

e “superfici non permeabili” (ghiaia; coppi rossi; cemento; asfalto; suolo nudo). I livelli informativi creati sono:

- superficie permeabile (comprendente verde a terra e alberature);
- edifici;
- superficie impermeabile (ghiaia, coppi rossi, cemento, asfalto);
- temperatura superfici;
- KWh tetti;
- KWh superfici a terra;
- Sky View Factor.

Individuati i livelli informativi necessari alla valutazione della vulnerabilità e completato il loro processo di produzione, si è proceduto a migrare tutte le informazioni utili all'interno di un nuovo geo database, appositamente creato, avente come struttura geometrica i confini censuari dell'Istat 2011 e la possibilità di gestione mediante comandi in SQL. Utilizzando il database ISTAT si sono determinate ulteriori valutazioni, concernenti la vulnerabilità “sociale”. Gli Indicatori creati a riguardo sono:

- popolazione totale;
- popolazione sensibile giovane (<10 anni);
- popolazione sensibile anziana (>65 anni).

Il nuovo geo database è stato utilizzato per produrre: Raster NDVI, Raster DSM, Raster LST, Raster SVE, Raster Incoming Solar Radiation. Queste nuove informazioni sono state utilizzate per la valutazione della vulnerabilità (SENSITIVITÀ – CAPACITÀ ADATTATIVA = VULNERABILITÀ) delle aree soggette ad accumulare calore, ovvero le isole di calore (figura.2), e delle piogge meteoriche intense, considerando 3 possibili scenari di pioggia: 1,20 mm; 2,60 mm; 3,10 mm.

In questo modo, le Linee Guida potranno indicare interventi mirati nelle aree la cui vulnerabilità ad acqua e/o calore è maggiore, andando a toccare e ad intervenire su ogni singolo parametro indipendentemente.

F4. Identificazione delle misure e delle strategie compensative

L'ultima delle 4 fasi è quella dedicata alla selezione e costruzione delle misure e strategie compensative per mitigare gli effetti degli impatti del cambiamento climatico sul territorio della città di Mantova. In questa fase vengono pertanto identificate in modo generale, ovvero, non declinate in specifici punti

del territorio tutta una serie di possibili misure raggruppate per tematiche un abaco. Nello sviluppo dell'abaco e la suddivisione in tematiche sono stati considerati diversi fattori: l'applicabilità rispetto alla normativa di riferimento del Comune di Mantova, gli impatti e le vulnerabilità sviluppati nella Fase 3 ed i tessuti del territorio comunale.

Conclusioni

Le “Linee guida per il piano di Adattamento Climatico” della città di Mantova sono poi state corredate di alcuni focus specifici su aree ben definite. In questo modo, attraverso i focus è stato possibile spiegare in modo diretto come utilizzare le informazioni delle linee guida in un processo che passo-passo porta l'amministratore pubblico ad essere in grado di fare scelte programmatiche e dare indirizzi progettuali specifici per l'adattamento climatico. Le linee guida non si sostituiscono al piano ma anzi ne costituiscono lo scheletro, in modo da creare una situazione che concorre al raggiungimento degli stessi obiettivi.

Note

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Co-Creation Pathway as a catalyst for implementing Nature-based Solution in Urban Regeneration Strategies Learning from CLEVER Cities framework and Milano as test-bed.

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Abstract

Nature-based solutions (NBSs) have been on the forefront of the urban regeneration processes in a later fashion; that direction fundamentally intertwines with the European Commission framework of Research and Innovation policy on “Re-Naturing cities and Green Infrastructure” aiming towards positioning the EU as leader in ‘Innovating with nature’. This research paper exploits the originality of using Co-Creation as Pathway for cities to better implement NBSs, and achieve flexible, open, equitable urban resilience, and adapt climate change strategies. Co-Creation dynamic processes build on involving stakeholders and engaging local community at every stage; moreover, account on collective governance and outputting social, economic and environmental ‘Co-benefits’. Primarily, the aim of this paper is to highlight the innovation of Co-Creation tools towards addressing NBS challenges, as well as, the assessment of front-runner cities’ governmental approaches in facilitations or deficiency towards the accomplishment of Co-creation processes. The case-study application of this work refers to the NBS Co-creation guidance -under development- for the H2020 project ‘Clever Cities’ under GA776604, specifically tailored for the cities of London, Hamburg and Milan.

Keywords: co-creation; CLEVER Cities; nature-based solutions; Urban Innovation Partnership; CLEVER Action Labs.

Introduction

CLEVER Cities basically developed two main concepts: Urban Innovation Partnership (UIP) and CLEVER Action Labs (CALs) as main representation of the powerful mecha-

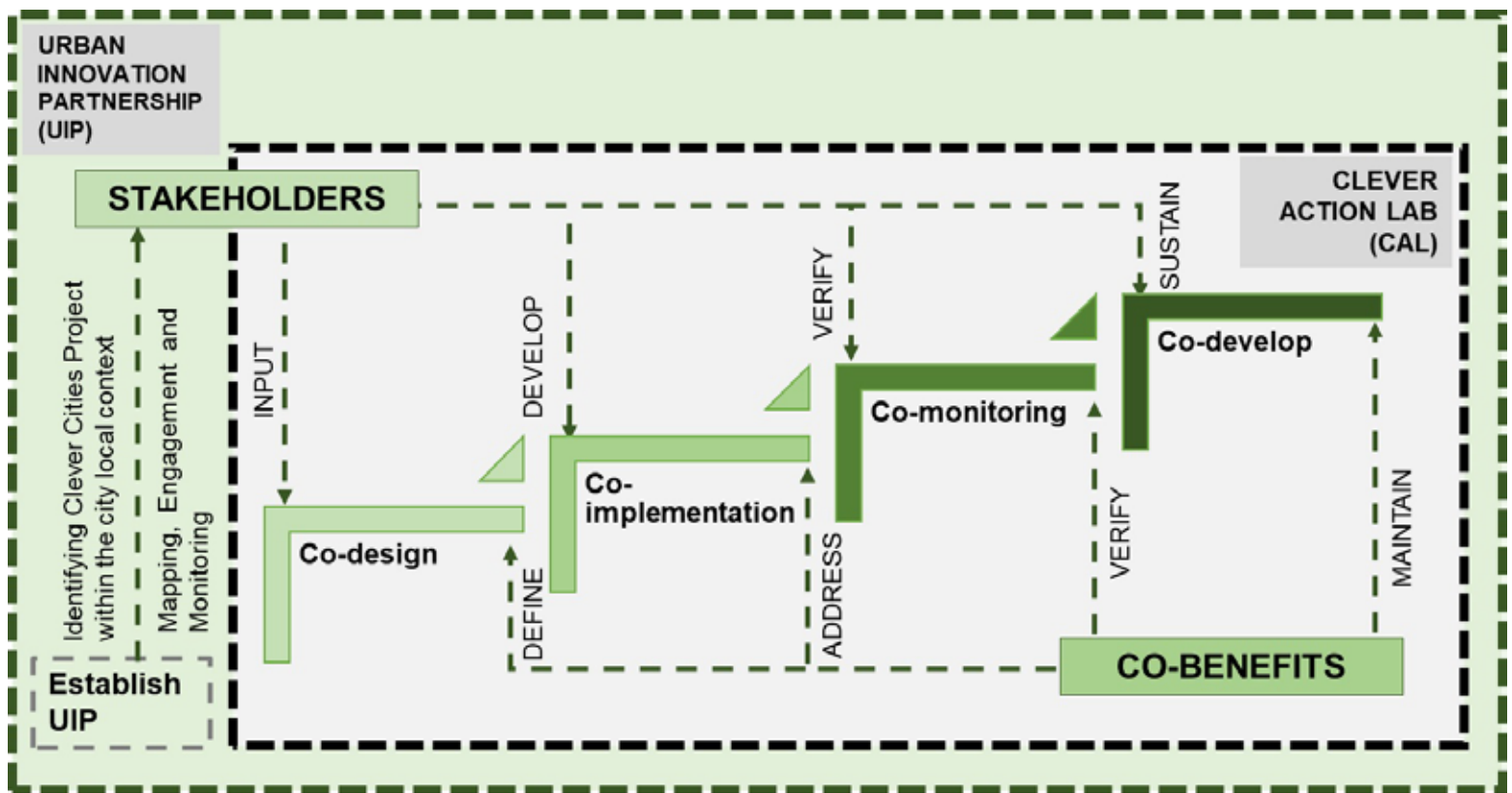


Figure 1: Diagram with the overall the UIP establishment and co-creation stages in CLEVER Action Labs.

nisms to implement nature-based solutions in urban fabrics. Three cities are on the forefront of the experimental processes: London, Hamburg, and Milan. Running on different scales, CALs work as an urban living lab of co-creative solutions implemented. Co-creation in the CLEVER Cities framework encompasses Co-design, Co-implementation, Co-monitoring and Co-development. The main notion of establishing a Co-creation process evolves on two horizontal axes (Stakeholders and Co-benefits). Stakeholders are expected to formulate inputs to the establishment of UIP and help define the later potential co-benefits. The UIP hence, works as a mixing pot for all potential stakeholders in the local cluster for FR Cities and/or represents an overall support for the co-creation processes to be held in FR Cities CALs. Individually, CALs go through a process of: defining co-design, addressing the co-implementation, verifying the co-monitoring, and sustaining the co-development.

Research Context

Co-creation of nature-based solutions is a fundamental approach to address the impacts of global environmental changes and create new opportunities for all people. So far, the knowledge frameworks to influence the processes and outcomes of climate chan-

ge mitigation and adaptation are still limited (Parsons, Fisher, & Nalau, 2016). Hence, this guidance aims to better understand the co-creation processes that shape the implementation of nature-based solutions at its best and most effective kind of way. The main reference point for this guide is the CLEVER Cities project framework. Toolkits for the co-design and co-implementation of nature-based solutions are being developed for cities to use these as reference in their co-creation processes.

What is Co-Creation?

Co-creation arose from the business world as 'the practice of collaborative product or service development: where developers and stakeholders are working together' (Pater, 2009). However, the evolution of co-creation in urban planning policies from a user-centred approach to a co-creative designing approach changed in the practice as well, since earlier 2007 emerging new domains of collective creativity (Sanders & Stappers, 2008).

Co-creation gained ground in the academic literature as a 'common framework' to integrate the co-production of knowledge with the co-design of the research based on implementation phase outcomes, definitions, and joint framing of a social problem (Mauser et al., 2013). In addition to that framework, stakeholder involvement and academic institu-

tional involvement were regarded through the lens of sectoral integration, with the ambition of transforming decision making processes into a reflexive learning processes that brings together different actors and knowledge practitioners (Galafassi et al., 2018).

In other words, successful solutions to environmental problems in a co-creation process require the combined efforts of different scientific disciplines and active dialogue between stakeholders from policy and society actors (Frantzeskaki & Kabisch, 2015). From a business approach, these values of co-creating better and more innovative solutions have a wider impact on problem-solving; by taking a developmental approach towards co-identifying a problem/need and co-solving a solution for it (Aarikka-stenroos, 2016).

Co-creation Principles:

According to Jansen and Pieters (2017, p. 4) complete co-creation processes will be perceived as inviting and inspiring for cities to tap into to address their challenges, if the following principles are achieved:

- Togetherness: there is equal collaboration between all internal and/or external parties.
- End-users: they play a central role to complete the overall process.

- Ongoing: The process is ongoing and participative in every phase.
- Productive: it leads to implementation of the co-created solution.
- Transparent: relevant information is accessible to all.
- Supported: supported by all stakeholders.
- Value-driven: results in value creation for end-users and involved parties.

- Co-Creation brings together different knowledge and capabilities

Co-creation is a novel form of interaction which involves innovative and active collaboration between two or more partners: NGOs, foundations, public institutions, private companies, academics, representatives of civil society and/or local development organizations, and citizens themselves. Each partner brings a different expertise: some know more about the area, others about the people and their daily experiences, and others about the local challenges.

Through the first phase of the Urban Innovation Partnership (UIP) establishment, partners explore the benefits of cooperating and highlighting each other's strengths, making the whole process more efficient and leading to better quality outcomes. The cooperative dialogue is not designed to force compromises, but rather to facilitate learning and build on complementary strengths and assets.

- Co-Creation is expressed through collective governance

A recent shift towards empowering the community rather than just consulting or documenting it is reflected in an increasingly popular method called "participatory appraisal," where local knowledge is not "extracted" by outsiders, but instead shared by its community, which is involved in problem-solving processes from the start (Rock, McGuire, & Rogers, 2018). However, that requires multi-stakeholder activity that in co-creation processes tend to be more conflictive or co-operative (ASHOKA, 2012).

The co-creation Pathway in CLEVER Cities is a form of "Open Innovation" in which ideas are shared, closely connected to user-generated content and actively communicated to allow creativity and shared responsibility. Moreover, co-creation in practice is more about motivating people, inspiring participation, sharing results, continuing development and delivering results at many levels.

Many cities, and organisations find it useful to set out their own principles for engagement – a form of commitment to a genuinely collaborative process which everyone involved signs up to. These principles set out the values and ways of working to which stakeholders will adhere during the process. The examples in CLEVER Cities framework are drawn from the experiences of Cities such as Berlin (Susanne Walz et al., 2012), Vienna (Arbter, 2012) and Edmonton in Canada (City of Edmonton, Aaron Aubin Consulting Inc., & O2 Planning + Design Inc, 2017)

- Co-creation brings Co-benefits and future spin-offs in shared results

Pater (2009) took a leap forward to identify the major ways in which co-creation processes achieve added value, such as co-benefits. Basically, co-creation results in a cultural paradigm change and future spin-offs:

- The direct results of a full co-creation project are the economic value generated by the return on investment as well as keeping participants engaged in the loop of progress and developments.

- The future spin-offs are the side-effects that are somehow unexpected, often hard to foresee, but result in added value to the long-term impact of co-created projects.

Nature-based Solutions: Definitions and challenges for implementation in urban regeneration projects.

The original definition of "Nature-based Solutions" derives from the International Union for Conservation of Nature (IUCN) World Conservation Congress as: "actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges (e.g., climate change, food and water security or natural disasters) effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits" (IUCN, 2012).

Definitions then slightly vary in scholars' articles based on the main implications. So far, the most complete guidance on NBS was developed by The European Commission (2015, p. 4) to be adopted in the EU Research and Innovation policy agenda for NBS & Re-Naturing Cities' relying on four principal goals to address nature-based solutions where they are defined as "actions inspired by, supported by or copied from nature that aim to help societies address a variety of en-

vironmental, social and economic challenges in sustainable ways".

While nature-based solutions are not new to the world of climate change adaptation and mitigation (previously under the umbrella of Ecosystem-based Adaptation (EBA), Urban Green Infrastructure (UGI) and Ecosystems Services (ESS), see (Kabisch et al., 2016; Kabisch, Korn, Stadler, & Bonn, 2017)). In most cases, these approaches are complementary, have considerable overlap, and are also used in the non-urban context. All of these terms focus on developing systemic approaches utilizing concrete implementation actions as solutions to address impending climate pressures and risks, based on the specific context (Bourguignon, 2017).

Objectively, the idea, which the IUCN defined in (2012) from a slightly different perspective, can be seen as an umbrella concept covering several approaches promoting the protection, sustainable management and restoration of ecosystems as a way to address societal challenges, while providing human wellbeing and biodiversity co-benefits at the same time. Related approaches and problem-solving techniques include 'ecosystem services', 'ecosystem approach', 'ecosystem-based adaptation and mitigation', 'blue-green infrastructure' and 'ecological engineering' (Cohen-Shacham, Walters, Janzen, & Maginnis, 2016).

- NBS and Urban Regeneration for addressing community needs

From a more holistic point of view, 'Nature-based Solutions are approaches, that use environmental processes and natural systems to help address a human or community need'. Nature-based solutions can look very different from community to community depending on the type, location, and scope of the hazard addressed, (Leung, Woiwode, & Smith, 2018). Henceforward, the implementation of nature-based solutions in CLEVER Cities plays an important role in connecting planned outcomes for urban regeneration processes with responses to specific societal challenges. De Lotto (2017) highlights the multi-scalar and interdisciplinary operational actions and tactics for incorporating NBS in planning policies and the management of urban regeneration projects: whether minimal interventions in ecosystems, intensively managed ecosystems and landscapes, and/or very intrusive new ways to co-create ecosystems,

such as artificial ecosystems like green and blue infrastructures (Eggermont et al., 2015). In fact, the interventions of NBS such as “Re-Naturing Cities” strategies cross beyond the boundaries of environmental improvements towards a multifunctional benefits approach that differs based on city contexts.

The Commission for Architecture and the Built Environment (CABE), which maintains the policy discourse of design-led regeneration, released guidance that maintaining environmental character and continuity should be core principles of urban regeneration policies (CABE, 2004). Henceforth, utilising NBS as a tool to achieve urban development goals while also benefiting society and the environment, can support a more inclusive urban regeneration towards a greater sense of community, combating social exclusion and reducing gentrification and inequalities within and between cities and regions (UIA, 2018).

In connection with the CLEVER Cities framework, Urban regeneration, see (Tallon, 2013), broadly encompasses the idea of improving, reorganising and upgrading an undesirable urban context (as opposed to the planning of new urbanisation). It can, for example, refer to the redevelopment of overcrowded areas of the city, economic growth in an area, or property development, see (Pastak & Kährlik, 2016; Vickery, 2007; Williams, Atkinson, & Tallon, 2017). Areas targeted for regeneration can be: spaces that have been abandoned (e.g. brownfields) or neglected (e.g. rivers that have been polluted); places facing particular environmental challenges, such as lacking quality green spaces or high vulnerability to climate change impacts; or areas facing social and economic issues, such as reduced human health and wellbeing, inequality and crime.

- Co-benefits of Nature-based Solutions

Many nature-based solutions result in multiple co-benefits for health, the economy, society and the environment, and thus they can represent more efficient and cost-effective solutions than more conventional approaches. However, nature-based solutions are considered highly advantageous because of their inherent capacity to provide important social, economic, and environmental benefits; for example clean water, healthy environments, and green spaces for recreation, in

addition to their primary function for climate mitigation, adaptation and flood management (Leung et al., 2018).

In urban landscapes, the co-benefits of NBS are being increasingly recognized as a result of provisioning and improved availability of urban green spaces, such as parks, green corridors, etc. Even though not exhaustive of NBS types, such collateral benefits include, improved quality of life, mental and physical health, and reinforced cultural identities, supporting a sense of belonging and place, etc., see (Keniger, Gaston, Irvine, & Fuller, 2013; Nesshöver et al., 2017). Moreover, an overarching review of the literature highlights the importance of health benefits generated by nature-based solutions, in particular, see (Hartig, Mitchell, de Vries, & Frumkin, 2014; Shanahan, Fuller, Bush, Lin, & Gaston, 2015).

Taking this aspect of multi-functionality into account and considering the plethora of co-benefits produced, nature-based solutions are often seen to represent more efficient and cost-effective solutions to climate change threats than conventional approaches, such as regular sewage or air conditioning systems, see (Connop et al., 2015, p. 100).

In CLEVER Cities, a validated approach drawn from case studies was developed to define key indicators for measuring NBS impact based on three dimensions of urban regeneration, see (Davis, Mederake, McFarland, McGlade, & Skodra, 2018). The corresponding indicators used in this framework of assessment include People, Business and Place as the main dimensions of urban regeneration aims and activities. Four thematic topics have been identified amongst these indicators to better prioritise and design a pertinent impact measurement framework within implementation sites in the FR Cities (Hamburg, London and Milan), as follows:

1. Human Health and well-being
2. Sustainable economic prosperity
3. Social cohesion and environmental justice
4. Citizen safety

Co-Creation Pathway in CLEVER Cities Framework

In CLEVER Cities, co-creation is developed as a whole process of participation, collaboration and interaction. The Pathway is designed in steps and feedback loops that considers stakeholders’ abilities to create and

provide added value. The complete co-design process works in conjunction with innovation towards a customization of nature-based solutions for the specific urban contexts of FR cities and FE cities.

The process envisages CLEVER Action Labs as Urban Living Labs (ULL) that ideally are strategic, civic and organic, and incorporate a wide spectrum of experimental platforms for governance, interventions and change. Urban Living Labs offer opportunities to foster sustainability in cities as sites to co-design, test and learn from innovation. A comparative study for the ULLs was conducted in 4 European cities to analyse the success based on the leading actors of partnerships whether user-driven or enabler-driven (Menny, Voytenko Palgan, & McCormick, 2018). For examples on ULLs indicators and good practices see (Schumacher, 2011). CALs are test-beds where cities implement at the innovative co-creation processes and nature-based solutions, bringing together different socio-spatial relations. They thus act as a bridge or interface between policies and scientific work to inform urban planning measures, governance and techniques (Bulkeley et al., 2018).

Co-created solutions, such as in the case of CLEVER Cities, are envisioned as ‘tailored’ nature-based solutions which enable cities to make decisions grounded in validated assumptions. This prevents the wasting of time and economic resources in the FR Cities test-beds (CALs) and allows FE Cities to learn from their experience. In sum, co-creation is a starting point of processes which usually have far reaching effects; however, some results cannot be measured in terms of profit but create enormous spill-over values in terms of co-benefits and future spin-offs, beyond those which correspond directly to the original project goals.

Co-Creation Pathway

The Pathway in CLEVER Cities actively involves end-users and stakeholders along the entire process and taking advantage of the different expertise that they provide. The co-designed Pathway is a procedure which is based on transparency, ongoing productive collaboration of co-design and supporting valuable solutions for co-implementation. Whereas Co-design is a well-established approach to creative practice, particularly

within the public sector. Co-design is often used as an umbrella term for participatory, co-creation and open design processes (Chisholm, n.d.). The involvement of actors along the process can be summarized as:

- Establishment of UIP by sharing expertise (field, technical, sector-based, business, financial) and additional resources.
- Co-design, co-implementation and co-monitoring the project: from design to assessment via cooperative management and the exploration of new forms of governance.
- Co-development: shared investment, replicability of successful experiences, procurement to the overall process and long-term planning.

16 steps are envisioned to support cities to accomplish successful implementation of NBS. Each step is composed by one or more activities, which can be freely adjusted by each city, depending on their local contexts. For each Step it is important to achieve an outcome. Each city has its own geography, geology, climate conditions, as well as social, economic and cultural structures. Hence, the content is merely flexible to be translated and transferred in each city local setting.

An application: Milano as a test-bed for Co-Creation methodology

In this research, we aimed to verify the feasibility and doability of such a complex methodology of Co-creation with the city of Milano

local Cluster partners as a test-bed. Numerous meetings were conducted, and prepared materials were furnished to support the process. A CLEVER Constellation was built in a local Cluster workshop to connect the main city's strategies, data resources, correlated projects, prospective replicability and grass-roots initiatives to the overall operating framework, see Figure 2.

Other constellations for stakeholder mapping and engagement planners were compiled as well to verify the interest of other local actors into the modalities of implementation. Stakeholder groups were divided on a matrix of interest based on roles of collaboration, involvement, consultation and information. The main challenges encountered during the overall validation of the steps and toolkit used were on the alignment between the (UIP) and CALs partners during the first phase of urban innovation partnership establishment.

Three main CALs are starting the implementation of nature-based solutions in Milan urban context by June 2019. CAL 1 is a laboratory of green roofs, CAL2 is a noise and safety barrier along a railway line in Loreeggio- Giambellino, and CAL3 is a mitigation greenway corridor along the Tibaldi station to connect between the other two CALs. The process takes into consideration the differences in urban scales and the types of envisaged NBS to get implemented, the timing, the

expected risks, and the future results. During the Workshop, Each CAL team was asked to consolidate a road mapping and time line planner to cope with the differences of local context and expected risks to encounter, see Figure 3.

Conclusion

The complexity of such a concept of Co-Creation is still under further academic and practical investigation. In this paper, we exposed the framework of CLEVER Cities project as an initiative to test the feasibility of Co-creation of nature-based solutions in urban contexts. Main principles and challenges encountered during implementation of NBS in urban regeneration projects are presented along with concepts of co-design and co-benefits. Milan as a test-bed showed a great potentiality for embedding NBS into the city's strategic plans (Milan 2030, resilience plans, etc.); grass-roots initiatives and similar correlated projects are on-board of the city's local cluster and UIP which allows a larger pool of stakeholder's involvement and future collaborations. More in depth, a collective basis consciousness towards outcoming co-benefits in relevant urban areas of CALs implementation is expected, which strengthens the whole co-creation concept and triangulates the envisioned steps and toolkit framework.



Figure 2: CLEVER Cities constellation within the city of Milano strategic context and stakeholder mapping matrix. Source: the authors, CLEVER Cities local Cluster - Workshop 29 October 2018, Fondazione del Politecnico di Milano.

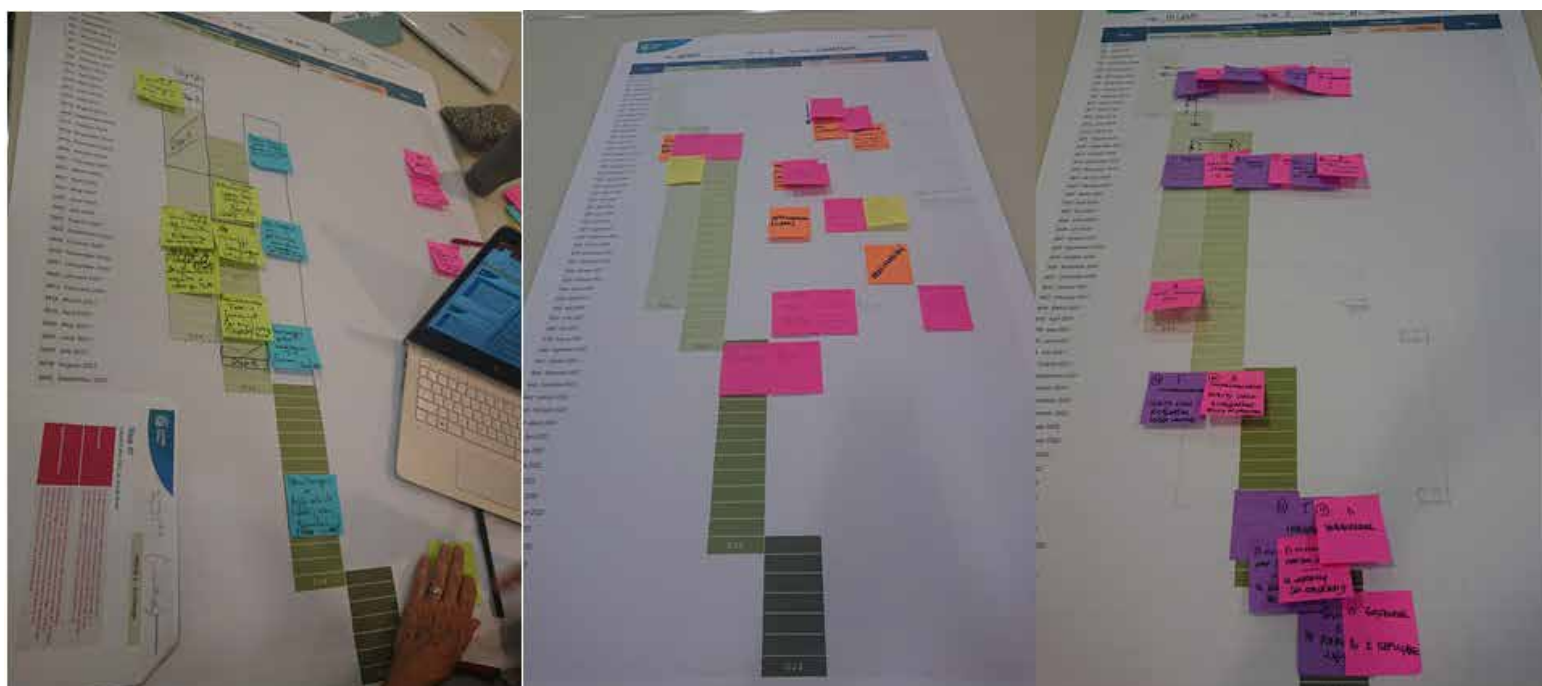


Figure 3: Road-maps and timeline planners for Milan three CALs. From left to right CAL1 (green roofs), CAL2 (Giambellino), and CAL3 (RFI). Source: the authors, CLEVER Cities local Cluster - Workshop 29 October 2018, Fondazione del Politecnico di Milano.

Notes:

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Ondate di calore e resilienza urbana: una proposta metodologica per la valutazione della vulnerabilità della Città Metropolitana di Milano per ciascuna sezione di censimento Istat

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Descrizione delle fasi di progetto e macro-obiettivi

Adattare le città alle ondate di calore implica identificare dapprima quelle aree urbane già soggette al fenomeno isola di calore urbana, ossia aree urbane nelle quali le temperature atmosferiche e quelle delle superfici risultano essere molto elevate rispetto le aree naturali limitrofe (Oke, 1982).

Il fenomeno è stato osservato in molte città di medie e grandi dimensioni, identificando nella morfologia e nella presenza/assenza di di vegetazione gli indicatori della sua intensità (Connors et al., 2013; Cui, de Foy, 2012; Imhoff et al., 2010; Li et al., 2012; Tran et al., 2006).

La valutazione della vulnerabilità della città – capace quindi di identificare le aree meno resilienti alle ondate di calore -, si propone come strumento di supporto al planning, scalabile a seconda del livello di sintesi richiesti dalle diverse amministrazioni (regionali, metropolitane e locali).

La sperimentazione qui proposta analizza, con lo scopo di classificare, aree omogenee della Città Metropolitana di Milano. Lo strumento si presenta come tool di supporto all'adattamento del territorio alle diverse scale amministrative, dalla scala metropolitana, sino ad arrivare a un dettaglio locale "di quartiere", utilizzando per questo come unità di analisi le sezioni censuarie ISTAT.

Nell'ordine dei lavori da svolgere, sempre la valutazione della vulnerabilità assume un duplice significato: il primo di individuazione spaziale delle aree prioritarie per lo sviluppo e l'applicazione delle azioni, il secondo di comunicazione, interna tra le amministrazioni pubbliche coinvolte, ed ester-