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Dottorato di Ricerca in Research Methods in Science and Technology – Ciclo XXXVII

Tematica Vincolata "Industria intelligente e sostenibile, energia e ambiente"

Candidata: MARTA CUPIDO

Titolo: MIGLIORIA DELLA RESILIENZA DI AREE STORICHE AL CAMBIAMENTO CLIMATICO ED ALTRI RISCHI

Title (in English): **Improvement of the resilience of historic areas to climate change and other risks**

Tematica: GREEN

SSD: GEO/10 – GEO/04

Problematic introduction in the international scientific contest and relevance of the problem

While negative impacts of climate-related and other hazards on urban areas are widely discussed, their impacts on historic areas have not been studied extensively enough[1]. Disaster risk reduction and climate change adaptation for historic areas, with their unique structure, composition, and set of regulations, call for advanced technologies, models, methods, and tools, either re-used from other domains or custom-developed, as well as the promotion of relevant public policies and participatory governance processes, including residents from local communities and the general public. In addition, according to the United Nations Educational, Scientific, and Cultural Organisation (UNESCO)[2], disaster risk reduction does not register as a priority area for management of World Heritage property, despite the increasing vulnerability of historic areas to hazards[3]. Further-more, historic areas are deeply embedded in larger urban and rural environments,

[1] A. Bigio, et al., *Climate-resilient, Climate-friendly World Heritage Cities*, Urban Development Series Knowledge Papers, Bd. 19, 2014.

[2] https://en.unesco.org/

[3] Global Platform for Disaster Risk Reduction, *Heritage and Resilience. Issues and Opportunities for reducing disaster risks,* Global Platform for Disaster Risk Reduction, Geneva, Switzerland, 2013.

providing important cultural, social, environmental, and economic functions, while relying on infrastructure services from these environments to keep functioning. Therefore, there is a need to increase awareness of climate change impacts and disaster risk reduction on historic areas. Solutions need to address issues of heritage managers and professionals with the objective of including resilience building strategies into conservation policies. These solutions should also address climate change adaptation and disaster risk reduction professionals as well as politicians and the general public, to include historic areas in wider urban resilience strategies.

Objectives and expected results

The overall objective of this project of research is to develop a unified disaster risk management framework for assessing and improving the resilience of historic areas to climate change-related and other hazards, based on the Ten Essentials for Making Cities Resilient[4], the Sendai action plan[5] and the RAMSES Transition Handbook[6]. This will give the project a unified view of the management process related with resilience building as well as preservation and reconstruction of historic areas, and guide the work during the project duration. This will be achieved, first of all by adapting and improving the Disaster Resilience Scorecard for Cities[7] covering not only acute shocks from natural hazards but also chronic stresses from climate change-related hazards, and then by developing tools and methodologies that will be combined into a collaborative disaster risk management platform for local authorities and practitioners, the urban population, and (inter)national expert communities.
In particular, these tools and methodologies will be developed to obtain:

a) Georeferenced properties of current condition of heritage assets, e.g. build material and existing protection measures;
b) hazard data, captured via existing climate services and novel monitoring techniques;
c) effects of hazards and potential measures, ageing and hazard simulation, based on the previous information;
d) an inventory of resilience enhancing measures;
e) risk-oriented vulnerability assessment;
f) prioritised safety measures over time.

The next step will be to embed the developed models, methods, tools, and datasets in an overarching disaster risk management framework integrating them in a comprehensive information and data platform incorporating decision support and guidance to support the collaborative formulation of sustainable protection and reconstruction strategies.
Finally, there will be also socio-economics objectives as well, such as:

a) Improve cooperation and communication between relevant stakeholders to enhance the formulation and implementation of sustainable resilience building strategies;

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[4] https://www.unisdr.org/campaign/resilientcities/toolkit/article/the-ten-essentials-for-making-cities-resilient.html
[5] European Commission, *Action Plan on the Sendai Framework for disaster risk reduction 2015 - 2030: a disaster risk informed approach for all EU policies*, 2016.
[6] https://ramses-cities.eu/fileadmin/uploads/Deliverables_Uploaded/RAMSES-Handbock-and-Training-Package-final-www.pdf
RAMSES was a European research project which aimed to deliver much needed quantified evidence of the impacts of climate change and the costs and benefits of a wide range of adaptation measures, focusing on cities.
[7] UNISDR, *Disaster Resilience Scorecard for Cities*, 2017.

b) Advocate and disseminate resource efficient resilience concepts, methodologies, and solutions to relevant practitioners of the public and private sector (e.g. construction, energy, logistics, finance, education);
c) Ensure that resilience and reconstruction of historic areas can be progressed in a systematic way, through European standardisation, which will ensure practical applicability and reproducibility.

Methodology

The models and data required to make an informed decision about potential impacts of climate-related and natural hazards is often not available on a spatial and temporal scale necessary for detailed planning of resilience enhancing measures. Therefore, the starting point will be, when necessary, the use of technological means for determining the current condition of tangible and intangible heritage assets (SAR and LIDAR data; Scanning Electron Microscope, X- Ray Diffraction, particle-size analysis, direct shear test for surveys and monitoring techniques in loco; 3D modelling). All these captured data will be fed into an information management system for geo-referenced properties of heritage assets via Geographic Information Systems and 3D visualisation software.
Based on the previous data, simulation models for what-if analysis, ageing simulation, and hazard simulation will be developed and calibrated.
Probabilistic risk-oriented vulnerability assessments will be used to link the information management systems for heritage assets and hazards with the above mentioned simulation models to estimate expected impacts of different hazard scenarios and identify the heritage assets most at risk, guide users in how to conduct risk and vulnerability assessments, and allow to establish systematic assessment and monitoring processes.
Based on the results of the impact and risk assessment, resilience enhancing measures need to be identified. Therefore, an inventory of suitable protection and recovery measures will be set-up by gathering, characterising, and assessing measures through the analysis of different performance criteria, including economic (e.g. benefit-cost ratio), sustainability (e.g. share of risk averted by implementing a measure, co-benefits, barriers to implementation), resilience (e.g. invasiveness of measures), as well as social and institutional (e.g. consistency with current regulations, acceptability by citizens).
The different criteria will be assessed for their usefulness, linked to funding opportunities identified in the financing inventory, and employed in the resilience pathway model. This information will allow to prioritise options and organise their implementation chronologically to design resilience pathways.

Bibliography

[1] A. Bigio, et al., *Climate-resilient, Climate-friendly World Heritage Cities*, Urban Development Series Knowledge Papers, Bd. 19, 2014.
[2] https://en.unesco.org/
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[4] https://www.unisdr.org/campaign/resilientcities/toolkit/article/the-ten-essentials-for-making-cities-resilient.html
[5] European Commission, *Action Plan on the Sendai Framework for disaster risk reduction 2015 - 2030: a disaster risk informed approach for all EU policies*, 2016.
[6] https://ramses-cities.eu/fileadmin/uploads/Deliverables_Uploaded/RAMSES-Handbock-and-Training-Package-final-www.pdf
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[7] UNISDR, *Disaster Resilience Scorecard for Cities*, 2017.

[8] UNISDR, *"Build Back Better in recovery, rehabilitation and reconstruction",* 2017. https://www.unisdr.org/files/53213_bbb.pdf

Relation to the work programme (SNSI and PNR)

This project will be a research and innovation action that addresses the issue of incompatibility of conventional resilience building methods and approaches to historic areas by developing approaches explicitly aimed at those areas. As historic areas are part of larger urban and rural environments, which operate in a multi-level governance context, it is necessary to involve many stakeholders in advancing resilience. Consequently, there will be a focus on providing a common language as well as common methods and tools, bringing them together in a collaborative information and data platform for end-users to enable successful cooperation and foster the exchange of best practice knowledge.

The developed framework will be supported by the recommendations for building back better by the United Nations Office for Disaster Risk Reduction (UNISDR)[8], including guidance on how to develop, monitor and review policies, plans, and programs, thus enabling the strengthening of policies, laws, and programs that promote, guide and support building back better. Together these results will help to formal-ise processes and systems to enable effective assessment of post-disaster damages and needs, subsequently supporting the formulation of recovery strategies.

The proposed collaborative disaster risk management framework and platform provide comprehensive decision-support for local authorities, including guidelines and models. This will include the pathway approach that does not focus on one specific solution, but instead is iterative and incorporates elements of flexibility and adaptability into the process of adapting to climate change and other hazards. The proposed platform will allow including local practitioners, affected community groups, as well as (inter)national expert communities in the resilience building process. In addition, an inventory of financing models and tools will be provided, categorised according to their applicability in different contexts and for different protection and reconstruction measures. Local activities (e.g. workshops, outdoor facilitated walks in case study areas, on-site and remote experiments in local research facilities) will be used to disseminate and verify results and include local stakeholders and the general public in the co-creation process.

In brief, by developing a unified resilience assessment framework based on the Resilience Scorecard for Cities, a set of common methods and metrics to evaluate existing approaches to resilience building for historic areas, practice-oriented arrangements and more integrative policy frameworks will be established. This process will also facilitate the review and strengthening of regional, national, and European laws and regulations, where appropriate. New policies as well as necessary changes to existing regulations resulting from the application of the developed methods and tools during the co-creation process will be actively advocated, e.g. by feeding results into existing and future standardisation initiatives and by involving people, industries, politicians and all other social and economic classes.

[8] UNISDR, *"Build Back Better in recovery, rehabilitation and reconstruction",* 2017. https://www.unisdr.org/files/53213_bbb.pdf