sustainability

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Enhancing Resilience of Cultural Heritage in Historical Areas: A Collection of Good Practices

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Abstract: Although the need to protect and draw upon the various benefits of heritage as an asset for resilience is nowadays more clearly highlighted than in the past, policies to protect heritage from disaster risk remain fragmented, while the importance of learning from heritage and existing knowledge for building resilience is underestimated. The aim of this study is to provide an insight on good practices dealing with cultural heritage when it comes to disaster risk management and climate change adaptation, aiming at increasing cultural heritage resilience of historical areas. To this aim, the paper applies the best practice research methodology for investigating cultural heritage resilience in historical areas through the codification and analysis of good practices collected from EU-funded projects. The results consist of more than 90 good practices reviewed and analyzed according to a set of criteria. The research findings, organized according to three main categories (i.e., institutional, structural/physical, social), contribute to emphasizing the importance of improving knowledge from already available good practices. Two main approaches have been highlighted in the discussion, according to the key role assigned to stakeholders, education, data, and technology. The results allow to take advantage of existing knowledge to support communities to increase resilience of cultural heritage in historical areas.

Keywords: historical area; resilience; cultural heritage; disaster risk management; good practice; EU-funded project

Citation: Santangelo, A.; Melandri, E.; Marzani, G.; Tondelli, S.; Ugolini, A. Enhancing Resilience of Cultural Heritage in Historical Areas: A Collection of Good Practices. *Sustainability* **2022**, *14*, 5171. https://doi.org/10.3390/su14095171

Academic Editors: Leire Garmendia, Alessandra Gandini and Gemma Garcia Blanco

Received: 28 March 2022
Accepted: 22 April 2022
Published: 25 April 2022

1. Introduction

Disaster risk reduction and climate change adaptation have become global priorities [1] closely interrelated with sustainability: disasters, many of which are exacerbated or triggered by climate change and are increasing in frequency and intensity, significantly limit the progress towards sustainable development [2]. The need for more closely aligned policies on disasters, climate change, sustainable development, and the environment is well known [3]. Nevertheless, most adaptation and mitigation policies are approached singularly, thus limiting the potential for synergies and minimizing trade-offs across adaptation and mitigation actions [4]. Moreover, disasters impact on such a wide scale that there is a need for cooperation and coordination that goes beyond geographical and institutional boundaries [5].

The United Nations Member States have formulated in 2015 the Sendai Framework for Disaster Risk Reduction (SFDRR) [2], a voluntary and non-binding agreement that recognizes the primary role of the national level in disaster risk reduction, while also acknowledging that the responsibility should be shared with other key stakeholders, including local governments and the private sector. It embeds guidelines to enhance government's policies for disaster risk management and reduction by improving prevention and reducing local vulnerability. Moreover, the SFDRR draws the attention of national and worldwide policy makers to the relations between cultural heritage protection and territorial resilience [6]. It is well recognized, indeed, that the cultural heritage sector has the potential to significantly contribute to increasing resilience to climate change [2,7,8]. In fact, despite being itself affected by climate change, cultural heritage should be considered as an irreplaceable source of knowledge to fight its impacts [9].

However, there is a need for frameworks, methods, and tools that provide better support to decision makers for identifying the most feasible climate change adaptation and disaster risk reduction measures [10,11]. On the one hand, although the SFDRR has been an important milestone for framing resilience at international level, the implementation and operationalization of governments' policies for disaster risk management and reduction remains limited [12]. On the other hand, despite research and policy guidance for managing cultural heritage under changing climate conditions has been incrementally increasing during the past decade [13–15], policies and planning tools still lack the adoption of a cross-domain approach and, in particular, policies to protect cultural heritage from natural and anthropic risks remain fragmented [16].

The principal argument of this research is that the importance of learning from traditional as well as innovative good practices and knowledge for building resilience appear underestimated [15]. Sharing good practices is believed to have a key role to empower the public authorities to act for reducing disaster risk and managing it while promoting policy coherence and aligning planning instruments. Good practices have the main and important role to clearly connect research with practice [17].

By acknowledging the need to enhance the integration of cultural heritage into the wider framework of sustainable development, this paper builds on already established European good practices that assume cultural heritage as a driver for boosting the resilience of historic areas. To this aim, the paper applies the best practice research methodology for investigating cultural heritage resilience in historical areas through the codification and analysis of existing good practices (GPs) collected from EU-funded projects to identify research trends and gaps for future studies. This research has been conducted as part of the H2020 SHELTER project, which aims to establish cross-scale, multidimensional, data-driven, and community-based operational knowledge framework for heritage-led and conservation-friendly resilience enhancement and sustainable reconstruction of historical areas, to cope with climate change and natural hazards.

2. Literature Review

Disaster risk management and climate change adaptation strategies share common approaches and methodologies around the three concepts of vulnerability, resilience, and adaptive capacity [18,19], where the adaptive capacity can be defined as the ability of a system to modify its behavior to better cope with changes of its living environment, therefore moving from potential to feasible adaptation [20].

Although certain aspects and materials of cultural heritage have survived over the past centuries, it is likely that cultural heritage may experience more severe climate change impacts in the coming decades [4] and may not sustain management actions implemented to adapt to the previous types of impacts [21]. Climate change influences disaster risk management of cultural heritage by modifying climatic and non-climatic factors that contribute to the vulnerability of cultural assets [13]. The concept of vulnerability has been defined for a long time as the interaction of both sensitivity and exposure [22]. It is the state of susceptibility to harm from exposure to stresses [23], the inherent aptitude to suffer a certain degree of damage in the presence of an assigned level of dangerousness, and it is based on the asset characteristics. However, in the last few years, an updated definition of vulnerability assessment includes also adapting the capacity of policies, environments, and society to the hazards [16,24]. Reducing vulnerability locally is the main and still unattended challenge that can make a difference in the immediate aftermath of a disaster, but also beforehand by preventing damage [6].

Moreover, communities' survival and well-being rely on their capability to face old and new risks [5]. The protection of cultural diversity and the promotion of cultural pluralism are increasingly recognized as enabler of community identity, cohesion, and sense of place, which become particularly important when disasters occur [25]. Furthermore, heritage offers evidence of past societal and environmental changes and provides capacity for learning and transferring traditional knowledge and skills to current socio-economic or environmental contexts and challenges [26,27]. The urgency to consider cultural heritage, after ensuring safety and well-being of people, is well documented and specialists in the heritage sector can have a unique role in supporting communities in post-disaster recovery phase [3].

Further, over the last decade, increasing reference has been made also to resilience in the framework of disaster risk management [28–30]. The importance of resilience is not to return simply to the pre-disaster state, but to be adaptive and to adjust to changing circumstances, collaboratively [3]. Resilience does not only concern the capability of coping with disasters (i.e., instantaneous resilience), but it needs to include the ability to reconstruct and recover quickly (i.e., dynamic resilience) [31]. Moreover, resilience towards extreme events is increasingly acknowledged as a learning process that must consider cultural, social, economic, and environmental dimensions through local knowledge and social memory [32].

As already pointed out by a number of scholars, e.g., [31,33], there is an increasing interest in resilience together with the need to adopt an interdisciplinary approach in assessing cultural heritage and resources. As pointed out by Fatorić and Egberts [25], scholars have recently started to investigate the community and stakeholder groups' perceptions of heritage values or benefits subject to climate changing risks [7]. Climate change threats to cultural heritage are increasingly being studied invoking national and international level responses [25,33]. According to Fatorić and Seekamp [21], barriers to cultural resource adaptation can be grouped according to four dimensions (i.e., institutional, technical, financial, and social barriers), and to increase research on climate adaptation strategies and impacts to cultural heritage characteristics, as well as collaboration among multi-level actors, are among the main needs to overcome the barriers. Other researchers focusing on policies are arguing that changes are needed to those policies addressing the prevention and preparedness phases to disasters, to accommodate various forms and stages of transformation of heritage in an era of climatic change [5,6,16,30,31].

Moreover, collaboration and integration are often addressed as a key to effective response and resilience [3]. Institutional challenges, identified among others as a lack of integration across sectors, are still a recurring issue [34]. Multi-sector partnerships, consisting in collaboration between different private or public agents and institutions, are believed to be able to encourage adaptation to climate change risks [31]. By conducting semi-structured interviews to Cultural Heritage Experts in Europe, Sesana et al. [35] found that increased collaboration between different experts, disciplines, institutions, and countries presents an opportunity to better implement adaptation strategies, while some other authors [27,36] suggest that barriers to the implementation of adaptation measures to cope with climate change can be overcome with adequate resources (e.g., financial resources, technology, know-how), effective communication and information, awareness raising, leadership, and collaborations among multi-level actors. Integrated and iterative risk management will not prevent disasters from occurring. Nevertheless, coordinated efforts and objectives across sectors are critical to reduce their effects [37,38].

3. Materials and Methods

The methodology identified for conducting the research is placed in the framework of the best practice research methodology, as described in [39]. The underlying theory is based on the identification of the reasons why a given practice works in a specific context [17]. The method applied consists in the combination of the content analysis methodology and the systematic literature review, aiming to collect both the explicit and latent data of the identified good practices, as effectively introduced by [40].

The methodology has been intended to address the following two main research questions: (i) what good practices have already been implemented in previous EU-funded projects around the concepts of resilience, disaster risk management and climate change adaptation of cultural heritage? (ii) To what extent can they be exploited in the framework on the H2020 SHELTER project? A systematic review of EU-funded projects was performed from December 2019 until May 2020 to detect the available good practices (GPs) aimed at increasing cultural heritage resilience in historic areas. The review has considered not only the already proven practices, but also the ones in a preliminary definition stage considered promising.

The aim of selecting EU-funded projects as the scope of this research is twofold: on the one hand, due to the wide coverage of EU-funded projects, that might be representative of European diversity and simplify the value recognition of practices applied to similar contexts; on the other hand, projects funded by the European Union after competitive selection are believed to be innovative and up-to-date examples that deserve to be investigated especially when a new project starts, to prevent unnecessary duplication of effort and resources.

Table 1 shows the structure of the repository specifically designed for the collection of the GPs. First, a progressive code was assigned to each of the practices entered to uniquely identify them. In addition, beside the reference field, twenty required fields were identified, grouped in three different categories (i.e., European project key information, main contents, implementation).

Table 1. Structure used for cataloguing the GPs, including main categories and required fields.

Categories	Required Fields
Progressive code	No.
European project key information	Project acronym Project title Funding program Project timeframe Practice relation with the project (i.e., collected and classified by the project; developed and implemented by the project)
Main contents of the GP	Practice name Keywords Necessary conditions for the application Barriers/obstacles to the implementation Good practice brief description Key factors/main objectives Main actions/measures Practice's scale (i.e., building, district, city, region, cross-regional multiscale) Addressed hazard Practice's resilience scope (i.e., cultural, social, economic, environmental, multiscope) Relevance to H2020 SHELTER project (i.e., high, medium, low)
Implementation	Location (if any specific) State-of-art (i.e., already implemented and validated, in progress—promising and inspiring) Main results/evidence after the application of the practice
References	Useful links and resources

The set of criteria used within the research was defined in collaboration with the H2020 SHELTER project consortium, by involving several expertise from different fields of research. Among the set of criteria, the budget allocated for the GP implementation was initially included. However, it turned to be an information rarely available in the documents analyzed to systematize the GP collection. Information related to funds were sometimes available in respect to the whole project and not to the specific GP, therefore they were not considered as relevant in the framework of the conducted observatory.

The methodological approach to collect the available knowledge and to structure the repository consisted of three steps. First, a set of keywords was identified for detecting the information in the EU-funded project databases. Second, the query was performed in each identified database, thus identifying the relevant results related to the addressed topics. Each result was then preliminarily analyzed by screening its summary and/or results-in-brief sections. Lastly, whenever the results were considered potentially relevant for the good practice collection, the project website, the project deliverables related to the GPs and all the available information on lessons learned have been deeply investigated.

The databases used for the research were CLIMAT-adapt Platform (https://climate-adapt.eea.europa.eu (accessed on 2 December 2019)) and CORDIS (https://cordis.europa.eu (accessed on 2 December 2019)). The European Climate Adaptation Platform (CLIMAT-adapt) was launched in 2012 to enhance the sharing of information related to climate change impacts, adaptation strategies and tools to reduce vulnerability. The information stored in the database is not only related to European climate change adaptation research projects but also to national, regional, and urban projects. INTERREG and LIFE projects, as well as national projects on climate change research in Europe, can be accessed through the platform. For research, the database containing the "Case studies" and "Guidance" from the knowledge section was investigated and proven notably useful. The first one contains the main outcomes of the strategies, methodologies, and tools validated in pilot cases. This allowed to identify and collect the practices and lessons learned applied and proven useful at the end of the project's lifetime. For the "Guidance" section, it stores handbooks, operational frameworks, and guidelines developed and shared at the end of the implementation time. Considering the scope of this research, these outcomes were helpful tools to collect strategies already implemented and validated at different scales and, in some cases, already replicated in other areas after the end of the project.

The Community Research and Development Information Service (CORDIS) platform collects information, outcomes, and key deliverables coming from the projects funded by the European Commission. It stores projects documents since 1984, from the first Framework Program (FP1) to H2020 Program. The information and documents retrieved in the platform were found to be less reliable and with knowledge gaps related to projects funded before the mid 1990s. Therefore, it was decided to collect GPs within the timeframe of the last two decades, due to the fact that the results from previous projects would not only have been incomplete, but also potentially outdated. The good practice observatory includes the outcomes of projects funded since the fifth Framework Program (FP5) (1998–2002).

Both platforms enabled filtering the contents by sector of research, addressed target and climate impact. Table 2 summarizes the keywords used for the query. They were defined according to the main topics of this research.

After the first selection of relevant initiatives using the keywords in Table 2, project websites were further consulted. This process allowed to retrieve more detailed information, in particular related to the lessons learned and the replicability of the practices. Whenever the projects did not propose a list of GPs, but rather a systemic methodology composed of several steps, this information was collected, assessed, and, whenever relevant, considered as a single good practice since, as stated in most of the ultimate results of the analyzed projects, one single action would not have served the same purpose if undertaken individually.

Table 2. Keywords used for the query, according to the field of application, the goal, and the hazard addressed.

Main Topic	Related Keywords
Field	Climate change; environment; climate change adaptation; cultural heritage; buildings; coastal areas; urban;
Goal	Disaster risk management; adaptation; historic areas; cultural heritage; natural heritage; disaster risk reduction; water management; resilience; urban resilience; security; monitoring; community engagement; critical infrastructures; early warning system; risk analysis; community; vulnerability; historic building; archaeological area;
Hazard	Heatwave; flood; earthquake; wildfire; storm; subsidence; climate related

4. Results

The list of the GPs collected is included in Appendix A, where information on (i) the GP name, (ii) the EU project acronym, (iii) the EU funding program, (iv) the territorial scale, and (v) the resilience scope is provided, together with the main website used as a reference. As explained in Section 2, Materials and Methods, the information concerning different aspects of each GP has been collected and organized. The codification of the available existing knowledge led to a total of 94 GPs coming from 42 EU-funded projects which were considered relevant—in case already implemented and validated—or promising and inspiring—if in progress, out of a total of 855 records screened and 104 reports sought for retrieval.

The majority of them (59 out of 94) were already validated and demonstrated. For the remaining 35 GPs, was not possible to find complete documentation, either due to the implementation being still in progress, or due to the lack of evidence on the implementation phase, but they have been considered promising and inspiring for the purpose of research by analyzing the preliminary results available in project websites or reports. Figure 1 shows the GPs distribution according to the state-of-art (i.e., already implemented and validated; in progress—promising and inspiring) and the type of hazard addressed.

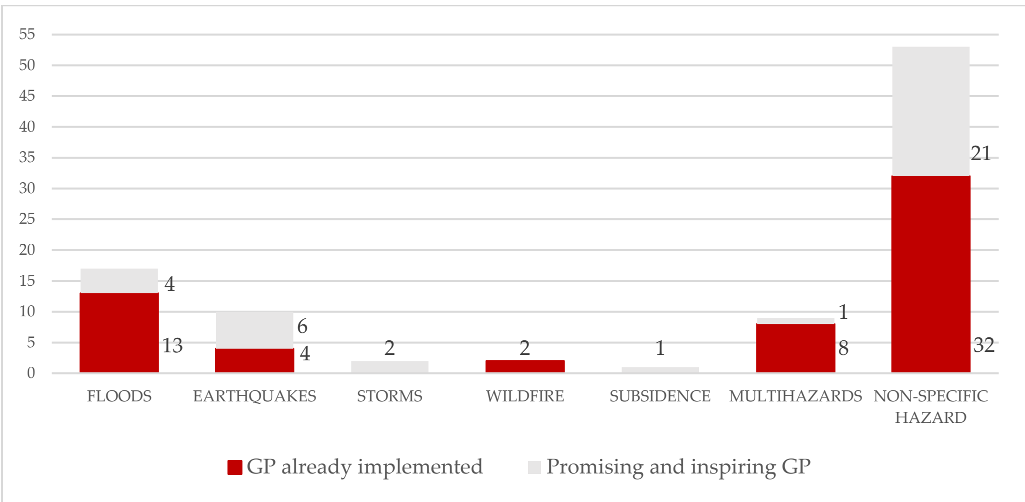

Figure 1. GP distribution according to state-of-the-art and type of hazard addressed.

Concerning the scale, most of the GPs refer to multiple scales, while 58 out of 94 GPs specifically refer to one among building, district, city, region, or cross-regional scale. The distribution is presented in Figure 2.

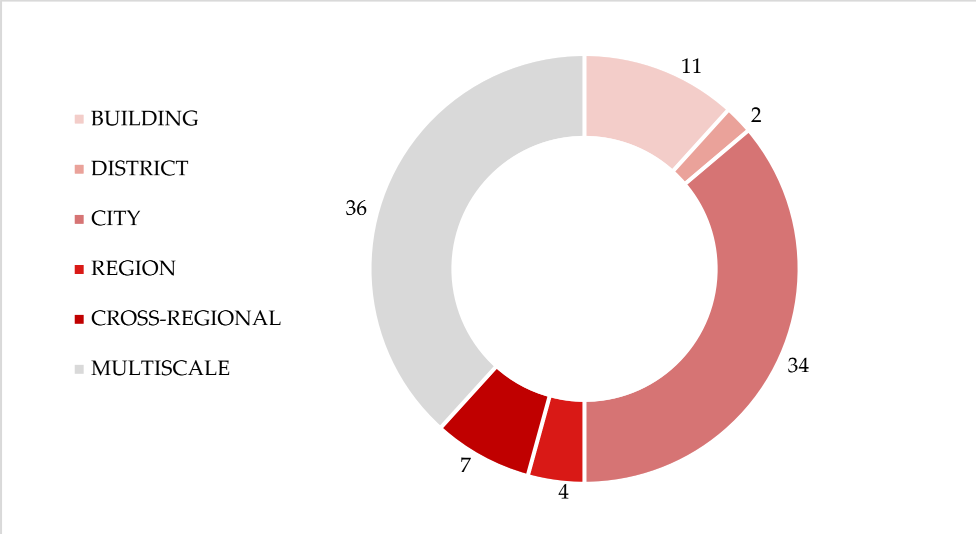

Figure 2. GP distribution according to the scale addressed.

The GP's resilience scope concerns the resilience characteristics to which the collected practices refer. Resilience phenomenon in historical areas is still not effectively approached or even theoretically supported [41,42]. SHELTER project acknowledges that resilience is a multi-faceted aspect, where four main dimensions—cultural, social, environmental, and economic resilience—have been identified and defined in Egusquiza et al. [42]. Ninety-three out of 94 GPs conceive resilience as a multi-scope feature, as they are all related to more than one dimension. There is only one exception, coming from *STORM* project, that deals with the development of ICT platforms and does not specifically address resilience. Therefore, it was excluded from the data presented in Figure 3. The social and the economic resilience scopes are the most prevalent, with the former counting for 76 GPs, and the latter representing the resilience scope addressed by 87 GPs out of 93.

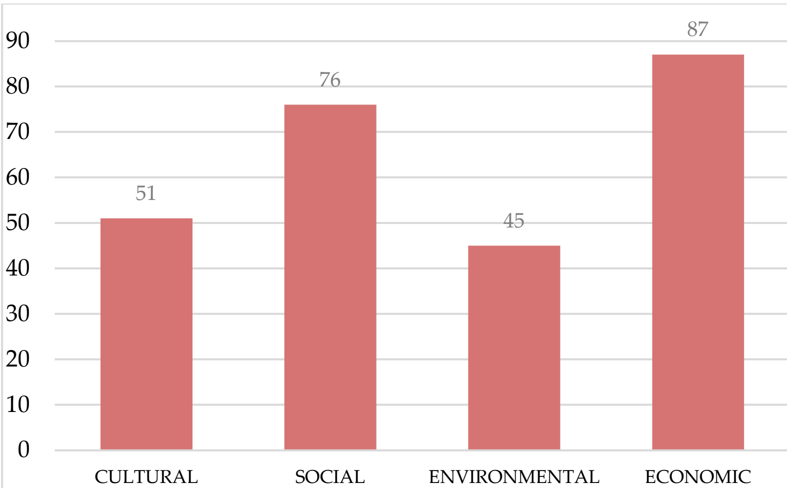

Figure 3. GP distribution according to the resilience scope.

Results are further described in the following sub-sections according to the specific type of hazard addressed by the practice (i.e., heatwave; flood; earthquake; wildfire; storm; subsidence; multi-hazard) and the type of adaptation measures.

The adaptation measures showcased by the GPs refer to three general groups (i.e., institutional, structural/physical, and social) that come from the identification of categories and examples of adaptation options from the Intergovernmental Panel on Climate Change (IPCC) of the United Nations [43], and they are briefly described as follows:

- Institutional measures range from economic instruments (e.g., taxes, subsidies, and insurance arrangements) to policy and tools to support resilience through land use (e.g., protected areas, building codes). Effective governance is important for efficient operations of institutions. In general, governance rests on the promotion of democratic and participatory principles, as well as on ensuring access to information, knowledge, and networking;
- Structural/physical measures highlight adaptation solutions that are discrete, with clear outputs and outcomes that are well defined in scope, space, and time. They include structural and engineering options, the application of discrete technologies, the use of ecosystems and their services to serve adaptation needs;
- Social measures refer to generation and implementation of locally driven adaptation strategies, operating on a learning-by-doing, bottom-up, empowerment paradigm that cuts across sectors and technological, social, and institutional processes.

4.1. Clustering Good Practices According to the Specific Hazard Addressed

Analyzing the GP collection by considering the addressed hazards gives a picture of which phenomena are the most investigated within the framework of EU projects in the fields of disaster risk management and climate change adaptation in cultural heritage. The results show that 17 out of 33 GPs addressing one specific hazard only focus on floods, 11 are related to earthquakes and 2 GPs have been found for both storms and wildfire. One GP only has been collected for subsidence. The GP distribution according to the hazard addressed, the project acronym and the prevalent category is included in Table 3.

Table 3. Summary of good practices clustered according to the specific hazard, listed in project alphabetic order.

Hazard	Project	Institutional	Structural/Physical	Social
Floods	BASE	●	● ● ●	●
	COREPOINT	●		
	CORFU	●		
	EPI-WATER		●	
	Flood ProBe		● ● ● ●	
	FRAMAB		○	
	PERICLES	●		
	ProteCH2save		○ ○	
	STAR-FLOOD	○		
Earthquake	APAME		○	
	LESSLOSS		●	
	NIKER		○ ○ ○ ○ ● ●	
	PERPETUATE		●	
	PROHITECH		○	
	SMR			●
Storm	ProteCHt2save		○ ○	
Wildfire	CALCHAS		●	
	ProteCHt2save		●	
Subsidence	SUBCOAST		○	

Legend: ● GP already implemented ○ Promising and inspiring GP.

4.1.1. Floods-Related Good Practices

Floods are intended to be the overflowing of the normal confines of a stream or other bodies of water, or the accumulation of water over areas that are normally not submerged [44]. Seventeen GPs related to floods have been collected, related to 9 EU projects. Among them, 5 GPs can be listed as institutional measures. The assessment of maturity level of flood risk management framework from *CORFU* project deals with assessing the preparation of stakeholders, as well as the cooperation and integration of risk awareness in the urban system. Concerning spatial planning, rethinking urban planning tools to include the adaptation measures with specific budget allocated to the adaptation Plan has been proposed by *BASE* project. *STAR-FLOOD* project has foreseen the obligation to keep under control the paved and impervious land surfaces by including in spatial planning tools specific flood-proof measures for flood-prone areas. Moreover, *PERICLES* project has identified the integration of cultural heritage in coastal and maritime policies as a good practice. Lastly, integrated coastal management strategy has been identified within *COREPOINT* project that underlines the importance of the establishment of a strategic alliance between the local authority and multidisciplinary academic experts.

When it comes to structural/physical measures, *BASE* project deals with the design and the implementation of mobile or fixed barriers and pumping systems and safety valves, depending on the characteristic and the location of the areas to be protected by floods. Barriers are also identified as good practice in the protection of areas located near to river basin by *ProteCH2save* project, while *EPI-WATER* project proposes to turn agricultural land in a temporary flood water storage to divert flooding and protect urban areas. Physical and mathematical models to study the behavior of floods are proposed in *ProteCHt2save* project, while the assessment of the reliability of flood defense systems and the development of an assessment methodology to identify the vulnerability of critical infrastructures is part of *Flood ProBe* project. The latter offers two additional GPs, consisting in the development of storyline methods and risk assessment tools, as instruments to analyze the phenomenon and the consequences of a flood on critical infrastructure in order to define what can be done to prevent damages. A flood risk assessment framework has been also developed within *FRAMAB* project which contributes to the preservation of cultural heritage supporting decision makers in mitigating the flood risk of infrastructural systems and prioritizing retrofitting interventions.

Participatory process to implement coastal flood defense strategy from *BASE* project represents the only good practice under the social category, dealing with increasing awareness of stakeholders and involving citizens and institutions in the management of water-related risk.

4.1.2. Earthquake-Related Good Practices

Earthquakes are catastrophic unpredictable events that may cause losses in terms of human lives and built heritage. The GPs embedded in EU-funded projects mostly concern the building scale and focus on increasing the knowledge of the practitioners in the construction sector in order to understand the seismic behavior of buildings and to implement suitable prevention measures.

No GPs has been found for the institutional category, while one only can be listed among social measures. The European Resilience Management Guideline, an operational framework developed by *SMR* project, aims at training and supporting municipalities and relevant stakeholders in implementing an integrated management process that enhances city resilience.

Among the structural/physical measures, more than a half of the GPs have been extracted from *NIKER* project, either as developed within the framework of the project or collected and classified by the project. Most of them deals with the diagnostic phase. They mainly consist of the implementation of structural analysis based on numerical models to preliminary assess the structural behavior of buildings and in the identification of a monitoring system that uses a numerical model to interpret the results starting from the detection of changes in the structure. Another seismic assessment-based method consists in the use of the capacity spectrum combined with kinematic or pushover limit analysis. Another diagnosis-related good practice has been found in *PERPETUATE* project, in which a displacement-based approach is used to assess the vulnerability of the cultural heritage. The method allows to understand if an existing building is able to fulfil selected performance levels in case of occurrence of an earthquake with defined characteristics based on annual rate of exceedance or returning period. In addition, *LESSLOSS* and *APAME* projects provide a broader perspective with two GPs focused on simulation of earthquake scenarios focusing on region and city scale. When it comes to the field of intervention techniques, *PROHITECH* project works towards the improvement of seismic performance of building using reversible mixed technologies, by exploiting the peculiarities of innovative materials and special devices, allowing ease of removal if necessary. Lastly, punctual periodical inspections and the use of recording systems are identified as good practice by *NIKER* project since they may contribute to the identification of variations in the response of the structure caused by increasing damage. The effect of possible interventions such as deep repointing or injections may be also evaluated by applying convenient inspection techniques before and after the intervention.

4.1.3. Storms-Related Good Practices

Storms are extreme meteorological events characterized by heavy precipitations and wind events that may cause huge losses to property and environment and have negative impact on human safety and infrastructure. Two GPs only have been identified specifically addressing storms, both belonging to *ProteCHt2save* project and covering the structural/physical category. The design and implementation of adequate drainage systems can contribute to the protection of the whole city with drain pits added to the drainage system in order to stop the flowing of water downhill. New systems, or parts of them, should be carefully designed for the new increased rain loads, in case the existing system is deemed not sufficient. At building scale, investigating the performance of original or altered building materials and component (e.g., wall assemblies) undergoing heavy rain situations and the combination with other environmental and intrinsic factors (e.g., temperature, salts, damage to building component etc.) allow the definition of the possible interventions to tackle with the excessive rain penetration improving the resilience of cultural heritage assets. To put in practice these two actions, detailed data on water behavior are needed together with punctual information about the building and the area of interest for the implementation of the interventions.

4.1.4. Wildfire-Related Good Practices

Two GPs were gathered concerning wildfires, both classified as structural/physical measures. The first one was collected within *ProteCHt2save* project and it is related to the protection of cultural heritage through the installation on buildings of fire-fighting devices such as tools on roof ridges or on cornices, dry sprinkler systems, copper pipes with hidden joints, whenever such installation does not harm the heritage value and characteristics. The second one belongs to *CALCHAS* project and focuses on the regional scale, with the development of an integrated forest fire analysis system to know when environmental conditions are favorable for fire development; it is also capable of estimating the evolution of a wild forest fire creating different scenarios aiming at exploring personnel training purposes and planning the necessary fire conservancy infrastructures (e.g., fire monitoring stations, firebreak zones, water tanks).

4.1.5. Subsidence-Related Good Practices

Subsidence is intended as the gradual settling of the ground surface due to natural or anthropogenic circumstances (i.e., groundwater pumping, drainage of organic soils, gas extractions) with possible negative effects and damages to buildings and infrastructures, an increased flood risk in low-lying areas, and possible damage to groundwater aquifers and aquatic ecosystems. As the phenomenon is continuous with long-term effects, monitoring the phenomenon is relevant to understand the hazard trend and to predict the possible consequences. A good practice has been identified as part of *SUBCOAST* project. It has implemented a methodology to assess the impact of subsidence on flood risk and to monitor the integrity of coastal barrier systems. This subsidence hazard forecast service is intended as an expansion of Copernicus service, and it helps flood-risk practitioners to accurately estimate subsidence rates.

4.1.6. Multihazard-Related Good Practices

Eight GPs have been identified as dealing with more than one hazard, as summarized in Table 4 according to the project acronym and the prevalent category. They have been developed by 7 EU-projects, all funded by either FP7 or H2020 programs.

Table 4. Summary of good practices clustered according to the type of hazards addressed, listed in project alphabetic order.

Project	Hazards Addressed	Institutional	Structural/Physical	Social
beAWARE	Wildfires, heatwaves, and floods			✔
BASE	Floods and storms	✔		
CIRCLE-2	Wildfires and heatwaves			✔ ✔
EU-CIRCLE	Wildfires, heatwaves, and floods		✔	
FIRESENSE	Wildfires and heatwaves			✔
KULTURisk	Floods and storms	✔		
PUCS	Floods and storms		✓	

Legend: ✔ GP already implemented; ✓ Promising and inspiring GP.

By addressing wildfires, heatwaves, and floods, *beAWARE* project focuses on social measures such as training and pilots set up, to teach stakeholders and managers of cultural heritage areas how to deal with a disaster event. The trainings focus on the use of the tools and methodology developed within the project, based on the establishment of key roles of the stakeholders and managers in all the disaster risk management phases. Focusing on the same three hazards and category, *EU-CIRCLE* project develops the so called "Critical Infrastructure Resilience Platform", a structural/physical measure to visualize the projected changes of climate variables over the critical infrastructure network, to gain a better understanding of the potential impacts of climate change. To create the platform, a risk analysis should be performed, and useful indicators need to be selected. Furthermore, wildfires and heatwaves are addressed through social measures by *FIRESENSE* project, to increase the resilience of areas of archaeological and cultural interest by using a network of multisensors for early warning. The control center implemented by the project can generate automatic warning signals for smoke/flame detection and abrupt temperature rise. Moreover, by reading weather data from official meteorological services as well as from local weather stations, this good practice can also issue alerts in case of extreme weather conditions. The same two hazards (i.e., wildfires and heatwaves) are addressed by two GPs collected in the framework of *CIRCLE-2* project. While the first one deals again with early warning systems, the second one is about increasing awareness among citizens by sending alerts through different channels (e.g., social media, municipality homepage, mail delivery; tv news), using a mix of soft measures to predict the events and inform the population of the alerts.

When it comes to integrated water-related hazards, such as floods and storms, GPs can be found from *BASE*, *KULTURisk* and *PUCS* projects. The Cloudburst Management Plan coming from *BASE* project follows under the institutional category. This good practice builds on a detailed socio-economic assessment to ascertain whether cloudburst and stormwater management can pay off for society as a whole, aiming at reducing the impacts of fluvial flooding due to heavy rains. The plan includes some concrete measures (e.g., the creation of stormwater roads and pipes that transport water towards lakes and the harbor, detention roads and areas for storing waters, green roads to detain and hold back water in smaller side streets). *KULTURisk* project promotes improved policies to deal with uncertain information from early warning systems that may activate alerts (e.g., in flood prone areas) although no disaster occurs. Targeted policies should take into consideration actions to be performed in case of uncertain information. Lastly, *PUCS* project develops a web-based tool to help city planning drawing maps that include detailed locations and characteristics of the flooded zones, socio-economic consequences, impacts on traffic infrastructure, and associated disaster emergency planning needs with the aim to predict changes in the frequency of extreme rain, storms, and pluvial floods.

4.2. Good Practices Addressing Non-Specific Hazards

The GPs belonging to this category do not specifically refer to one or more specific hazards. They rather focus on various causes and consequences of climate change as part of a multi-faced phenomenon. In total, 53 GPs have been collected coming from 24 EU-funded projects. Table 5 shows the GPs distribution according to the project acronym and the category.

Table 5. Summary of good practices clustered according to good practice category, listed in project alphabetic order.

Project	Institutional	Structural/Physical	Social
CARISMAND			○ ○ ● ● ●
Clim-ATIC			●
CLIMAbiz		●	
DERRIS	●		
EFFESUS		○	
EMPOWER	●		
ENHANCE	●	●	
ESPREssO	○ ○ ○		○ ○ ○ ○
EU-CIRCLE		●	
Flood ProBe		●	
HERACLES		●	
HERICOAST			●
KULTURisk			● ● ●
I-REACT			●
IDEal RESCUE		○	
NOAHS ARK		○	
PLACARD	○ ○ ● ● ● ● ●		● ● ● ○
ProteCHt2save		○	
PUCS		○	
RESIN	●		
RESCCUE		●	
RESILENS		○	
STORM	○ ○ ○	●	● ●
SWARE	●		●

Legend: ● GP already implemented; ○ Promising and inspiring GP.

4.2.1. Good Practices Falling under Institutional Measures

GPs under this adaptation measure category mainly refer to explore innovative financing instruments, to address governance and cooperation among different institutions, and to improve planning instruments, especially in the field of urban planning.

Encouraging the use of innovative financing instruments at various scale is the aim of *PLACARD* project, where the integration of climate finance and risk transfer mechanism in policies are implemented to boost immediate post event actions. *EMPOWER* project deals with green bonds to finance climate-friendly investment projects. Moreover, *ESPREssO* project demonstrated that effective risk reduction investments can reduce the economic losses caused by disasters, as well as shifts in investment strategies can benefit the local/regional economy, even before the disaster. In the framework of *DERRIS* project instead, insurance companies have been identified as important actors to support climate adaptation action in small and medium size enterprises including their risk assessment expertise to disaster risk management process. Specific tools and instruments for small medium enterprises and municipalities have been provided to increase their risk awareness and build the resilience of industrial districts.

When it comes to governance and cooperation among different institutions, *PLACARD* project collected six GPs concerning the improvement of collaboration between actors from climate change adaptation and disaster risk reduction fields. In particular, they concern: the development of transnational and interregional collaboration with a joint focus on current and future risks; the use of social network analysis for the identification of the key actors and for strengthening their interactions; fostering dialogue and learning on monitoring, reporting and evaluation through a better coordination of the relevant actions and processes, a more effective use of resources and a stronger collaboration among actors operating in the different domains; the designation of climate-risk councils at different governance levels, therefore leading to the development of targeted policies; the promotion of cross-sectorial collaboration for tailoring climate-related risk measures from the upper territorial levels to the local administrative level, by also including a wide range of private actors; and lastly, the development of integrated training courses within organizations or across institutions.

Additional GPs have been collected aiming at improving governance and cooperation. *ENHANCE* project developed a multi-sector partnership that involves a mix of partners from the public and private sectors and civil society organizations to reduce the risk from natural hazards. *ESPREssO* project identified those partners to bridge the knowledge gap between science and policy. Indeed, to promote knowledge exchange, the project also creates frameworks and platforms available to all the actors in all phases of disaster risk management, providing incentive schemes for sharing information, if necessary. Within the same project, identifying and ensuring the necessary expertise, equipment, and other forms of capacities within public institutions for implementing disaster risk governance can help in identifying possible gaps in the roles necessary for disaster risk reduction. When it comes to increase cooperation among governmental institutions and among stakeholders and private sectors, *STORM* project offers two GPs. The first one aims at ensuring the cooperation between civil protection/emergency sector and cultural heritage sector by including and adequately developing it in national policies. The second good practice aims at implementing interdisciplinary disaster risk management programs at site level. It consists of a methodology to define and promote the common framework and vision that should ultimately preside over heritage management decisions in each governance level.

Lastly, there are several GPs dealing with urban planning tools, management strategies and maintenance plans. *PLACARD* project developed a methodology for conducting the vulnerability assessment of urban areas, providing valuable input for climate change adaptation plans. *RESIN* project promoted the adoption of nature-based solutions within urban planning tools to strengthen ecosystem-based adaptation and risk reduction. Furthermore, guidelines have been developed in *STORM* project to draft maintenance plans for conservation intervention, to be made available to authorities and skilled staff in the realization of the conservation interventions, while *SWARE* project adopted data gathering as a good practice for collecting a data baseline for the natural and built heritage management strategies.

4.2.2. Good Practices Falling under Structural/Physical Measures

The following GPs mainly address the need of monitoring hazards, urban resilience and assessing climate-related risks. To do so, software-based initiatives and online tools have been developed.

More than one project developed tools and ICT platforms that can support both monitoring and assessment activities while also informing governance and planning. *ProteCHt2save* and *HERACLES* projects developed and applied respectively mobile devices and an ICT platform with the aim to map and identify cultural heritage assets at risk by collecting a large amount of data in the field of risk evaluation and management. Data collection also allowed them to draft guidelines to be used in case of disasters. Within *STORM* project, the use of digital tools and ICT platform have been used to improve accuracy of data and to serve as a collaborative network, used in all phases of disaster risk management. Moreover, to increase resilience of cultural heritage through software-based initiatives, two GPs have been gathered from *PUCS* and *EFFESUS* project. The former, called "World Heritage Service", uses a combination of scientific data and methods to produce quantitative maps available through an online platform that keeps site managers, tourist organizations and emergency services informed about the occurrence patterns and impacts of extreme weather events. The latter consists of a web-based decision support system with the main aim of helping managers to prioritize sustainable retrofitting measure to improve the energy performance of historical districts. *CLIMAbiz* project also developed special computational models to estimate the costs of climate change-related impact for businesses and the costs of their adaptation practices.

As for monitoring and assessing, *RESCCUE* projects developed a resilience assessment framework which enables to highlight the current resilience of cities and the urban functions to climate change, identifying also the most critical aspects to be improved. A climate change risk assessment methodology has been developed by *EU-CIRCLE* project for assessing the risk for critical infrastructures in different steps, starting from understanding each organization's assets and operations, up to the definition of climatic thresholds for each asset. Moreover, *ENHANCE* project developed an agent-based model to simulate the climate-related risks and assess their effect. This model can be used to characterize different stakeholders towards a risk sharing arrangement. Moving from the risk management to the adaptive capacity of a system, *RESILENS* project develops the resilience management matrix and audit toolkit to achieve a holistic resilience measurement and management, which assumes a dual function, both as a diagnostic tool and as a tool for assessing the effectiveness of measures to support and improve the systems resilience.

Focusing on the preparedness phase, an advanced analysis tool has been developed by *Flood ProBe* project aiming at defining the interdependencies of infrastructure network after a disaster occurs, to design possible failure scenarios. Different scenarios are developed also in the framework of *NOAHS ARK* project, where a vulnerability atlas for Europe has been set and the effectiveness of various strategies can be predicted according to foreseen scenarios. PEOPLES resilience frameworks [45] are instead developed within *IDEal RESCUE* project and they consist of quantitative and qualitative models to measure the disaster resilience of communities in terms of capital assets such as hospitals and health care facilities.

4.2.3. Good Practices Falling under the Social Measures

Good practices that can impact on the social sphere largely make use of ICT to raise awareness of citizens and to involve the wider population in the disaster risk management process. To do so, the GPs focus on setting early warning systems able to warn the population at risk, on improving skills and knowledge of practitioners in various fields, and to develop communication strategies able to make risk reduction and preparedness attractive to citizens.

Dedicated alert apps and drones for alerts have been applied by *CARISMAND* project to engage the community, encouraging citizens to be part of the preparedness phase and to help in the emergency one. Phone-based early warning system has been developed in *Clim-ATIC* project, to inform the public, to provide guidance on the precautions to take, and to improve efficiency in evacuations. The use of targeted mobile apps and social media have been highlighted also by *I-REACT* project to improve the effectiveness of emergency phase. The app allows citizens to report events, and to receive information during the emergency. To involve as many people as possible in the system, the application features several fun quizzes and an award program. *KULTURisk* project focused on delivering information easy to understand by stakeholders, as the basis to support decision-making. The early warning messages should be received by many different recipients such as civil protection, managers of the cultural heritage areas, security bodies, and through different channels (e.g., SMS, emails, ring alerts). In addition, stakeholders and providers are encouraged to work together to define an effective strategy to use information from early warning system to guarantee a unique and easy information to the users. Lastly, a proper communication should be ensured between early warning system providers and stakeholders to allow the latter to understand how early warning systems work.

Promoting a systematic process for sharing data, information and knowledge for climate change adaptation and disaster risk reduction is at the basis of *PLACARD* project that developed guidelines to support a cultural shift. Moreover, it developed a knowledge platform intended as a connector of people and knowledge, forum for peer-learning, dialogue and exchange across climate change adaptation and disaster risk reduction domains. Lastly, joint emergency exercises are suggested by *PLACARD* project to strengthen collaboration on various levels among different actors. According to *ESPREssO* project, mapping the field of relevant actors helps in making clear with whom it is relevant to share knowledge and information, and it helps making clear roles and responsibilities without wasting resources and time. Moreover, engaging processes for stakeholder's involvement and cooperation contributes to promote their inclusion and engagement towards disaster risk reduction. Lastly, by considering the cooperation not only among institutions, but also among private and public sectors, *SWARE* project developed a public-private participatory policy-making model aimed at increasing public awareness of the studied areas.

Crowdsourcing information through web search, mobile apps and social media is applied by *CARISMAND* project. Indeed, it allows the systems to locate an event though people searching information about it; damage assessment can be crowdsourced as technologies allow having a direct contact with communities on the ground who can comment about the extent of the damages. By addressing citizens, *CARISMAND* project also collected two GPs aiming at raising public awareness and sharing information; firstly, the project aimed at making risk reduction preparedness attractive to citizens investigating several facets, such as the contents, their form, and the platform where they are displayed. Videos, spots, humor communications and visual contents can help in raising public interest on the strategies to protect cultural heritage assets. Secondly, to set an effective communication strategy through social media and technology in advance is also presented in the project as a good practice, where locals' cultural use of technology, legal framework, risk culture and language issues must be considered. Furthermore, *HERICOAST* project suggested to use the storytelling of maritime history through films, photos, and text, with stories linked to their geographical position with digital maps.

Moving to measures to improve skills, *STORM* project developed two GPs consisting in planning of drills for involved stakeholders and disaster risk management training courses for both practitioners and other workers involved in cultural heritage management. The former conceives drills as a key for the success of emergency plans, first aid actions on cultural heritage and assessment of the cooperation between the stakeholders involved. The latter consists in training programs to protect cultural heritage targeted to practitioners in various fields (e.g., heritage site managers, disaster managers, climatology experts), civil servants and residents, as all these figures are considered key actors in the field of disaster risk management and climate change adaptation.

5. Discussion

The research allowed collecting existing knowledge and operationalizing it to increase cultural heritage resilience of historical areas. This section aims at discussing the solutions coming out from the GPs investigation, by depicting the main trends and gaps.

After the review of the collected practices, the areas for which solutions are already available and those where gaps still exist have been clarified. However, it is worth to highlight that GPs cannot be easily transposed from one situation to another [17], and good practices should not be intended as unique solutions. The applicability, replicability, as well as the timeframe in which they have been considered a valid approach are fundamental components to be further investigated.

In this investigation, the gathering of the necessary conditions for the implementation of the GPs and the encountered (or foreseen) obstacles allowed a first assessment of the potential challenges for their replicability. A deep knowledge of the case study areas investigated, including the availability of risk maps, historical data, and monitoring data, resulted to be one of the necessary preconditions to most of the GPs collected. The availability of resources and skilled staff turned to be not only the most common necessary condition for the GP implementation, but also the most prominent barrier for the long-lasting maintenance of the good practice, as also pointed out by [27,36]. Among others, the long-term maintenance of structural/physical practices (e.g., flood barriers, monitoring networks) and of platforms, tools, apps developed within the projects are among the most frequently identified obstacles for the application of the GPs.

Looking at the knowledge collected from the spatial scale, most of the GP clearly acknowledged the need of adopting a strategic perspective to support adaptation responses that require a broader spatial perspective to be taken, as for [46]. Multi-scale and city scale are by far the most prevalent, confirming the emerging challenge of local government to adopt policy instruments and planning tools to effectively manage all the disaster risk management phases while steering the urban and territorial transformation process [47].

Similar to Hirsenberger et al. [48], the GP collection contributed not only to highlight the highly contextual factor of challenges and opportunities, but also the useful insights that come from collaborative projects in multidisciplinary settings such as the EU-funded projects. Horizon 2020 followed by the Seventh Program Framework (FP7) turned to be the most successful funding programs in terms of GP availability, confirming that climate change adaptation and disaster risk reduction measures applied to historical areas and cultural heritage have gained increasing attention in the last decade [2,7,8], and call for an international level response and a multi-disciplinary approach [27,31,33,35].

Throughout the knowledge collected, two main trends have emerged. On the one hand, gathering data and testing new technologies have driven largely most of the practices. On the other hand, many projects acknowledge the need of improving existing collaborations among stakeholders, to ensure they develop advanced skills to deal with climate change and its consequences on cultural heritage, and that citizens are not left apart from this process of conservation and valorization of cultural heritage assets. The two main trends are discussed below together with the most evident gaps identified.

5.1. Data- and Technology-Driven Approach

The data-driven approach relies on data collection, analysis, and interpretation to support strategic decisions. As highlighted above, several GPs invested on data gathering for e.g., the realization of risk maps, also with the help of simulation numerical models. These tools help authorities to identify high-risk areas, critical infrastructure network interdependencies and to build for different scenarios in relation to the scale of the event and to prepare for them. On the contrary, to collect historical data through archives, in-dept surveys of the cultural heritage assets and local stories is a practice that remains underapplied, although the in-depth investigation and monitoring of the physical and structural characteristics of cultural heritage asset is widely recognized to be at the basis of cultural heritage preservation and conservation [49–51]. One practice only (i.e., *ProteCHt2save*) made explicit the need of collecting punctual information about the buildings and the area of interest for the implementation of the interventions. The data-driven approach that emerged from the current GPs underestimates the importance of understanding the construction history and modifications of the cultural heritage assets, and this should be highlighted as a shortcoming.

Testing and promoting the use of web-based platforms and social media was found also largely applied by many projects, not only for improving the way the stakeholders operate, but also to include citizens in the process and to raise awareness of the risks for each area. This approach was also proven valid in the response and recovery phases in some of the research projects analyzed. For instance, quite a number of GPs applied early warning systems that involved the affected population. Bearing in mind that many citizens can be reached thanks to these technologies, it has emerged the need to make the cultural heritage site managers and public authorities ready to use them as much as possible and to include them in the city management plans.

Likewise, the importance of exploiting new technologies has proved to be a winning factor in previous EU projects in the fields where these solutions have been tested, both as an institution-citizen exchange and vice versa.

5.2. Stakeholder Engagement- and Education-Driven Approach

Many investigated GPs rely on the need to identify all the stakeholders that should be engaged to successfully address disaster risk management and climate change adaptation of cultural heritage. Indeed, it has turned to be fundamental to get on board all the actors and to define the key role that each one brings to the overall process [35]. This has to be done periodically, to make sure to get the most updated picture and to outline new possible tools and expertise available. This is essential to do not waste time and resources in all the disaster risk management phases.

Improving governance and planning at different territorial scales (i.e., from national to local) has been identified as a milestone in many GPs, to improve the preparedness phase, but also in case of emergency [47]. The collection highlighted the need to actively involve both public and private bodies in the process of fighting climate-related hazards. Furthermore, undertaking agreements with universities and scientific experts would ensure the key expertise are taken into account.

The inclusion of several expertise resulted also one of the main trends. Similar to De Masi et al. [52], the analysis performed highlights the importance of interdisciplinary collaborations. A stronger involvement of experts from social sciences and humanities may ensure that historical considerations are properly addressed. The analysis of historical testimonies can provide knowledge on how human beings have already survived to natural disasters, while anthropologists may help in drafting adaptation strategies.

6. Conclusions, Limitations, and Research Implications

This research provides insights on how to increase cultural heritage resilience of historical areas through a showcase for good practices that deal with cultural heritage, disaster risk management and climate change adaptation. To this aim, the paper applies the best practice research methodology combining content analysis methodology and the systematic literature review for investigating cultural heritage resilience in historical areas through the collection and analysis of good practices from EU-funded projects.

The results consist of 94 good practices reviewed and analyzed according to a set of criteria. The research findings have been described according to the specific type of hazard addressed by the practice (i.e., heatwave; flood; earthquake; wildfire; storm; subsidence;

multi-hazard) and three main categories referring to the cluster the adaptation measures belong to (i.e., institutional; structural/physical; social).

Some research limitations must be acknowledged. First, a limited list of hazards has been considered in this research. The selection has been made based on the scope and case studies included in the H2020 SHELTER project, that set the framework of this investigation. Future research might be conducted applying the same methodology to complement the findings from this investigation.

Moreover, the collection shows a substantial lack of solutions for managing and preventing hazards such as subsidence and heatwaves. For what concerns subsidence, several monitoring techniques are available, but few long-term solutions have yet been identified. This is certainly also related to the fact that adaptive long-term urban planning strategies have not been largely adopted by many cities. As regards to heatwaves, this phenomenon has been studied in relation to the health of citizens and workers. However, currently little to no knowledge and solutions are available and applicable in the field of natural and cultural heritage. Therefore, the lack of solutions for these hazards should be addressed by future projects and research.

Lastly, although cultural heritage should be considered in its broader meaning, encompassing both the tangible dimension and the intangible one, intangible aspects such as local traditions, practices, and craftsmanship result to be underrepresented among the collected good practices. More effort should be made for safeguarding cultural heritage to enhance not only historical buildings or sites, but also all the intangible elements that are intrinsic to these assets.

Concluding, the paper provides insights on the role of good practices to bridge the gap between theory and practice in the field of resilience of cultural heritage in historical areas. The research contributes to inform policy makers and practitioners on available measures and solutions to be applied to improve cultural heritage management while increase resilience and reducing vulnerability.

Author Contributions: Conceptualization, A.S., E.M. and G.M.; methodology, A.S. and E.M.; data curation, A.S., E.M. and G.M.; writing—original draft preparation, A.S.; writing—review and editing, E.M. and G.M.; supervision, S.T. and A.U. All authors have read and agreed to the published version of the manuscript.

Funding: This research has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 821282. This paper reflects only the author's views and neither Agency nor the Commission are responsible for any use that may be made of the information contained therein.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are openly available. This data can be found here: https://shelter-project.com/download-document/?deliverables/D1.2.pdf (accessed on 25 March 2022).

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Good practices database, listed according to the related EU project alphabetic order.

No.	Good Practice Name	EU Project	Funding Program	Scale	Resilience Scope	References
1	Archaeological and paleoseismic data and results including quantitative morphology, geophysical prospecting and GPS results	APAME	FP5	Region	Social; economic; environmental	https://cordis.europa.eu/project/id/ICA3-CT-2002-10024/results (accessed on 25 March 2022)

Table A1. *Cont.*

No.	Good Practice Name	EU Project	Funding Program	Scale	Resilience Scope	References
2	Design and implementation of flood protection measures: mobile barriers	BASE	FP7	City	Economic; social; environmental	https://climate-adapt.eea.europa.eu/metadata/case-studies/realisation-of-flood-protection-measures-for-the-city-of-prague (accessed on 25 March 2022)
3	Design and implementation of flood protection measures: fixed barriers (levees, dykes, earth mounds, solid concrete walls)	BASE	FP7	City	Economic; social; environmental	https://climate-adapt.eea.europa.eu/metadata/case-studies/realisation-of-flood-protection-measures-for-the-city-of-prague (accessed on 25 March 2022)
4	Design and implementation of flood protection measures: closures, pumping systems and safety valves	BASE	FP7	City	Economic; social; environmental	https://climate-adapt.eea.europa.eu/metadata/case-studies/realisation-of-flood-protection-measures-for-the-city-of-prague (accessed on 25 March 2022)
5	Participatory process to implement coastal flood defence strategy	BASE	FP7	City	Economic; social; environmental	https://climate-adapt.eea.europa.eu/metadata/case-studies/timmendorfer-strand-coastal-protection-strategy-germany/-cost_benefit_anchor (accessed on 25 March 2022)
6	Comprehensive Adaptation Plan	BASE	FP7	City	Social; economic; environmental	https://base-adaptation.eu/implementation-copenhagen-cloudburst-strategy-copenhagen-denmark (accessed on 25 March 2022)
7	Cloudburst Management Plan	BASE	FP7	City	Social; cultural; economic	https://climate-adapt.eea.europa.eu/metadata/case-studies/the-economics-of-managing-heavy-rains-and-stormwater-in-copenhagen-2013-the-cloudburst-management-plan (accessed on 25 March 2022)
8	Training and Pilot Set up to validate the methodology prototype developed in the project	beAWARE	H2020	Multiscale	Social; cultural; economic	https://beaware-project.eu/ (accessed on 25 March 2022)
9	Integrated forest fire analysis system (IFFAS)	CALCHAS	LIFE+	Region	Economic; social; environmental	https://climate-adapt.eea.europa.eu/metadata/case-studies/calchas-an-integrated-analysis-system-for-the-effective-fire-conservancy-of-forests (accessed on 25 March 2022)
10	Making Preparedness Attractive	CARISMAND	H2020	Multiscale	Social; cultural; economic	https://www.carismand.eu/resources.html (accessed on 25 March 2022)
11	Technology and social media: Education and Communication Strategy	CARISMAND	H2020	Multiscale	Social; cultural; economic	https://www.carismand.eu/resources.html (accessed on 25 March 2022)

Table A1. *Cont.*

No.	Good Practice Name	EU Project	Funding Program	Scale	Resilience Scope	References
12	Dedicated Alert Apps	CARISMAND	H2020	Multiscale	Social; cultural; economic	https://www.carismand.eu/resources.html (accessed on 25 March v2022)
13	Drones for Alerts	CARISMAND	H2020	Multiscale	Social; cultural; economic	https://www.carismand.eu/resources.html (accessed on 25 March 2022)
14	Crowdsourcing information	CARISMAND	H2020	Multiscale	Social; cultural; economic	https://www.carismand.eu/resources.html (accessed on 25 March 2022)
15	Local heat and UV alert system	CIRCLE-2	FP7	City	Social; environmental	https://climate-adapt.eea.europa.eu/metadata/case-studies/tatabanya-hungary-addressing-the-impacts-of-urban-heat-waves-and-forest-fires-with-alert-measures (accessed on 25 March 2022)
16	Smart Sun Educational Programme	CIRCLE-2	FP7	City	Social; environmental	https://climate-adapt.eea.europa.eu/metadata/case-studies/tatabanya-hungary-addressing-the-impacts-of-urban-heat-waves-and-forest-fires-with-alert-measures (accessed on 25 March 2022)
17	Phone-based early warning system	Clim-ATIC	INTERREG Northern Periphery Programme 2007-2013	Multiscale	Social; environmental; economic	https://climate-adapt.eea.europa.eu/metadata/case-studies/multi-hazard-approach-to-early-warning-system-in-sogn-og-fjordane-norway (accessed on 25 March 2022)
18	Climate Risk Management Model for financial institutions	CLIMAbiz	LIFE+	Cross-regional	Social; economic	https://climate-adapt.eea.europa.eu/metadata/case-studies/financial-institutions-preparing-the-market-for-adapting-to-climate-change-2013-climabiz (accessed on 25 March 2022)
19	Adoption of an Integrated Coastal Management strategy (ICZM)	COREPOINT	INTERREG IIIB	City	Social; environmental; economic	https://climate-adapt.eea.europa.eu/metadata/case-studies/integrated-management-and-adaptation-strategies-for-cork-harbour-ireland (accessed on 25 March 2022)
20	Assess Maturity Level	CORFU	FP7	City	All	https://www.corfu7.eu/ (accessed on 25 March 2022)

Table A1. *Cont.*

No.	Good Practice Name	EU Project	Funding Program	Scale	Resilience Scope	References
21	Insurance company supporting climate adaptation action in small and medium size enterprises	DERRIS	LIFE	City	Economic; social; environmental	https://climate-adapt.eea.europa.eu/metadata/case-studies/insurance-company-supporting-adaptation-action-in-small-and-medium-size-enterprises-in-turin-italy--challenges_anchor (accessed on 25 March 2022)
22	Web based Decision Support System (DSS)	EFFESUS	FP7	City	Economic; environmental; cultural	https://cordis.europa.eu/project/id/314678/it (accessed on 25 March 2022)
23	Green bonds—Financing climate friendly investments projects	EMPOWER	INTERREG Europe	Cross-regional	Economic; environmental	https://www.interregeurope.eu/policylearning/good-practices/item/2739/green-bonds-financing-climate-friendly-investments-projects/ (accessed on 25 March 2022)
24	Multi-Sector Partnership (MSP) for managing DRR	ENHANCE	FP7	City	All	https://cordis.europa.eu/docs/results/308/308438/final1-enhance-d1-4-final-publishable-summary-report.pdf (accessed on 25 March 2022)
25	Agent Based Model (ABMs)	ENHANCE	FP7	City	Social; economic; environmental	https://cordis.europa.eu/docs/results/308/308438/final1-enhance-d1-4-final-publishable-summary-report.pdf (accessed on 25 March 2022)
26	Temporary flood water storage in agricultural areas	EPI-WATER	FP7	Cross-regional	Economic; social; environmental	https://climate-adapt.eea.europa.eu/metadata/case-studies/temporary-flood-water-storage-in-agricultural-areas-in-the-middle-tisza-river-basin-hungary (accessed on 25 March 2022)
27	SHIELD MODEL Sharing Knowledge: map the field of relevant actors	ESPREsSO	H2020	Multiscale	Social; cultural; economic	https://cordis.europa.eu/project/id/700342/results/it (accessed on 25 March 2022)
28	SHIELD MODEL Bridge knowledge gaps between science and policy	ESPREsSO	H2020	Multiscale	All	https://cordis.europa.eu/project/id/700342/results/it (accessed on 25 March 2022)
29	SHIELD MODEL Create frameworks and platforms	ESPREsSO	H2020	Multiscale	Cultural; economic	https://cordis.europa.eu/project/id/700342/results/it (accessed on 25 March 2022)
30	SHIELD MODEL Harmonizing capacities	ESPREsSO	H2020	Multiscale	Cultural; economic	https://cordis.europa.eu/project/id/700342/results/it (accessed on 25 March 2022)

Table A1. *Cont.*

No.	Good Practice Name	EU Project	Funding Program	Scale	Resilience Scope	References
31	SHIELD MODEL Engaging stakeholders	ESPREsSO	H2020	Multiscale	Cultural; economic	https://cordis.europa.eu/project/id/700342/results/it (accessed on 25 March 2022)
32	SHIELD MODEL Leveraging investments	ESPREsSO	H2020	Multiscale	Cultural; economic; social	https://cordis.europa.eu/project/id/700342/results/it (accessed on 25 March 2022)
33	SHIELD MODEL Developing communication	ESPREsSO	H2020	Multiscale	Cultural; economic; social	https://cordis.europa.eu/project/id/700342/results/it (accessed on 25 March 2022)
34	Use of Critical Infrastructure Resilience Platform	EU-CIRCLE	H2020	City	Social; economic; environmental	http://www.eu-circle.eu/research/case-studies/case-study-1/ (accessed on 25 March 2022)
35	Multihazard risk assessment	EU-CIRCLE	H2020	City	Social; economic	http://www.eu-circle.eu/research/case-studies/case-study-2/ (accessed on 25 March 2022)
36	Multisensor early warning system Network	FIRESENSE	FP7	District	Cultural; economic; environmental	https://cordis.europa.eu/project/id/244088/reporting (accessed on 25 March 2022)
37	Guidance on improving performance of urban flood defences	Flood ProBe	FP7	Multiscale	Environmental; social; economic	http://www.floodprobe.eu/ (accessed on 25 March 2022)
38	Assessment methodology and tool to identify likely level of damage to critical buildings	Flood ProBe	FP7	Multiscale	Environmental; social; economic	http://www.floodprobe.eu/ (accessed on 25 March 2022)
39	Risk assessment tool	Flood ProBe	FP7	Multiscale	Environmental; social; economic	http://www.floodprobe.eu/ (accessed on 25 March 2022)
40	Advanced Analysis tool—defining the interdependencies of infrastructure networks	Flood ProBe	FP7	City	Economic; social	http://www.floodprobe.eu/ (accessed on 25 March 2022)
41	Storyline method	Flood ProBe	FP7	City	Environmental; social; economic	http://www.floodprobe.eu/ (accessed on 25 March 2022)
42	Flood Risk Assessment Framework	FRAMAB	H2020	Building	Cultural; economic; environmental	https://www.eccomasproceedia.org/conferences/thematic-conferences/uncecomp-2017/5358 (accessed on 25 March 2022)
43	Managing disaster events coordination through the ICT platform	HERACLES	H2020	Multiscale	Cultural; social; economic	https://www.dropbox.com/s/erhliz76j4gv78m/HeraclesVirtualCourse10Guidebook.pdf?dl=0 (accessed on 25 March 2022)

Table A1. *Cont.*

No.	Good Practice Name	EU Project	Funding Program	Scale	Resilience Scope	References
44	Digital platform for CH	HERICOAST	INTERREG Europe	Region	Social; economic; environmental	https://www.interregeurope.eu/policylearning/good-practices/item/572/coastlight-digital-dissemination-of-coastal-heritage/ (accessed on 25 March 2022)
45	Use of a targeted mobile app and social media	I-REACT	H2020	City	All	https://cordis.europa.eu/project/id/700256/it (accessed on 25 March 2022)
46	PEOPLES framework	IDEal RESCUE	H2020	City	All	https://www.researchgate.net/publication/284507306_Framework_for_defining_and_measuring_resilience_at_the_community_scale_The_PEOPLES_resilience_framework (accessed on 25 March 2022)
47	EWS addressed to several recipients	KULTURisk	FP7	City	Social; economic	http://www.kulturisk.eu/results (accessed on 25 March 2022)
48	Ensure a unique information provided by EWS	KULTURisk	FP7	City	Social; economic	http://www.kulturisk.eu/results (accessed on 25 March 2022)
49	Communication between EWS providers and stakeholders	KULTURisk	FP7	City	Social; economic	http://www.kulturisk.eu/results (accessed on 25 March 2022)
50	Policies integrating uncertain information from EWS	KULTURisk	FP7	City	Social; economic	http://www.kulturisk.eu/results (accessed on 25 March 2022)
51	Simulating earthquake scenarios	LESSLOSS	FP6	City	Social; economic; environmental	https://cordis.europa.eu/project/id/505448/it (accessed on 25 March 2022); [53]
52	Structural Modelling and Analysis	NIKER	FP7	Building	Cultural; economic; social	https://cordis.europa.eu/project/id/244123/reporting/it (accessed on 25 March 2022)
53	Monitoring for the diagnosis phase	NIKER	FP7	Building	Cultural; economic; social	https://cordis.europa.eu/project/id/244123/reporting/it (accessed on 25 March 2022)
54	Seismic assessment based on the structural numerical model	NIKER	FP7	Building	Cultural; social; economic	https://cordis.europa.eu/project/id/244123/reporting/it (accessed on 25 March 2022)
55	Punctual and/or periodical inspections	NIKER	FP7	Building	Cultural; economic	https://cordis.europa.eu/project/id/244123/reporting/it (accessed on 25 March 2022)
56	Static Monitoring System	NIKER	FP7	Building	Cultural; economic	https://cordis.europa.eu/project/id/244123/reporting/it (accessed on 25 March 2022)

Table A1. *Cont.*

No.	Good Practice Name	EU Project	Funding Program	Scale	Resilience Scope	References
57	Dynamic identification and monitoring	NIKER	FP7	Building	Cultural; economic	https://cordis.europa.eu/project/id/244123/reporting/it (accessed on 25 March 2022)
58	Vulnerability atlas for Europe and accompanying management guidelines	NOAHS ARK	FP6	Building	Cultural; economic; social	https://cordis.europa.eu/docs/results/501/501837/124722791-6_en.pdf (accessed on 25 March 2022)
59	Policy integration of cultural heritage in coastal and maritime policies	PERICLES	H2020	Multiscale	Cultural; economic; environmental	https://cordis.europa.eu/project/id/770504/reporting (accessed on 25 March 2022)
60	Displacement-based approach for vulnerability assessment of CH	PERPETUATE	FP7	Multiscale	Cultural; social; economic	https://cordis.europa.eu/project/id/244229/reporting (accessed on 25 March 2022)
61	Implementation of a comprehensive Climate Risk Management (CRM) approach	PLACARD	H2020	Cross-regional	Social; economic; environmental	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/4-1-safeguarding-sound-governance/ (accessed on 25 March 2022)
62	Cross-sectorial collaborations	PLACARD	H2020	City	Social; economic; environmental	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/4-1-safeguarding-sound-governance/ (accessed on 25 March 2022)
63	Ensuring effective financing	PLACARD	H2020	Cross-regional	Social; economic	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/ (accessed on 25 March 2022)
64	Risk governance as focused collaboration	PLACARD	H2020	Cross-regional	Social; economic environmental	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/ (accessed on 25 March 2022)
65	Social Network Analysis: Stocktaking and Social Network Analysis as tools to enhance CCA and DRR interactions	PLACARD	H2020	Multiscale	Social; economic	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/ (accessed on 25 March 2022)
66	Joint emergency exercises to strengthen collaboration on various levels between CCA and DRR actors	PLACARD	H2020	Multiscale	Social; economic	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/ (accessed on 25 March 2022)
67	Fostering dialogue and learning on monitoring, reporting and evaluation	PLACARD	H2020	City	Social; environmental	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/ (accessed on 25 March 2022)

Table A1. *Cont.*

No.	Good Practice Name	EU Project	Funding Program	Scale	Resilience Scope	References
68	Mainstreaming approaches through education	PLACARD	H2020	Multiscale	Social; economic	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/ (accessed on 25 March 2022)
69	Ecosystem-based Adaptation and risk reduction	PLACARD	H2020	Multiscale	All	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/ (accessed on 25 March 2022)
70	Information and knowledge management to foster stronger CCA-DRR institutions	PLACARD	H2020	Multiscale	Social; cultural; economic	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/ (accessed on 25 March 2022)
71	Use knowledge platforms and portals to enhance learning and collaboration	PLACARD	H2020	Multiscale	Social; cultural; economic	https://www.placard-network.eu/strengthening-institutional-coordination-capacities/ (accessed on 25 March 2022)
72	Improvement of building seismic performance by means of reversible mixed technologies (RMT)	PROHITECH	FP6	Building	Social; cultural; economic	https://cordis.europa.eu/project/id/509119/reporting (accessed on 25 March 2022)
73	Damage identification using mobile devices (MONDIS mobile app)	ProteCHt2save	INTERREG Central Europe	Multiscale	Cultural; social; economic	https://www.interreg-central.eu/Content.Node/D.T2.2.1-Manual-of-good-and-bad-practices.pdf (accessed on 25 March 2022)
74	Use of physical and mathematical models to understand the hazard and the hydrogeological and natural processes	ProteCHt2save	INTERREG Central Europe	Multiscale	Cultural; environmental; economic	https://www.interreg-central.eu/Content.Node/D.T2.2.1-Manual-of-good-and-bad-practices.pdf (accessed on 25 March 2022)
75	Design and implementation of adequate drainage systems	ProteCHt2save	INTERREG Central Europe	Multiscale	Cultural; environmental	https://www.interreg-central.eu/Content.Node/D.T2.2.1-Manual-of-good-and-bad-practices.pdf (accessed on 25 March 2022)
76	Implementation of automatic fire-fighting systems	ProteCHt2save	INTERREG Central Europe	Building	Cultural; economic	https://www.interreg-central.eu/Content.Node/D.T2.2.1-Manual-of-good-and-bad-practices.pdf (accessed on 25 March 2022)
77	Investigation of the performance of building components/interventions against excessive rain penetration	ProteCHt2save	INTERREG Central Europe	Building	Cultural; economic	https://www.interreg-central.eu/Content.Node/D.T2.2.1-Manual-of-good-and-bad-practices.pdf (accessed on 25 March 2022)

Table A1. *Cont.*

No.	Good Practice Name	EU Project	Funding Program	Scale	Resilience Scope	References
78	Territorial protection through the use of barriers	ProteCHt2save	INTERREG Central Europe	Multiscale	All	https://www.interreg-central.eu/Content.Node/D.T2.2.1-Manual-of-good-and-bad-practices.pdf (accessed on 25 March 2022)
79	World Heritage Service	PUCS	H2020	City	Social; cultural; economic	https://climate-fit.city/stories/cultural-heritage/ (accessed on 25 March 2022)
80	Emergency Planning Service—expert knowledge meets real experience	PUCS	H2020	City	Social; economic; environmental	https://climate-fit.city/stories/cultural-heritage/ (accessed on 25 March 2022)
81	Resilience Assessment Framework	RESCCUE	H2020	City	All	https://toolkit.resccue.eu/wp-content/uploads/2021/01/D6.4.pdf (accessed on 25 March 2022)
82	Resilience Management Matrix and Audit toolkit	RESILENS	H2020	City	All	https://cordis.europa.eu/project/id/653260/results (accessed on 25 March 2022)
83	IVAVIA (Impact and Vulnerability Analysis of Vital Infrastructures and built-up Areas) methodology	RESIN	H2020	City	Social; economic; environmental	https://resin-cities.eu/resources/deliverables/ (accessed on 25 March 2022)
84	European Resilience Management Guideline through five tools	SMR	H2020	City	Cultural; economic; social	https://smr-project.eu/fileadmin/user_upload/Documents/Resources/Non-WP_publications/SMR-EMRG-handbook-WWW-compressed.pdf (accessed on 25 March 2022)
85	Spatial planning tools to prevent floods (Water Assessment and Signal Area)	STAR-FLOOD	FP7	City	Environmental; social; economic	https://cordis.europa.eu/project/id/308364/reporting (accessed on 25 March 2022)
86	Implement interdisciplinary DRM programmes at site level, with the definition of a common Frame of Reference	STORM	H2020	Multiscale	Cultural; social; economic	https://cordis.europa.eu/project/id/700191/results (accessed on 25 March 2022)
87	Maintenance plan for conservation interventions	STORM	H2020	Multiscale	Cultural; economic	https://cordis.europa.eu/project/id/700191/results (accessed on 25 March 2022)
88	Inclusion of emergency sector cooperation in national policies	STORM	H2020	Multiscale	Cultural; social; economic	https://cordis.europa.eu/project/id/700191/results (accessed on 25 March 2022)
89	Planning of drills for involved stakeholders	STORM	H2020	Multiscale	Cultural; social; economic	https://cordis.europa.eu/project/id/700191/results (accessed on 25 March 2022)
90	Use of digital tools and ICT platforms	STORM	H2020	Multiscale	n.a.	https://cordis.europa.eu/project/id/700191/results (accessed on 25 March 2022)

Table A1. *Cont.*

No.	Good Practice Name	EU Project	Funding Program	Scale	Resilience Scope	References
91	DRM training courses for professionals and non-involved in CH management	STORM	H2020	Multiscale	Cultural; social	https://cordis.europa.eu/project/id/700191/results (accessed on 25 March 2022)
92	Subsidence hazard forecasting service (key module of Copernicus)	SUBCOAST	FP7	Region	All	https://cordis.europa.eu/article/id/90318-assessing-subsidence-hazards-in-coastal-lowlands (accessed on 25 March 2022)
93	Public-private participatory policy making model for tourism development, management and promotion	SWARE	INTERREG Europe	District	Social; economic	https://www.interregeurope.eu/policylearning/good-practices/item/239/lough-derg-marketing-group/ (accessed on 25 March 2022)
94	Gather baseline data about natural and built heritage	SWARE	INTERREG Europe	Cross-regional	All	https://www.interregeurope.eu/policylearning/good-practices/item/216/river-suir-heritage-audits/ (accessed on 25 March 2022)

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