfi Coast (CS7)	Italy	Weather extremes (rainfall and heatwaves) cause droughts altering soil composition and moisture, causing damage to crops, and increasing the risks of wall failure, erosion and landslides
	Construction of Mandras (paddocks) on the island of Lemnos (CS5)	Greece	Rising temperatures have adverse effects on biodiversity, agricultural production, and labour
Traditional outdoor leisure practices related to knowledge concerning nature	Mountaineering practice in the Alps (Alpinism) (CS2)	Italy, France, and Switzerland	Rising temperatures and melting glaciers, along with unpredictable weather patterns and shifting seasons, contribute to heightened risks (ice/snow instability, rockfalls and landslides) making the practice risky or inaccessible
	Skating on natural ice (CS12)	Netherlands	Shifts in freeze/thaw cycles, coupled with rising temperatures, result in the thinning or complete loss of inland ice making the practice no longer viable or highly improbable

Table 2. Categorization of Key Types of Measures (KTM) and Sub Key Types of Measures (SUB KTM) for adaptation, including specifications/explanations and examples from ICH Cases Investigated in Green Heritage. The Categorization of KTM and SUB KTM is based on EEA (2022)[2]

KTM	SUB-KTM	SUB KTM specifications	Examples from ICH cases
Governance and institutional	1. Policy instruments 2. Management and planning 3. Coordination, cooperation and networks	• Creation/revision of policies, regulations, technical rules, or standards • Mainstreaming adaptation into other sectors/policies • Creation/revision of coordination formats or stakeholder networks	• Revising regulation and product standards hindering adaptation in the agriculture sector (CS7, CS3) • Revising regulations governing hunting and fishing practices for sustainable resource management (CS11, CS1) • Community-led initiatives and partnerships for co-managing ICH or coordinating economic activities for mutual benefits (CS11, CS7) • Technical coordination table among local policymakers and various stakeholders to monitor, plan, and act to ensure the safe execution of the event (CS8)
Economic and finance	1. Financing and incentive instruments 2. Insurance and risk-sharing instruments	• Creation/revision of incentive mechanisms, funding schemes or contingency funds for emergencies	• Funding schemes for the assessment and monitoring of the state of tangible assets (CS1, CS5) • Incentive schemes to support the ICH community and the provision of ICH ecosystem services for risk reduction (CS13, CS7)
Physical and technological	1. Grey options 2. Technological options	• Development, upgrade, or replacement/ rehabilitation of physical infrastructure • Early warning systems, hazard/risk mapping, or services and process	• Monitoring weather forecasts and site conditions to adapt schedules or practices (CS2) • Implementing climate-smart or precision agriculture to adapt to droughts (CS3) • Mapping land use practices and abandonment to tailor interventions (CS5, CS7)
Nature-based solutions and ecosystem-based approaches	1. Green options 2. Blue options	• Development or improvement of existing green or blue infrastructure • Natural or semi-natural use and management of land and marine areas	• Use of constructive traditions as climate resilient solutions for enhancing soil fertility and reducing erosion (CS7) • Using resistant crops to adapt to both droughts and heavy rainfall (CS3) • Juvenile repopulation of species (CS11)
Knowledge and behavioural change	1. Information & awareness raising 2. Capacity building and empowering	• Research and innovation • Communication and dissemination • Decision support tools, databases, and knowledge-sharing platform • Identification and sharing of good practices • Knowledge transfer/training	• Assessment and monitoring of the state of resources (CS14, CS7, CS12) • Digitization of ICH or R&I for retrofitting (CS7) • Communication and dissemination of scientific information to preserve resources (CS6, CS1) • Sharing of knowledge and good practices between regions sharing traditions (CS7, CS2)

[2] Grey options involve technological and engineering solutions to enhance adaptation. Green and blue options rely on the ecosystem-based approach and make use of services provided by natural ecosystems, respectively land and marine, to improve adaptation.

Case Studies on Climate Change Impacts and Innovations in Intangible Cultural Heritage

In this article, we briefly present three case studies derived from research carried out in GH and SDW pertaining R&I to adapt and safeguard ICH from climate change impacts. The three case studies reflect different aspects of ICH and how R&I is supporting their safeguarding and adaptation to derive insights and reflections on the role of policy and R&I. These include the art of drystone walling and the tradition of olive oil production in the Mediterranean region along with their cultural landscapes, and the rainfed agricultural practices in sub-Saharan Africa.

Case Study 1: TERRACESCAPE and STONEWALLSFORLIFE

TERRACESCAPE and STONEWALLSFORLIFE[3] are two complementary initiatives funded under the LIFE Programme. Both projects were aimed at demonstrating the use of drystone terraces as green infrastructures resilient to climate change impacts in the Mediterranean region.
While TERRACESCAPE is focused on Andros Island in Greece, STONEWALLSFORLIFE operates primarily in the Cinque Terre National Park in Italy, addressing the challenges posed by extreme weather events, particularly rainfalls and associated hazards such as landslides. Terrace cultivation historically played a crucial role in supporting primary production on these territories and contribute to ecosystem services by enhancing rainwater percolation, reducing soil erosion, and promoting local biodiversity. Both projects recognize the deep connection between traditional land management practices and local cultural identities,

Agricultural terraces with dry-stone walls in the Cinque Terre National Park © Parco Nazionale delle Cinque Terre (Jacopo Grassi).

Aerial view of the Manarola Amphitheatre in the Cinque Terre National Park © Parco Nazionale delle Cinque Terre (Emanuele Raso).

[3] STONEWALLSFORLIFE: Using Dry-Stone Walls as a Multi-purpose Climate Change Adaptation tool https://www.stonewalls4life.eu/
TERRACESCAPE: Employing Land Stewardship to Transform Terraced Landscapes into Green Infrastructures to Better Adapt to Climate Change https://lifeterracescape.aegean.gr/en/

and they seek to revitalize these practices and restore terraces to improve environmental and agricultural sustainability.
TERRACESCAPE preserved traditional practices by linking cultural heritage with economic opportunities. TERRACESCAPE successfully restored 100 hectares of ancient terraces on Andros Island, significantly revitalizing local agricultural practices and improving soil health. A comprehensive adaptation plan was developed, incorporating a GIS-supported Decision Support Tool (DST) to guide terrace restoration and management, including reuse and cultivation, implementing climate smart agricultural practices, and demonstrating their ecological and productivity function, as well as their role in limiting climatic change impacts in the entire island landscape. The tool assisted authorities and stakeholders in planning and monitoring restoration activities, optimizing land use, recultivation with climate-smart agriculture, and mitigating erosion risks. The project also engaged local communities through a series of educational workshops, which helped to increase awareness of sustainable agricultural practices and promoted the potential of terraced landscapes for sustainable tourism.
STONEWALLSFORLIFE is currently operating in Italy and focuses on the conservation and restoration of drystone terraces that are crucial for maintaining the landscape, the related agricultural tradition and preventing soil erosion in the Cinque Terre National Park (a World Heritage Site famous for its cultural landscape). Innovative restoration methods and materials were introduced and tested to improve stability and resilience such as enhancing water drainage and resistance to rainfall. A digital mapping tool was also designed to track the condition and maintenance needs of these structures. The project included a robust training program for ICH transmission, equipping communities and particularly disadvantaged people with the skills needed to carry

Dry-stone wall reconstruction and restoration in in the Cinque Terre National Park © Parco Nazionale delle Cinque Terre (Emanuele Raso)

out effective restoration and maintenance of the walls. Collaboration among local governments, environmental groups, and community stakeholders was a cornerstone of the project, fostering a collective approach to managing these critical cultural and environmental assets and contributing to the transmission/safeguarding of the constructive tradition as well as creating new job opportunities for maintainers.

The methods and tools developed by STONEWALLSFORLIFE and TERRACESCAPE have been recognized for their potential to be replicated in other Mediterranean regions or Greek territories, further contributing to the preservation of the traditional practice.

Both projects benefited from strong community involvement, awareness and institutional support. TERRACESCAPE leveraged the cultural and tourism potential of the terraced landscapes, which provided additional motivation for conservation efforts. Similarly, STONEWALLSFORLIFE capitalized on the community awareness of climate risks, the territorial vulnerability, and the urgent need for wall conservation in the area that was affected by extreme weather events (a destructive rainstorm in 2011 caused landslides in neglected terraces and multiple damages and losses including some fatalities), which fostered community engagement and institutional action. The integration of modern technology, such as GIS and digital mapping tools, facilitated effective management and monitoring of restoration activities, as well as demonstrate their adaptation potential.

Despite the successes, the projects faced several challenges. TERRACESCAPE encountered difficulties in ensuring the long-term economic sustainability of the restored agricultural practices, as market conditions and farming practices evolve. STONEWALLSFORLIFE faced obstacles related to fragmented land ownership and regulatory hurdles, which complicated the implementation of restoration activities, requiring careful negotiation with multiple stakeholders and advocating for regulatory changes.

Both projects have laid a strong foundation for continued efforts in terrace restoration and wall conservation. TERRACESCAPE's outcomes are being integrated into the Greek National Recovery and Resilience Plan, ensuring that the project's experience and methodologies are sustained and expanded. STONEWALLSFORLIFE's approaches and tools have been integrated into the Cinque Terre National Park climate adaptation plan and are being considered for replication in other Mediterranean regions, with plans to further develop and refine the restoration techniques and community training programs. The projects' successes highlight the potential for traditional land management practices to contribute to climate resilience and sustainable development, thereby ensuring their safeguarding.

Case Study 2: Rainwatch[4]

The Rainwatch project, is a groundbreaking unfunded collaborative initiative led by Professor Rosalind Cornforth and Galiné Yanon from the Walker Institute (University of Reading, UK) and AfClix (Africa Climate Exchange). It focused on enhancing the resilience of rural communities dependent on rainfed agriculture in the Sahel region of Africa, a region highly vulnerable to climate variability and extreme weather events, which significantly impact agricultural productivity and food security. Rainwatch developed and implemented a real-time monitoring system to track rainfall patterns, a critical component for effective agricultural planning and drought management in this arid and semi-arid region.
This project addresses the lack of daily rainfall data in sub-Saharan Africa by improving access to practical climate information. It provides simple, understandable rainfall and temperature plots that benefit users, including farmers, scientists, and policymakers. The initiative serves as a low-cost, real-time monitoring system that tracks critical climate attributes and acts as an early warning system for droughts and floods.

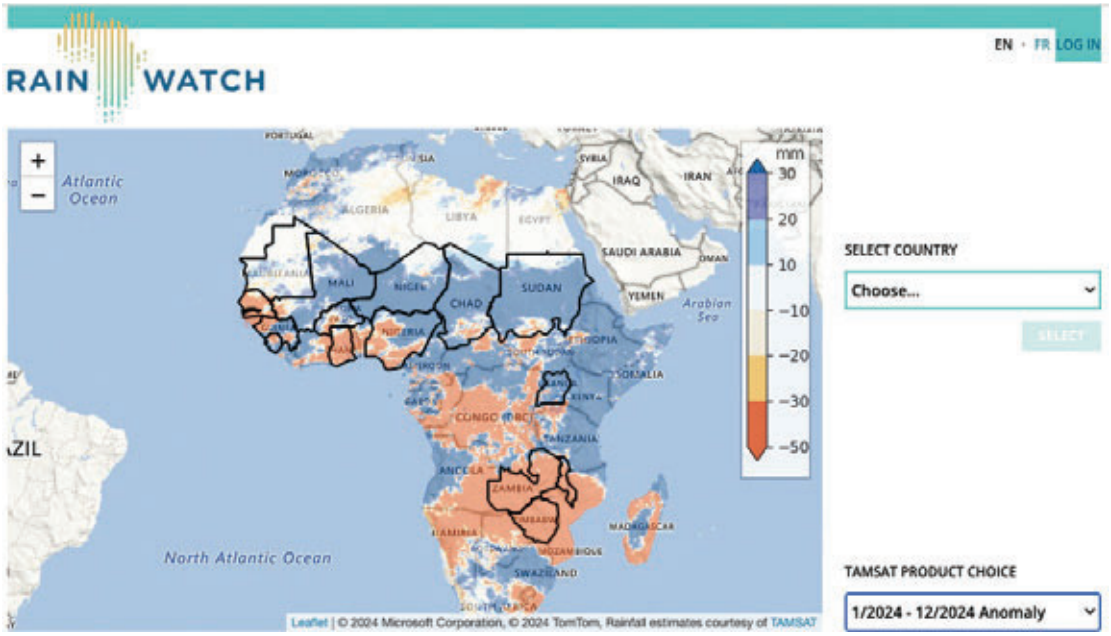

Figure 4. RainWatch Dashboard Interface. Source: https://data.rainwatch-africa.org/

[4] https://walker.reading.ac.uk/project/rainwatch/
RAINWATCH: Providing real-time rainfall information for user communities in sub-Saharan Africa

Rain Watch prioritized intermediate technology solutions over complex dashboards, aiming for practicality and usability. Much of the design was informed by historical rainfall patterns and people's collective memories of past events. Rain Watch aimed to compare current rainfall data with historical records, particularly droughts and flooding events, to inform responses and actions.

The ability to monitor rainfall patterns in real-time has empowered local communities to adapt their agricultural practices to changing weather conditions, improving crop yields and reducing the risk of crop failures. The dissemination and exploitation of Rain Watch is being done by the individual National Meteorological Services and communicated directly with relevant institutions and individuals on the ground, facilitating the transfer of knowledge significant to local communities ensuring the practical applications.

The initiative built partnerships with decision-makers and meteorological services to ensure the integration of generated knowledge into institutional structures, refine the methodologies to establish clear links from research findings to tangible outcomes, enabling the translation of research into actionable storylines (adaptive pathways) working across various sectors and communities.

Rainwatch's data-driven approach has influenced local and national policies by providing evidence-based recommendations for climate adaptation strategies in the agricultural sector. The project's findings have been used to advocate for policy changes that support sustainable agricultural practices and improve resilience to climate extremes. This policy impact stresses the importance of integrating scientific data into decision-making processes to address climate challenges effectively.

Rainwatch's success was driven by strong partnerships with local governments, non-governmental organizations (NGOs), and international agencies. These collaborations ensured that the data reached relevant stakeholders. The use of National Metereological Services for data dissemination was a key enabler, providing broad reach and accessibility. The project faced challenges related to the sustainability of the monitoring system beyond the project's lifespan. Ensuring that the network remains operational and continues to provide valuable data requires ongoing investment and maintenance.

The project has established a model for how real-time data can be used to support climate adaptation and improve agricultural resilience. Future efforts will focus on expanding the network, enhancing system capabilities, and addressing the sustainability challenges identified during the project.

Case Study 3: Sustainolive

Co-funded by the Horizon 2020 Framework Programme and the PRIMA programme, Sustainolive[5] addresses the environmental challenges facing the olive oil sector in the Mediterranean basin. The olive oil sector is a backbone of socio-economic and cultural life of many European (Spain, Portugal, Italy, Greece) and African regions (Tunisia and Morocco) and a predominant landscape of these areas. This project aims to improve the sustainability of olive cultivation by addressing issues such as soil erosion, water overexploitation, and climate-related stress on olive trees. It promotes the implementation and uptake of innovative solutions set in management practices based on agroecological concepts and knowledge exchange with key actors in the sector. Through the introduction of innovative solutions integrated with agro-ecological traditional practices, Sustainolive seeks to ensure the long-term stability of olive oil production.

Typical olive grove cultural landscape. Source: Montes-Osuna & Mercado-Blanco (2020)

Sustainolive introduced a range of sustainable farming practices designed to mitigate environmental impacts and enhance soil and water management. These practices include composting, biodiversity conservation, and the adoption of water-efficient irrigation techniques. The project organized workshops and field demonstrations to showcase these practices and facilitate their adoption among farmers. Additionally, Sustainolive developed a suite of tools, including a carbon footprint calculator and a nutrient balance tool, to help farmers assess and improve their sustainability practices.
The project produced several key resources, including a handbook of protocols and a manual of good practices[6]. These resources

[5] Sustainolive: Promoting the sustainability and adaptation of the olive grove sector https://sustainolive.eu/
[6] https://sustainolive.eu/wp-content/uploads/2023/09/D1.4.-Handbook-of-protocols-and-methods-T1.2.pdf
https://sustainolive.eu/download/10945/

provide practical guidance for implementing sustainable agricultural practices and improving environmental stewardship. The project also developed an app that enables farmers to communicate directly with experts and access information on best practices. Sustainolive facilitated extensive knowledge exchange among farmers, researchers, and policymakers, organizing webinars, training events, and other activities such as demonstrative events in the field with testimonials of farmers who adopted the measures, and developing recommendations to share insights and experiences related to sustainable olive cultivation. This knowledge dissemination and exchange has strengthened the capacity of stakeholders to address environmental challenges and implement effective adaptation strategies.

Figure 6. Field visit in an olive experimental farm in Italy. Source: Sustainolive Newsletter n°3.

Sustainolive's success was supported by strong collaboration between researchers, local stakeholders, and industry partners such as farmers and farmer cooperatives. The use of digital tools and platforms facilitated knowledge dissemination and engagement with farmers, especially during the COVID-19 pandemic when in-person meetings were restricted. The project's focus on practical, on-the-ground solutions helped to overcome resistance to change and promote the adoption of sustainable practices. The project faced several barriers, including regulatory constraints on agroecological practices and economic challenges related to transitioning to sustainable methods. The influence of chemical producers on farmer decision-making also posed a challenge, as it affected the willingness of some farmers to adopt alternative practices.

Conclusion: Insights and Reflections

This article has explored the interactions of climate change and ICH through case studies from Green Heritage, and how R&I is supporting the adaptation of intangible cultural heritage (ICH) with three case studies on R&I initiatives examined in the context of Green Heritage and SD-WISHEES projects. By examining how R&I is contributing to addressing the challenges posed by climate change to ICH several critical insights and reflections can be drawn. The experiences of the projects highlight the importance of addressing different types of enablers and barriers for effective safeguarding and adaptation of ICH and uptake of solutions. Enablers such as strong community involvement, institutional support, and the use of innovative tools have been critical to the success of these initiatives. However, the projects also faced significant barriers, including regulatory constraints, economic challenges, and fragmented governance. Overcoming these barriers requires coordinated efforts among policymakers, researchers, and local stakeholders to create supportive environments for the sustainable adaptation of ICH.

One of the primary insights from these case studies is the importance of integrating ICH considerations into climate adaptation policies and plans at different levels. The findings highlight that effective policy frameworks must go beyond the traditional focus on tangible heritage and built environments to include ICH, which is deeply intertwined with local ecosystems and traditional practices. Extreme weather events and slow-onset environmental changes can threaten traditional practices that are vital for community identity and cohesion. Policies that explicitly address these impacts and incorporate ICH concerns into climate adaptation strategies are essential for ensuring that cultural practices not only survive but thrive amidst environmental changes.

Addressing the risks and vulnerabilities associated with climate change often requires significant data, capacity, and background knowledge. Engaging stakeholders and end users in the design, development and dissemination of R&I outcomes can help overcome barriers related to data interpretation and technical adaptation. Supportive national policies and regulatory frameworks are crucial for facilitating the uptake of R&I outcomes.

The case studies reviewed reveal that innovative tools and methodologies developed through research can significantly enhance the adaptability of ICH. For example, the GIS-supported Decision Support Tool (DST) from TERRACESCAPE provides a sophisticated means to guide the restoration of traditional terraces, while the real-time rainfall monitoring system from Rainwatch

offers essential information for agricultural planning in vulnerable regions dependent on the tradition of rainfed agriculture. Sustainolive highlights the importance of agroecological practices integrating scientific advancements with traditional knowledge in composting and water-efficient irrigation techniques. These innovations illustrate how scientific advancements can often complement traditional knowledge and support traditional practices, providing communities with the means to adapt their cultural-dependent practices to changing climatic conditions effectively.

Another key insight is the active involvement of heritage communities and stakeholders in adaptation efforts. The case studies demonstrate that successful adaptation of ICH is heavily reliant on meaningfully engaging local communities in the process. The participation of community members ensures that adaptation measures are culturally appropriate and aligned with traditional practices. The involvement of end users and stakeholders in the R&I process is crucial for ensuring that the outcomes are both relevant and applicable considering their needs. Community and stakeholder-led approaches, as demonstrated by the projects, significantly enhance the utility and adoption of innovations and ensure the reinterpretation and transmission of ICH.

TERRACESCAPE and Sustainolive engagement with local farmers and STONEWALLSFORLIFE's collaboration with stakeholders underscore the value of community-driven initiatives in preserving and revitalizing traditional practices. For example, in the STONEWALLSFORLIFE project, training and engaging community members in the restoration of drystone walls not only ensured that the solutions were tailored to local conditions but also fostered a sense of ownership and commitment. Sustainolive's workshops and field demonstrations provided practical knowledge exchange, empowering farmers to adopt sustainable practices tailored to their specific needs.

Similarly, the Rainwatch project's real-time monitoring system was developed in close collaboration with local institutions, which ensured that the technology met user needs and facilitated its integration into agricultural practices. Co-creation throughout the R&I lifecycle, from initial design to implementation and dissemination, ensures that outputs are not only innovative but also fitting within existing institutional and community frameworks. Aligning R&I outputs with local needs and conditions is essential for maximizing adoption and sustainability. The Rainwatch project's real-time rainfall monitoring system, for example, was designed with the practical needs of Sahelian farmers in mind, ensuring that the R&I outcomes were user-friendly and integrable into existing agricultural practices.

In summary, the adaptation of intangible cultural heritage to cli-

mate change involves a multifaceted approach that integrates policy innovation, research advancements, and community engagement. The insights from Green Heritage and SD-WISHEES illustrate that while the challenges are substantial, the potential benefits are profound. By recognizing and harnessing the resilience embedded in cultural practices, we can enhance both the preservation of heritage and the capacity of communities to adapt to a changing climate. Moving forward, it is crucial to continue supporting research and policy initiatives that address the complexities of ICH and climate change, ensuring that cultural heritage remains a cornerstone of sustainable and resilient futures.

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