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ACKNOWLEDGING THE CONTEXT FOR URBAN RESILIENCE PLANS. Place-based compatibility of adaptation measures in the case of Mantua (Italy)

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ABSTRACT
The unavoidable present and future impacts of climate change are a crucial challenge in the urban agenda. Local governments play a key role in addressing these impacts through effective adaptation measures. The large number of international best-practises refer to various geographical and climate contexts, providing an extensive but generic database of measures. This research outlines the process, that took place in building an adaptation plan in a mid-size Italian city, of acknowledging the local impacts, context and governance framework in refining an international list of measures in a place-based one. To choose the most feasible, meaningful and locally adapted measure, a compatibility matrix has been used. The results are then applied to 5 neighbourhood wide masterplans, where site-specific vulnerabilities and urban structures are acknowledged in order to show how full implementation of the measures could look like.

Keywords: adaptation plan, climate change, resilience, vulnerability.
Topic*:* urban morphology

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1. Introduction

Since Paris' *COP21*, climate change has become a leading topic in the political agenda as one of the most serious threats in the urban and rural areas (Tollin, 2015). The *Covenant of Mayors* started in 2008 gave strong results in the mitigation framework, reducing widely the greenhouse gas emissions in those cities that adopted it and tracing the path for other cities to follow the same steps (Kona et al., 2016). However, global temperatures are still rising, and extreme climate-related events are more likely to happen. Cities are exposed to a whole range of these events, causing great damages and life-loss. Responses to such extreme events are based on the notions of adaptation and resilience.

From the planning point of view, climate change resilience can be defined as policies and measures for adaptation aimed at reducing the impacts of climate change on natural and built systems and mitigating the environmental externalities of these systems that may favour the climate changes in the medium and long term (Musco, 2008). State of art of resilience planning in Europe is not homogeneous: many countries are now equipped with national indications on mitigation and adaptation strategies, however their translation in sectorial climate plans and tools are left to local initiatives and few local municipalities have successfully integrated adaptation in their existing main planning tools (Musco et al., 2016).

While the international and national scale delivers climate information and projections, financing, networking programs and strategies, the local governments are the core institutional unit to place-based policies and planning (DCCEE, 2010). In particular, Agrawal (2009) recognizes three critical roles that local governments have in climate adaptation: 1) structuring responses to local impacts; 2) mediating between individual and collective responses to vulnerability; and 3) governing the delivery of resources to facilitate adaptation (Measham et al., 2011). The challenges brought by the climate change scenario require to innovate the planning process with new tools. Compared to the traditional planning process in Italy, that is based on stable regional and local environmental contexts, new perspectives and tools are needed to acknowledge social, economic and environmental changes driven by climate change impacts (Musco, 2016).

Since the impacts of climate change are experienced locally and differ according to geographic areas, effective adaptation needs for place-based approaches (Measham et al., 2011).[1] In fact, Musco (2016) recognizes that there are no appropriate policies and adaptation measures that are suitable to be applied anytime and in all contexts. Adaptation is based on the geomorphological, social and economic specificities of the place, therefore to effectively downscale national and international directions on adaptation and build a city-wide operational plan, it's fundamental to acknowledge the peculiar local characteristics and spatial conformation of the built environment.

The effectiveness of the adaptation plan it's not only connected to the good design of the solutions and measures included but also to the forms under which it is implemented. Municipalities and local authorities are often organized in specialized departments, each competent for specific actions and plans, that do not always coordinate in the way that retrofit planning approaches require (Hodson & Marvin, 2016). Therefore, while building the adaptation plan, it is necessary to acknowledge the local governance system and identify the existing tools in which the measures can be incorporated.

Willing to develop its own adaptation plan, the city of Mantua (Italy) started a year-long collaboration with the IUAV University of Venice. It's an operational tool that allows plans to introduce adaptation in an integrated way in the urban changes expected in the coming years. It has the objective of increasing the resilience of the territory with respect to the impacts of climate change, strategically defining the key, procedural and physical points of climate adaptation in a specific context.

[1] Measham et al. specify that the term "place-based" refers to a spatially distinct group of bio-physical and social conditions, which can, in principle, occur at any scale but tend to focus at local and regional scales where global and local drivers manifest themselves in particular ways

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Previous steps

The process that led to the Mantua's plan followed a tailored methodology that included, amongst other, climate data analysis, local stakeholder involvement, GIS analysis and compatibility matrix evaluation. This paragraph will briefly synthesize two previous parts of the whole process in order to understand the final step, extensively described in the rest of the paper.

Through stakeholder involvement, questionnaires and data analysis, previous steps of this work identified the climate change trends and their impacts in the city, namely: drought; extreme temperatures; urban flooding; poor air quality; strong winds; low water quality; invasion of alien species.

Vulnerability assessment took place through GIS analysis of quantitative data derived through remote-sensing technologies as LIDAR flights and Landsat 8 satellite images and data derived by the local census tracts. This has been done following the IPCC's 2014 methodology on vulnerability assessment (IPCC, 2014). Through these technologies, detailed data on surface composition and three-dimensional shapes of both the built and natural environment have been produced. This data has been processed in indicators such a built fraction, solar radiance on rooftops and on the ground, amount of vegetation and its height, sky-view factor and other indicators useful to analyse the built and natural environment. (Negretto et al., 2018)

2. Objectives

The steps analysed in this research paper follow the ones listed before and conclude the process that leads to the adaptation plan. Acknowledging all the inputs of the local framework derived by the climate and spatial analysis, the last part of the work aims to identify the best adaptation measures and understanding how to implement them in the local governance structure. (*Fig.*1)

Fig. 1 Conceptual representation of the planning process. Local climate impacts, morphology and governance are acknowledged to identify the best adaptation action. Source: Author's drawing.

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International toolkits and academic knowledge have identified a whole range of options and measures to successfully spread adaptation in the built environment. However, in these frameworks, the built environment is considered in a broad way in order to embrace the widest list of impacts and different situations. Some of these toolkits derive their content by adding and listing best practices realized in different nations and latitudes, on coastal, inland and mountainous contexts. In the need of place-based adaptation previously outlined, there is a gap from this broader knowledge to the one needed by local governments and professionals in order to identify the best option that can fit their local context and needs.

The objective of the research presented in this paper is to shape a local list of adaptation measures. It arises from to the following research question: "In the effort of building place-based adaptation at a local level, how can general toolkits and academic knowledge be contextualized to meet local needs and requirements?".

To fill this gap and answer this question for the Mantua's context, it has been followed a process that evaluates the compatibility of the adaptation measures to three local requirements: (i) the first requirement derives from the local impacts previously identified in the vulnerability assessment, in order to choose and prioritize only the adaptation measures that address local hazards and vulnerabilities; (*Fig*.2) (ii) the second requirement derives from the local governance structure, in order to choose only those adaptation measures that can find direct application in the plans already ruling the city; and (iii) the third requirement derives from the local context of the urban fabrics, in order to choose and shape adaptation measures that can fit the local morphology, built environment, infrastructure and natural environment.

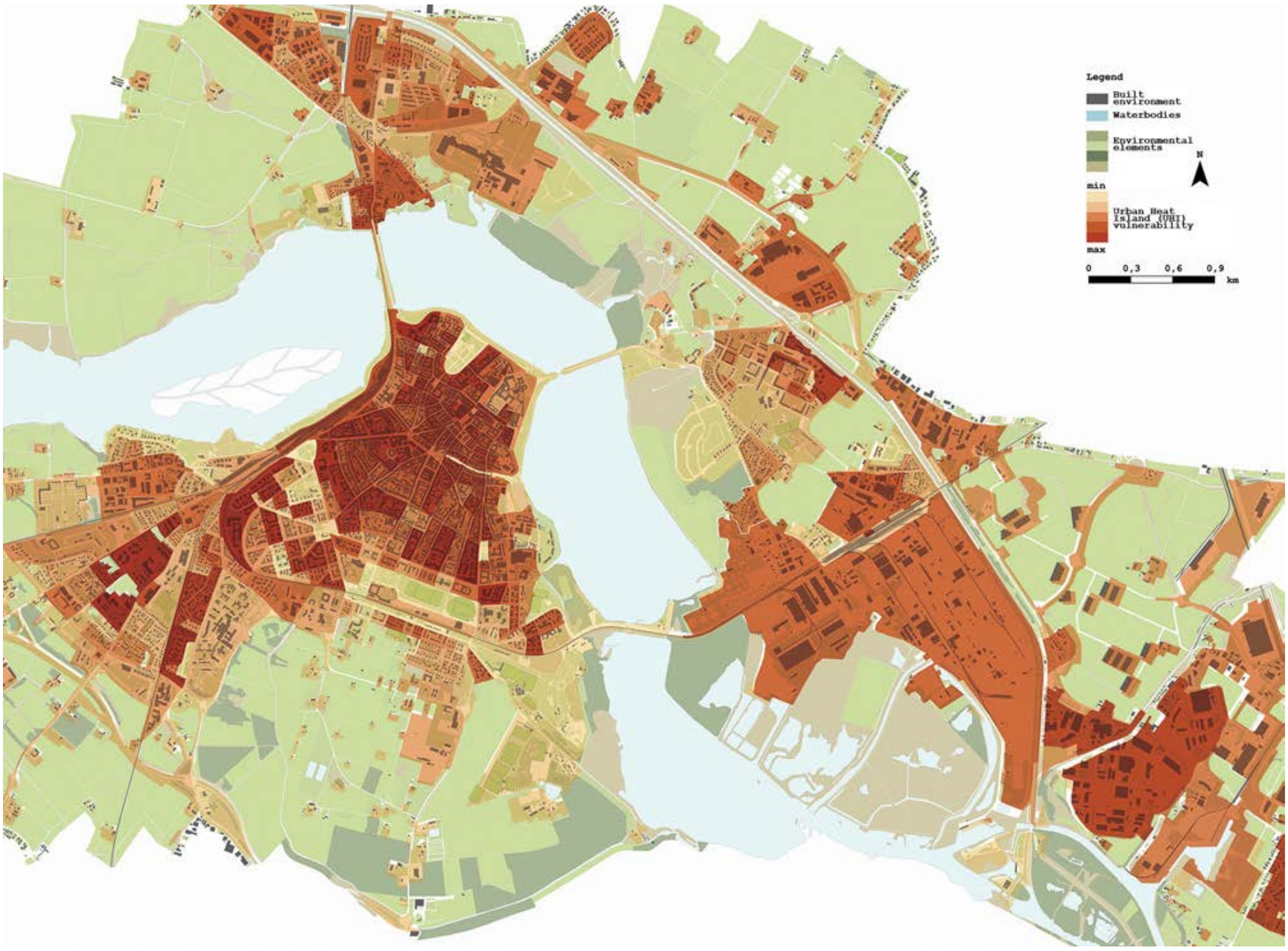

Fig. 2 Urban heat island vulnerability assessment classified by census tract. Darker red identifies high vulnerability areas where to prioritize intervention. Source: Author's drawing.

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3. Methodology

To purse the need for contextualization outlined in the previous paragraph, it has been applied a methodology that evaluates the compatibility of the adaptation measures to the Mantua's context. As stated before, this compatibility needs to meet the local requirement in terms of impacts, governance, and urban fabrics. Each measure has been evaluated in a compatibility matrix that assesses its feasibility or not in a certain context (La Rosa & Privitera, 2013). A measure is considered compatible with the context when it meets the impact's reduction requirements and does not contrast with the urban fabric's law requirements.

The starting point of this process of inclusion and exclusion is the list of measures produced by LIFE Urbanproof (Urbanproof, 2018c). Urbanproof is co-financed by the LIFE programme for the Environment and Climate Action (2014-2020) and its overall aim is to increase the resilience of municipalities to climate change equipping them with tools for supporting informed decision making on climate change adaptation planning. One the tools developed in this framework it's a comprehensive list of adaptation measures derived from best practices. The project partner municipalities are Greek, Cyprian, and Italian, so the best practices are already oriented towards a Mediterranean context. Each action is described and assessed in its capacity to absorb CO_2, its cost of implementation and maintenance, the physical space it needs for implementation, etc. This list also highlights the capacity of each measure to counteract climate change impacts, including water-related impacts, by storing or slowing runoff, increasing groundwater recharge and infiltration (Urbanproof, 2018a) and heat-related impacts, by reducing peak temperatures and increasing evapotranspiration (Urbanproof, 2018b).

To this initial core based on Urbanproof's toolkit, additional measures and best practice have been included based on other Italian municipalities' experiences, local stakeholder knowledge, and Italian Civil Protection experience (Negretto et al., 2018). Once the matrix has been filled with the missing fields based on scientific literature, the process of compatibility took place.

3.1. Impacts and vulnerability

To assess the compatibility of a measure with the context, the first step has been to evaluate if the specific measures could counteract the local impacts and vulnerabilities identified in the vulnerability assessment (see. previous paragraph). Based on the information and features provided in the description, it has been evaluated which measures could successfully address adaptation to one or more local impacts. This process has been refined with morphological and social indicators of the vulnerability assessment. (*Fig*.3)

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Fig. 3 Graphic representation of the outcome of the compatibility matrix between impacts and adaptation measures. Source: Author's drawing.

3.2. Local governance

The second step to evaluate compatibility with the context is related to the local framework of law, requirements, and plans. On one hand, a process of exclusion took place of those measures which were in conflict with the local laws and requirements and could not be implemented in any case. For example, the creation of open water basins and tanks that could store stormwater in the surface for more than two days were excluded due to the high propagation of mosquitos and health issues. On the other hand, a process of relating each measure to a local planning tool ensured that the implementation could actually take place. This has been done by connecting the measures to the existing governance structure, understanding which is the best tool to implement it. For example, measures that include cooling or greening of the roofs have to be implemented through different planning tools according to the public or private property of the building.

The outcome of this process is the exclusion of the unfeasible measures and the potential inclusion of measures in plans future revisions.

3.3 Compatibility with context and urban fabrics

The third and final step in evaluating compatibility is related to the shape and form of the built environment. The Mantua municipality is divided into urban fabrics from a planning point of view that acknowledges the local difference in form, building age, location, and other parameters. This classification of homogeneous neighbourhoods and parts of the city is called ATO in Italian regulatory system, which stands for "optimal territorial units". In Mantua, the ones considered are historic residential area (UNESCO), long-established residential areas, new residential and developing areas, industrial activity areas, lake and river shore, agricultural areas and water bodies. This classification has been connected to the one of Local Climate Zone (LCZ) as regions of uniform surface cover, structure and human activity (Stewart & Oke, 2012). This process ensured that each part of the city could be classified in these territorial units and that missing data spots could be filled. (*Fig.*4)

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Fig. 4 Homogeneous urban fabrics of the city of Mantua. Source: Author's drawing.

Based on this classification of the city, it has been evaluated the compatibility of each adaptation measure to the specific territorial unit. This has been done by following the requirements listed in the description of the actions and comparing them to the qualitative and quantitative indicators developed with the GIS analysis in the vulnerability assessment. For example, while some actions could retrofit successfully also historical buildings, others could only be applied to new constructions in lower density urban fabrics where there is a greater amount of space near the building. (*Fig.*5)

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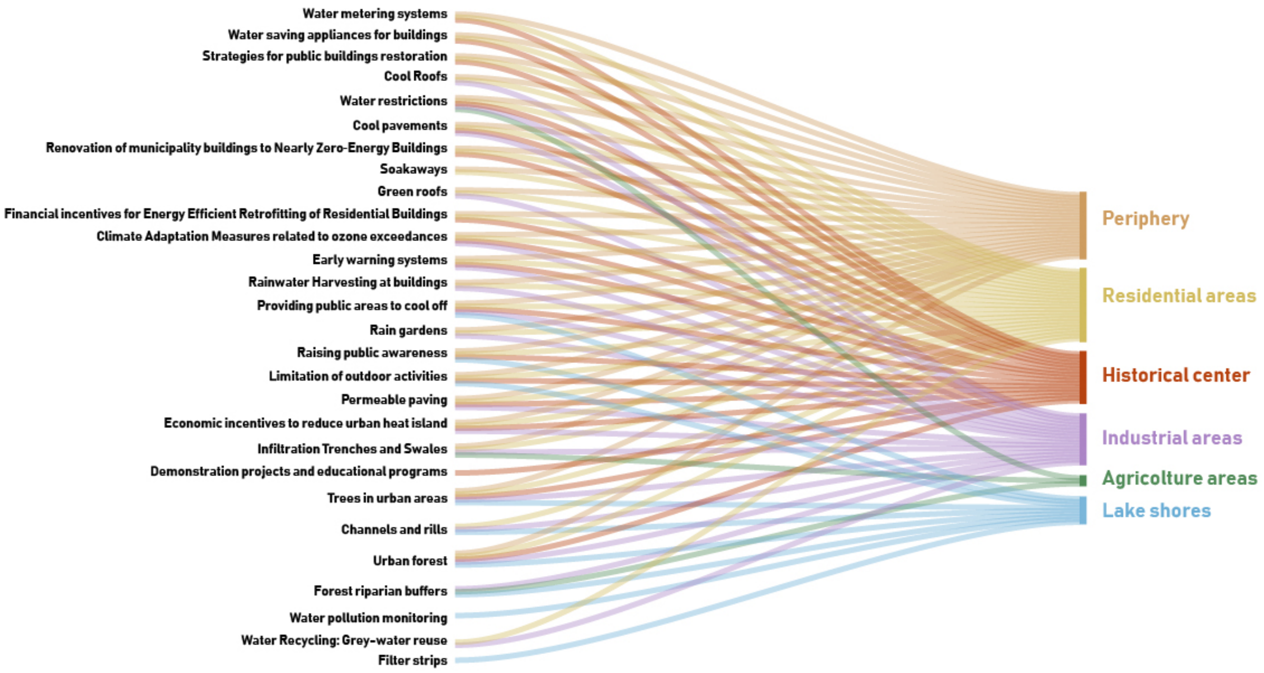

Fig. 5 Graphic representation of the outcome of the compatibility matrix between adaptation measures and urban fabrics. Source: Author's drawing.

4. Results

The results of this process are the identification of feasible, meaningful and locally adapted measures that the Municipality can apply with its already existing local governance. This enabled the Mantua's municipality to build the adaptation of its territory through a range of locally shaped actions of different typologies: physical infrastructure; policy; information and behaviour change; incentives on private property; alert and monitoring and first response. Through the connections of this actions to impacts, morphologies and planning tools, and through the framework of vulnerability provided, the local authority can choose the best actions for a specific part of the city and with which planning tool implement it. (*Fig.*6)

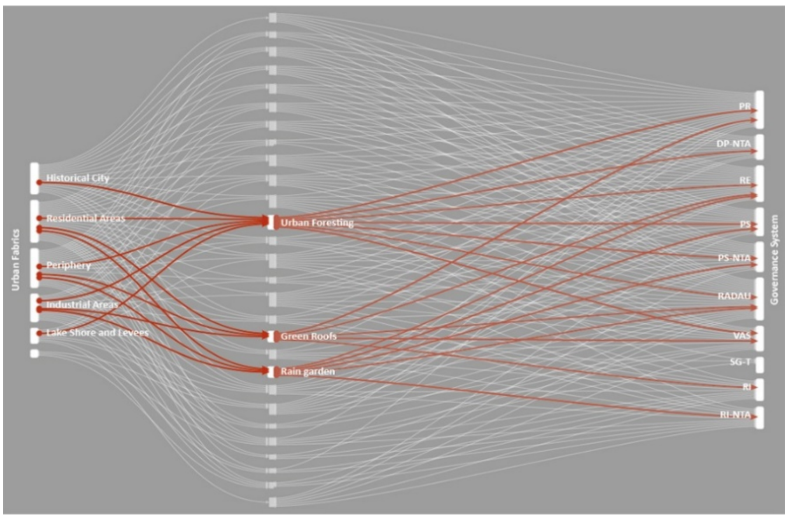

Fig. 6 Example of the relation between measures, urban fabric and planning tools of the local governance system. Source: Author's drawing.

This is exemplified in the neighbourhood wide masterplans, where site-specific vulnerabilities and urban structures are acknowledged in order to show how full implementation of the measures could look like. The masterplans focus on target areas to demonstrate how to build a neighbourhood strategy made of adaptation actions. Five different target areas, demonstrative of most of the built environment, have been chosen to show how to apply the range of solutions to the different parts of the city. Each of these target areas had a high priority in at least one vulnerability classification. These masterplans have a double purpose: on one side to test the application of the matrix of actions and on the other to be the base of a local stakeholder's involvement to raise awareness and take action. (*Fig*.7)

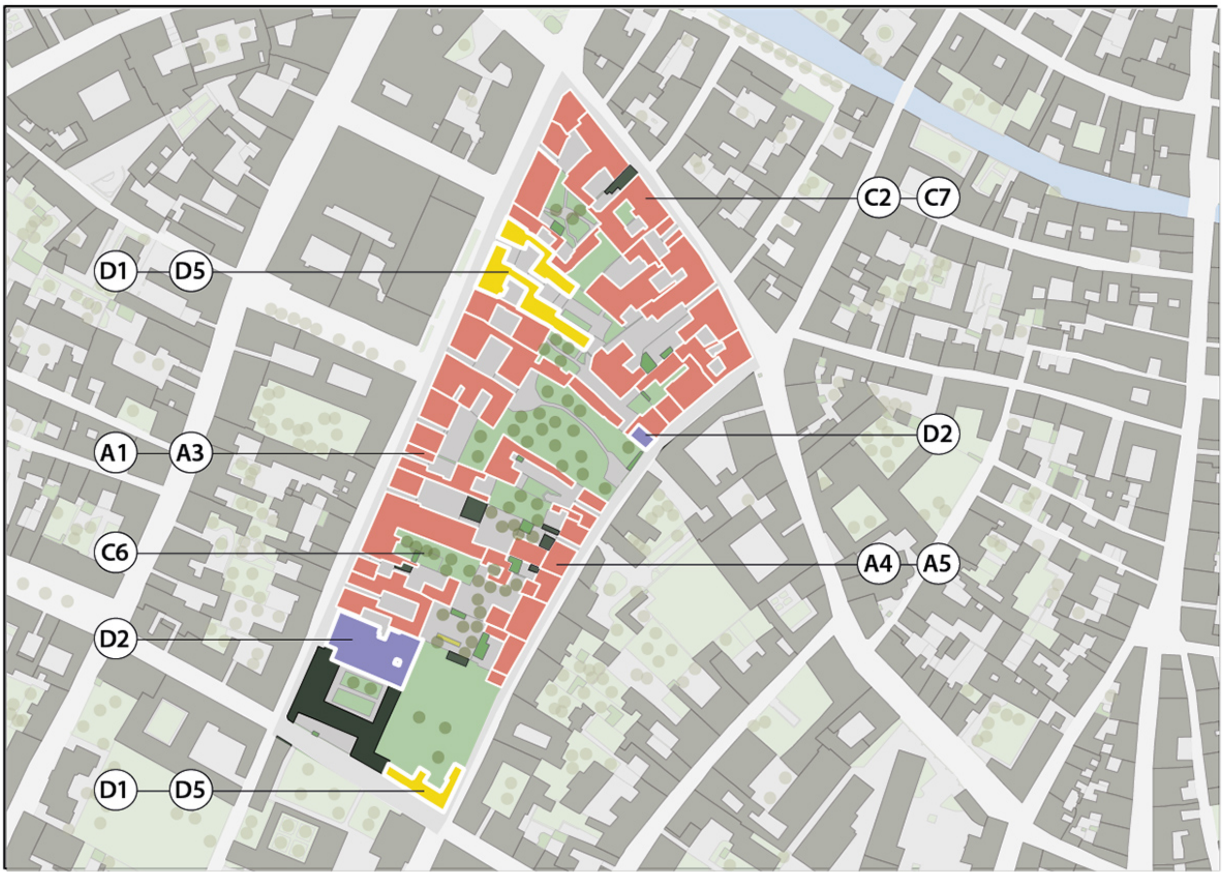

Fig. 7 Example of one of the neighbourhood-wide plan. Each number and colour represent a certain measure. Author's drawing.

5. Discussion

The planning process presented in this paper addresses climate change adaptation and resilience building in a mainstreaming perspective, in a way it can become an integral part of urban planning in general (Wamsler, 2016). The 3-step methodology to acknowledge the context and refine adaptation options can be applied by other cities who are willing to develop an adaptation plan like the one required by the Mayors Adapt by The Covenant of Mayors, the world's largest movement for local climate and energy actions.

The strength of the approach of the case described is that the feasibility of the measures is assessed previous the implementation moment, usually a time-constraint period. This allows the policy-maker to have a clear

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scheme of which action can be implemented, with which planning tool and in which part of the city. The local municipality can incorporate adaptation from the very beginning of a project or a plan review, maximizing the mainstreaming opportunities, and not just as retrofits or modifications for the project approval. An urban adaptation plan enables to embed essential adaptation actions into existing and future plans and policies, helping to prevent adaptation being regarded as an "optional extra" (Ribeiro et al., 2009). However, since the measures and prescriptions of an Urban Adaptation Plan are not mandatory, the effective implementation of the measures is connected to political will and may vary from case to case, and during time. To ensure that adaptation is included in the local urban agenda, current and future, it should be accompanied by public dialogues and participatory processes to build lasting consensus and by recurring capacity-building activities to ensure coordination of the internal departments on the themes of adaptation and resilience.

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