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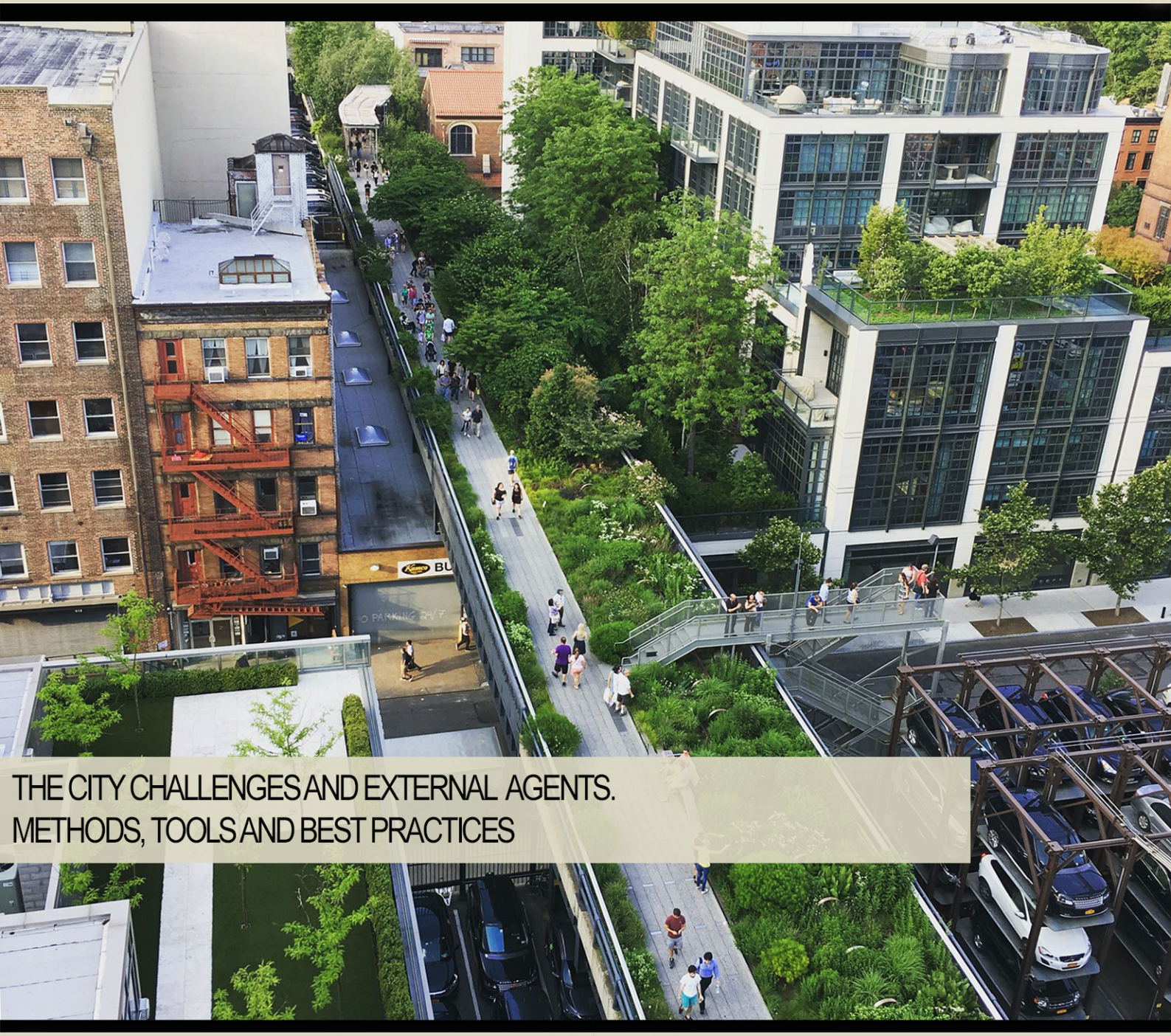

THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

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The city challenges and external agents. Methods, tools and best practices

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Cities need to modify and/or adapt their urban form, the distribution and location of services and learn how to handle the increasing complexity to face the most pressing challenges of this century. On these topics and the ones born during the last year, the scientific community is working in order to minimize adverse effects on the environment, social and economic issues and people's health.
The three issues of the 14th volume will collect articles concerning with the effects of climate change, the ageing of the population, the reduction of energy consumptions from fossil fuels, immigration flows from disadvantaged regions, innovation technology, the optimization of land use and the impacts, in the short and long period, with innovative methods, tools, techniques and practices.
For this Issue, the section "Focus" contains two contributes. The first article of the section is titled "Fostering the climate-energy transition with an integrated approach" by Anna Codemo, Sara Favargiotti, Rossano Albatici (University of Trento, Italy). The paper deals with the well-known topic of climate change and investigates the relationship between adaptation and mitigation strategies in order to evaluate the possibility of combining them in planning policies and design practices. The proposed case study is the Hammerby Siostadt district in Stockholm that could be a significant example also by considering the policies that the City of Stockholm has implemented since 1976, with the adoption of the first environmental program and the development of the policy of adaptation and mitigation.
The second article, titled "Project suggestions for post-earthquake interventions in Italy" by Maria Angela Bedini, Giovanni Marinelli (Polytechnic University of Marche, Italy), focuses on the objective resettlement in the areas of origin of the displaced population. The study aims at providing a set of practical suggestions to make it possible for the population to lead an acceptable "coexistence" with the seismic risk in the high hilly and mountainous areas. This paper also highlights some contents of the current implementation of urban plans (SUM Minimum Urban Structures), which are meant to serve as a dynamic tool for reviving fragile areas.
Two papers address the section "LUME" (Land Use, Mobility and Environment). The first, titled "Congestion toll pricing and commercial land-use: clients' and vendors' perspective", by Mahmoud Saffarzadeh, Hamid Mirzahossein, Ebrahim Amir (Tarbiat Modares University, Iran). The paper investigates the effects of the Tehran congestion toll pricing (CTP) on commercial land uses (CLUs) by examining the clients' behaviour in these business applications concerning the price increase. In the case study of Tehran metropolis, Iran's capital, which has experienced congestion pricing for more than four decades, both clients and vendors' viewpoints were modelled using discrete choice models.
The second article, titled "Recycled aggregates in constructions. A case of Circular Economy in Sardinia (Italy)" by Ginevra Balletto, Giuseppe Borruso, Giovanni Mei, Alessandra Milesi (University of Cagliari, Italy). The paper highlights a theoretical framework for the circular economy, adapting a model of the industrial location to the construction of the Cagliari stadium. Authors build a georeferenced database of activities related to the extraction, processing, and disposal of materials related to construction due to the MEISAR Project. Findings show that the demolition and reconstruction of the Cagliari stadium for the way it was

designed will activate a circular economy process, which will develop between five sub-circular clusters of the city of Cagliari based on the use of recycled aggregates.

The section "Covid-19 vs City-19" collects one publication.

The article titled "Bicycle and urban design. A lesson from Covid-19" by Nicolò Fenu (University of Cagliari, Italy), questions: what is the role of mobility for society and the design of our cities? What is the role of sustainable mobility, of using bicycles addressing the Covid-19 emergency? During and after this emergency, the use of the bicycle can give answers addressing urban quality, liveability for spaces in our cities. The research studies the urban policies of 5 cities: Barcelona, Bogota, Brussels, Milan and Paris and analyses the measures implemented during the first lockdown, from February 2020 to May 2020.

The new Review Notes section propose four insights on the themes of the TeMA Journal.

The first research "Ecological transition: which transactions?" is by Carmen Guida and Federica Natale. This contribution aims at defining the definition and intervention domain of ecological transition. The outbreak of a novel coronavirus and consequent health, economic and social crisis leads to a new era: significant financial resources, plenty room for economic maneuvers may turn the ongoing pandemic into an opportunity, for the following years, to build more sustainable societies and environments. Within this scenario, urban areas play an essential role, as proved in the second paragraph with the support of interesting scientific publications reviewed in the Urban Planning Literature review section of Review Notes.

The second research "Strategies and guidelines for urban sustainability: The impacts of the Covid-19 on energy systems" is by Federica Gaglione. The contribution highlights how the Covid-19 pandemic has a substantial impact on energy systems around the world and on all components of the urban system, for instance on the mobility system and built environment. Furthermore, the review underlines that in this pandemic scenario, the issue of energy has become the focus of discussions by the scientific community and the European Commission. In this direction, the latest documents issued by the European Commission on energy before and after the Covid-19 crisis are analysed with the aim of identifying the priorities and strategies aimed at both reducing energy consumption and improving it in the various territorial contexts.

The third research "Toward greener and pandemic-proof cities? Italian cities policy responses to Covid-19 pandemic" by Gennaro Angiello. The section provides an overview of the policies and initiatives undertaken by three major North American cities in response to the Covid-19 outbreak: New York City (US), Mexico City (MX) and Montreal (CA). Based on this overview, a cross-city analysis is employed to derive a taxonomy of urban policy measures. The article concludes with a discussion on the effectiveness of such measures in providing answers to epidemic threats in urban areas while, at the same time, improving the sustainability and resilience of urban communities.

The last research "Citizen science and urban development" is by Stefano Franco. The section tackles the issue of citizen science, a new data collection methodology for research project that generates sustainability benefits, and that is recently finding applications in urban context to solve social and environmental issues while providing useful information that can be also used to develop urban plans.

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Fostering the climate-energy transition with an integrated approach

Synergies and interrelations between adaptation and mitigation strategies

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Abstract

Cities have a key role in tackling the challenges related to climate change and they constitute an ideal framework to engage with low carbon and green agendas, and to transform the built environment with resilient and inclusive measures.

In this paper, the relationship between adaptation and mitigation strategies has been investigated, to evaluate the possibility of combining them in planning policies and design practices. To this end, recent studies and European policies are reviewed to examine the interrelation between adaptation and mitigation strategies, and to explore to which extent a more integrated approach is foreseen towards urban transitions. The review allows an assessment of synergies, trade-offs and conflicts between adaptation and mitigation in urban practices and highlights several win-win solutions, such as Green Urban Infrastructure and climate sensitive design. However, the analysis indicates a lack of guidance and coordination, leading to the tendency to consider separately adaptation and mitigation, both in policy and in practice.

The study intends to provide an overview of the interrelations and to present the gaps in current processes, with the aim of fostering a more integrated approach at the local level and of implementing more efficiently low carbon and adaptive solutions.

Keywords

Mitigation; Adaptation; Urban design; Climate policies; Integrated approach.

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1. Introduction

Tackling climate change has recently become a priority for the European Union and for the United Nations, with ambitious programs to reduce carbon emissions and to drive towards sustainable development. The European Union set long-term and short-term targets: reducing carbon emissions by 40% by 2030 and reaching carbon neutrality by 2050 (European Commission [EC], 2018). As highlighted in the Pact of Amsterdam and in the Paris Agreement, cities have a key role in contributing to this challenge. Cities are responsible for around 70% of greenhouse gas emissions due to the extensive use of energy in the building and transport sectors (Grafakos et al., 2019). Additionally, they are vulnerable to the effects of climate change, such as floods and heat waves. Therefore, cities have been implementing actions to respond to these challenges, and they have been self-organizing with climate plans, due to the European and international support for bottom-up approaches (Reckien et al., 2018).

According to the United Nations Framework Convention on Climate Change (UNFCC), mitigation and adaptation address different issues of climate change: the former aims at reducing the causes, while the latter seeks to decrease the impacts. Both policies are necessary to effectively tackle climate change and, even though there is a tendency to consider them separately, many interrelations between their strategies exist in cities. Several studies have investigated the relationships between the two policies and have identified, in different urban scales and components, their synergies, conflicts and trade-offs.

However, despite many studies have highlighted the possibilities of combining mitigation and adaptation in urban areas, an integrated approach is still undeveloped. Thus, urban policymakers acknowledge that, to implement adaptation and mitigation actions, they need to integrate them (Creutzig et al., 2020), but few efforts have been made for an integrated approach (Reckien et al., 2018, Pietrapertosa et al., 2019). A recent study of Reckien et al. (2018) analyzed 885 European cities' climate plans and showed that 66% have a mitigation plan, 26% have an adaptation plan, and 17% have a combined plan.

Landauer et al. (2018) concluded that the lack of combined approaches is due to lack of legislation or guidelines. Other studies (e.g. Klein et al., 2005; McEvoy, 2006) argued that mitigation and adaptation have many differences concerning spatial and temporal scales, and actors and sectors involved. Considering the local scale ideal to combine place-specific policies, national and supranational ones, and to translate policies into specific actions, the study draws upon policies and strategies for urban adaptation and mitigation, to identify practices that combine the challenges in the built environment.

The practice of urban and building design is framed by strategies, laws, regulations and operating rules, including building and energy codes, that often separated the design of a building from its surroundings and limited cross-scale interactions. In the design practice, more attention should be paid to consider the influence of microclimate on a building, or the materials of a building on the local microclimate. In city planning, environmental performances, such as retention capacity and temperature regulation, should be integrated in the plans and regulations. Hence further effort is needed to mainstream combined approaches for climate action at the urban scale.

The purpose of this paper is to identify successes, gaps and challenges to respond to the climate-energy transition in the urban environment with an integrated approach, and to try to make steps forward in the assessment of a combined approach.

The method of the research is presented in section 2. Section 3 provides a literature review of recent studies focusing on this topic and presents a re-elaboration of synergies, conflicts and trade-offs of the design practices in the built environment. Section 4 describes the current policy references and resources on adaptation and mitigation in urban areas and identifies ongoing attempts to integrate the two policies. The case study of the city of Stockholm is introduced in section 5 to provide an example of integration between adaptative and mitigative actions in urban planning. The identified successes and gaps for a combined approach are presented in Section 6. Finally, Section 7 reports some conclusions and recommendations for future works.

2. Method

As a first step of the study, interactions between urban adaptation and mitigation strategies are identified. Many examples of positive and negative interrelations are collected from the literature (e.g. Landauer et al., 2015; Grafakos et al., 2018), referring to the terminology given by Klein et al. (2003). Considering that many sectors influence adaptation and mitigation policies (e.g. mobility, constructions, energy production), in this study we focus only on built environment and measures that transform its surfaces.

Based on the literature, we provide a list of urban practices contributing to adaptation and mitigation and we try to define the drivers of conflicts, trade-offs and synergies between them. Measures with different scales are selected, ranging from building-scale, developed in specific projects (e.g. green roofs, insulation), to the urban one (e.g. wetlands, parks), which are normally implemented by local plans.

Urban practices related to adaptation and mitigation are generally regulated by planning polices and urban development management tools, which are guided by planning instruments, and by programs addressing environmental issues ranging from the European level to the local one. To have an overview on how to address climate-related challenges in the urban environment, the study analyses the European climate adaptation, mitigation and urban policies, to identify strategies or guidelines for integrated approaches. Specifically, the policy analysis aims at identifying potentials and constrains to integrate adaptation and mitigation, scale-related and cross-sector issues, administrative priorities and processes, and limitations.

Finally, the case study of Stockholm in Sweden is presented, by examining interrelations and policy coordination between mitigation and adaptation, and by identifying adaptation strategies influencing mitigation and mitigation strategies affecting adaptation.

By providing a collection of key interactions between urban mitigation and adaptation, and presenting the climate policies and their integration in the urban development plans, we try to contribute to the ongoing debate and stimulate more efforts for climate integrated approaches to practitioners and decision-makers.

3. Interrelations between adaptation and mitigation strategies

To tackle the challenges related to climate change, urban areas should contribute to reduce greenhouse gas emissions and to become more prepared to extreme events. To this end, the climate-energy transition in cities is possible by engaging in mitigative and adaptive actions. Adaptation and mitigation strategies are complementary actions to avoid serious impacts of climate change and they can be combined to create a mix of long-term and short-term effects against it. However, adaptation and mitigation strategies may lead to conflictual situations and incompatible actions. Hence, efforts are required to develop and to implement strategies that facilitate successful integration.

The separation of the approaches led to the mitigation and adaptation dichotomy, which is characterized by 3 main differences. The two policies have incompatibilities concerning the spatial and temporal scale: benefits of mitigation are evident in the long-term and at the global scale, whereas adaptation has immediate effects, which can still be effective in decades, and they are place-specific (IPCC, 2007). Another difference emerging is that they involve different stakeholders: mitigation deals primarily with energy and transport sectors, while adaptation, operating from national to single building scale, deals with more sectors and beneficiaries. The third type of incompatibility is related to the extent to which the costs and effects of the policies can be evaluated: while mitigation is estimated in terms of CO_2-equivalents, adaptation benefits are difficult to express in a single metric and they depend on the social, political and economic contexts (Klein et al., 2005).

Klein et al. (2007) defined the different interactions resulting from the integration between adaptation and mitigation: the ideal scenario is to obtain a successful integration, thus generating synergies or co-benefits; while differences in policies objectives or scale's priorities may cause conflicts or trade-offs, especially when they are not coordinated by a common vision.

Urban practice	Driver of conflicts	Description	Source
Green Urban Infrastructure (GUI)			
Urban greening	Physical space request	high demand of space (against M)	Grafakos et al., 2018
Wetlands (storm water system)	Physical space request	high demand of space (against M)	Landauer et al., 2015; Grafakos et al., 2018
Building and Infrastructures (BI)			
Urban densification	Physical space and perviousness request	less drainage, UHI, flood risk; more air cooling (against A)	Landauer et al., 2015; Grafakos et al. 2018
Ventilation	GHGs emissions; lack of energy efficiency	high demand of energy (against M)	Grafakos et al., 2018
Water Management (WM)			
Water pumping	GHGs emissions; lack of energy efficiency	high energy demand (against M)	Grafakos et al., 2018; Grafakos et al., 2019
Flood protection with walls	GHGs emissions	emissions through material production and biodiversity loss	Grafakos et al., 2018

Tab.1 Measures leading to conflicts between adaptation and mitigation

Based on the literature review, a list of measures leading to conflictual interrelations between adaptation and mitigation is provided in Tab.1. A source of potential conflict is the land-use patterns: climate change mitigation is driven by the idea of densification, while a key point of adaptation is the use of open spaces and less densely built environments (Hamin & Gurran, 2009). For example, higher density of urban areas reduces the need to travel and offers more possibilities to develop energy efficiency measures, reducing carbon emissions. However, these mitigation strategies conflict with the demand for space required by adaptation, such as green spaces to retain water or to create cooler microclimates (McEvoy, 2006). According to Dymen and Langlais (2013), the dense city concept may lead to several conflicts of interests with handling of storm drainage, preparedness to drought, retention of environmental qualities, microclimate comfort, and liveability, which all require physical space. Trade-offs are thus necessary to implement open spaces that provide several ecosystem services.

Grafakos et al. (2018) highlighted that some adaptation strategies, such as water pumping or walls for flood protection, conflict with mitigation since they require high energy use or emissions during construction.

Moreover, several studies (McEvoy, 2006; Laukkonen et al., 2009; Landauer et al., 2015) state that other reasons for a negative interrelation between the two policies is the lack of coordination and of monitoring, leading to scarce balance of interests. Setting a common vision based on sustainable development at the local scale could be a guide to ensure proper choices in urban planning (McEvoy, 2006) and to prioritize the measures needed (Laukkonen et al., 2009).

Trade-offs are defined as "a balancing of adaptation and mitigation when it is not possible to carry out both activities fully at the same time, e.g. due to financial constraints" (Klein et al., 2007, p.749). Trade-offs may have a positive or neutral meaning, hence the ability to negotiate them is essential. According to Grafakos et al. (2018), negotiations are necessary in decisions between "soft" or "hard" engineering, and in situations where the temporal scale of implementation causes uncertainties, such as planning, financial, or data related. Due to the interaction between different scales and sectors, some measures that generally produce positive effects in terms of adaptation and mitigation can require some negotiations. For example, implementing Green Urban Infrastructures (GUI) provides many benefits from social, environmental, health and economic points of view and generates many synergies between adaptation and mitigation. However, Demuzere et al. (2014) identified some trade-offs: maintenance and construction activities cause greenhouse gas emissions,

fertilization reduces run-off capacity, tree shade in cold climates reduces solar radiation, thus increasing heating demand. In such cases a common vision and coordination between sectors and stakeholder is helpful to avoid conflicts.

The positive interaction between adaptation and mitigation results in synergies or co-benefits. In some of the analyzed articles, the two terms are used as synonyms; in others (e.g. Klein et al., 2007), a distinction is made: "co-benefits" are measures beneficial for both policies, whereas "synergies" consist of a greater effect of the combined measures, than the sum of their effects if implemented separately. Since the purpose of the study is to investigate the opportunities for integrated approaches in planning policies and designing practices, in this paper, we will not make a distinction between synergies and co-benefits.

Despite the dichotomy between adaptation and mitigation, local measures have shown several win-win solutions in different sectors, with which both climate policies are achieved. A detailed list of specific urban design solutions providing synergies between adaptation and mitigation is shown in Tab. 2, and is divided by the following sectors: Urban Green Infrastructure (GUI), Building and Infrastructure (BI), Energy Sector (SE), and Water Management (WM).

First, GUIs lead to many synergies, developing climate resilient urban areas and reducing emissions (Demuzere et al., 2014, Shirgir, 2019). GUIs are multifunctional and multiscale green and blue spaces (e.g. forests, green roofs, wetlands) that provide cross-scale provisioning, regulating, and cultural ecosystem services (Demuzere et al., 2014). The European Commission (EC) recognized the value of GUI and of its ecosystem services for the cities, and supports the re-naturalization of built environment through nature-based solutions (EC, 2015; EC, 2016).

(a) (b)

Fig. 1 (a) Green roof with energy production in Basel (Source: Stefan Grossert) and (b) roof-top farming on top of the Dakakker office building in Rotterdam (Source: Ossip van Duivenbode).

Demuzere et al. (2014) categorized the services and benefits of GUI that are beneficial both for mitigation or adaptation: CO_2 reduction via photosynthetic uptake during the day and its release during the night; thermal comfort and reduction of energy use, by lowering air temperature through shading and evapotranspiration; improvement of air quality and reduction of flooding problems by infiltrating water and by bioretention; improvement of air quality due to pollutants absorption.

However, the cooling effect strongly depends on the water of the vegetation: if during heat waves there is no water available, the cooling effects is not relevant (Viguié, 2020).

For example, green roofs reduce carbon emissions and temperatures in buildings, they adapt to higher temperatures, and collect rainwater, preventing flooding during heavy rains (Laukkonen et al., 2009). Moreover, they can be integrated with other functions and lead to several co-benefits, such as production of renewable energy or production of food (Fig. 1).

Urban practice	Drivers of synergies	Source
Green Urban Infrastructure (GUI)		
Green roofs and walls	Temperature reduction (A), water retention (A), carbon sequestration (M)	Landauer et al., 2015
Parks, urban forests	Reducing temperature (A) and carbon sequestration (M)	Landauer et al., 2015
Shading buildings with trees	Energy efficiency (M) and reduce need for air conditioning (A)	Gupta & Gregg, 2013; Landauer et al., 2015
Urban agriculture	Reduce need for transportation (M), reducing carbon footprint (M), increase permeability (A), food production (A)	Grafakos et al., 2019
Wetlands (storm water system)	Flood protection (A), carbon sequestration (M)	Landauer et al., 2015, Grafakos et al., 2018
Building and Infrastructures (BI)		
Passive cooling of buildings with night ventilation	Indoor comfort (A) and reducing energy needs (M)	Gupta & Gregg, 2013; Landauer et al., 2015; Grafakos et al., 2018
Building orientation, window performance, insulation	Indoor comfort (A) and reducing energy need (M)	Gupta & Gregg, 2013; Landauer et al., 2015; Grafakos et al., 2018
Increasing resilience of building fabric / adaptive skins	Resilience of the building (A) and energy efficiency (M)	Landauer et al., 2015
Climate sensitive design	Climatic comfort (A) and energy saving (M)	Landauer et al., 2015
Albedo	Minimize the effect of solar radiation (A, M)	Gupta & Gregg, 2013; Landauer et al., 2015
Multiservices infrastructures	Regulating and provision services (A,M)	Hamin & Gurran, 2008
Reuse, recycling	Reduce carbon footprint (M), improve adaptive capacities (A)	Hamin & Gurran, 2008; Thornbusch et al., 2013
Energy Sector (ES)		
Local energy sources, district heating/cooling	temperature comfort (A), energy efficiency (M)	Landauer et al., 2015; Grafakos et al., 2018
Alternative energy sources - RES	reduce transportation and operational energy use (M)	Landauer et al., 2015
Alternative energy sources - smart grids	reduction GHG emissions (M), reduction risk of power shortages (A)	Grafakos et al., 2018
Energy efficiency in buildings	Energy saving (M), enhance building adaptive capacities (A)	Landauer et al., 2018
Water Management (WM)		
Water saving	Adapt to less precipitation (A) energy saving (M)	Grafakos et al., 2018

Tab.2 Measures leading to synergies between adaptation and mitigation

Second, Building and Infrastructures (BI) is another category in which many synergies and co-benefits between adaptation and mitigation occur, particularly in case of passive building design. In this case, the main strategies that simultaneously achieve mitigation and adaptation are energy efficiency urban systems, by reducing waste heat and carbon emissions; measures on form and orientation of buildings, which maximize energy saving and ventilation and reduce the use of heating or cooling systems; design surfaces of building fabric that are heat resistant and climate resilient (Rosenzweig et al., 2015).

Transforming the built environment is particularly challenging, since the retrofitting measures should be also climate adaptive (Grafakos et al., 2018). However, many passive measures, such as improving insulation or increasing the albedo, besides reducing energy needs, also have an impact on the indoor comfort, improving existing conditions.

Third, the Energy Sector (ES) has many sources of synergies: the implementation of measures can contribute to reduce carbon emissions or energy use and to improve temperature comfort or adaptive capacity of the energy infrastructure. For example, the use of alternative energy sources (RES) and decentralized systems (smart grids) locally produced contributes to reduce transportation, operational energy use and risks of power shortages (Landauer et al., 2015).

Finally, synergies and co-benefits may be achieved in Water Management (WM) by using Blue and Green Infrastructure solutions to filtrate and reduce run-offs, such as wetlands, retention areas, green riparian zones, and by adopting solutions to save water consumptions (Grafakos et al., 2018).

According to the analyzed studies, significant opportunities to combine mitigation and adaptation measures take place when dealing with urban regeneration and energy retrofitting. Moreover, building regulations support both safety, energy efficiency, thermal comfort, thus requiring consideration of cross-cutting issues between the two strategies. Strategic planning and urban design should seek to simultaneously address resilience and energy transition and to promote win-win solutions.

4. European efforts for an integrated approach

As previously discussed, many opportunities are available to generate synergies and to combine the effects of adaptation and mitigation in urban practices. It is therefore interesting to analyze and understand if an integrated approach is supported from a policy perspective. For this purpose, we investigated adaptation and mitigation policies focusing on built environment, and urban policies that deal with climate change challenges (Tab.3). The analysis allowed us to provide a general framework, to identify cross-cutting goals and direct reference to an integrated approach as well as gaps.

According to the literature reviewed, developing plans or projects with an integrated approach is convenient, as well as necessary to tackle climate challenges. However, the process might be not simple and clear in all steps, since mitigation and adaptation emerged in policy as two different strategies and have been separately institutionalized. Landauer et al. (2015) collected studies that identified potentials for cross-cutting goals and synergies between the objectives of the two strategies in the policy level. These include, for example, urban regeneration as a bridge for the dichotomy, building retrofitting and regulations to create synergies between adaptation and mitigation, and supporting behavioral change and actors' inclusion.

EU Mitigation strategies for the built environment are contained in various policies sectors: in "Climate action policies" (specifically as "Greenhouse gas emission reduction", "Energy efficiency", "Renewable energy" policies), in "Energy policies" (as "Energy strategy", "Energy efficiency" and "Renewable energy" policies) and in "Environment policies", precisely in "Urban environment" for which the 7th Environmental Action Programme helps cities to manage their areas in a sustainable way.

The three main strategies to mitigate climate change are energy efficiency, use of renewable energy and greenhouse emission reduction, as mentioned in the climate and energy packages. The first, 2020 climate and energy package (2009), provided by European Commission (EC), aims to reach the 20% energy goals by 2020[1]. The second, the 2030 climate and energy framework (2014) is the framework that defines the energy targets by 2030[2], with the goal of reaching climate neutrality by 2050 as indicated in the EU vision "A clean planet for all" (2018). The strategy outlines a road to the decarbonization of Europe's energy supply and to a climate neutral economy by 2050, which requires a deep transformation in energy, building, and transport sectors as well as in society.

[1] 20% cut in greenhouse gas emissions, 20% of EU energy from renewables, 20% improvement in energy efficiency compared to the levels registered in 1990

[2] 40% cuts in greenhouse gas emissions, 32% share for renewable energy, 32.5% improvement in energy efficiency compared to the 1990 levels

Date	Name	Type	Objectives
Climate mitigation (energy efficiency, renewable energy, greenhouse gas emissions)			
2009	2020 climate and energy package	legislation	20% cut in greenhouse gas emissions, 20% of EU energy from renewables, 20% improvement in energy efficiency
2014	2030 climate and energy framework	framework	40% cut in greenhouse gas emissions, 32% share for renewable energy, 32.5% improvement in energy efficiency
2017	Strategic Energy Technology (SET) plan	plan	transition towards climate neutral; collaboration; improving technologies
2018	A clean planet for all	vision+directive	energy efficiency target for 2030 of at least 32.5%, climate neutral by 2050
2020	European green Deal	strategy	long-term low greenhouse gas emission development strategies
Climate adaptation			
2013	EU Adaptation Strategy	strategy	promoting action by member states climate-proofing action at EU level Better informed decision-making
2018	Evaluation of the EU adaptation Strategy	report	adoption of comprehensive adaptation strategies by Member States, Provide LIFE programme, Covenant of Mayors, knowledge gap, Climate-ADAPT, climate proofing of the common agricultural policy, the cohesion policy and the common fisheries policy, resilient infrastructure, Promote insurance and other financial products
Urban policies			
2013	7th Environmental action Programme, PO 8: Sustainable cities	action programme	policies for sustainable urban planning and design: take in consideration environmental issues; raise awareness; involve local actors
2016	Pact of Amsterdam - Urban Agenda for the EU	urban agenda	better regulation; better funding; better knowledge
2018	Regional Development and Cohesion Policy 2021-2027 - post2020 Cohesion Policy	investment policy	key investment priorities; tailored approach; flexible framework; improve investments
2019	Seville Commitment	commitment	implementation of 2030 SDG

Tab.3 Overview of the European environmental policies and urban policies

Precisely, the mitigation goals regarding the built environment consist of the modernization of the building sector, which currently accounts for 40% of energy demand (European Commission, 2018) and the increase of building renovations, by promoting highly energy efficient and decarbonized buildings, sustainable renewable heating, and user engagement.

Adaptation strategies are contained in the "Climate action policies", with which EU promotes actions to help countries dealing with future and inevitable impacts of climate change. Adaptation policies are not detailed as the mitigation ones: EU Adaptation Strategy (2013), in which "action 3" specifically refers to adaptation in cities and which was updated in 2018, invites member States to adopt national strategies to become climate-proof and to have better informed decision-making. EU has recognized the importance of further effort and guidance in adaptation from the European level and, for this reason, added it in the primary future research interests (Horizon 2021-2027).

Besides defining the above-mentioned objectives, EU promotes voluntary programmes and initiatives aimed at mainstreaming and sharing adaptation actions between cities (e.g. Climate-Adapt, Covenant of Mayors) and at supporting bottom-up approaches for more resilient infrastructures, for climate-proof action integration in every sector, and for bridging the knowledge gap.

As highlighted in the New Urban Agenda and in the Paris Agreement, cities will have a key role in contributing to sustainable development and they will tackle many environmental and societal issues. The key role of urban areas in these future challenges is acknowledged both by EU and UN, that signed the Seville Commitment in

2019, recognizing the importance of implementing the 2030 SDGs. In 2013, EU adopted the 7th Environmental Programme, in which "Sustainable cities" were a specific priority objective. The document defines policies for sustainable urban planning and design taking in consideration environmental issues, it raises awareness, involves local actors, and it proposes a low carbon economy. In 2016 EU made the effort of combining all the challenges involving urban areas in one document, the Pact of Amsterdam or Urban Agenda for EU, addressing an integrated and coordinated approach to EU policies. In the Pact of Amsterdam both mitigation and adaptation are relevant, and they are part of the twelve priority actions.

In the Urban Agenda for EU, the climate adaptation action plan provides future design, implementation and monitoring actions, and revision of the existing EU legislations. According to the document, climate adaptation - which in Europe is mainly related to increasing temperatures, precipitation, extreme precipitation events, floods and water scarcity - is weakened by lack of knowledge, awareness, resources, conflicting priorities and coordination. Even though currently still around 75% of European cities are without an adaptation plan (Reckien et al., 2018, Pietrapertosa et al., 2019), the role of Europe was essential in raising awareness and increased voluntary commitment (Reckien et al., 2018). EU adaptation action plan aligns with several statements of the New Urban Agenda (2016) in risk and vulnerability reduction by building resilience and responsiveness, and it specifically refers to Goal 11 of the Sustainable Development Goals (SDGs) to "make cities and human settlements inclusive, safe, resilient and sustainable".

The energy transition action plan promotes clean, secure, affordable energy systems, to be achieved through socially inclusive and progressive policies. The plan considers trade-offs and synergies with other environmental priorities, namely "clean air" and "climate adaptation": only a coordinated approach will meet the decarbonization and environmental targets. The role of cities in energy transition is to decarbonize heat systems and to retrofit buildings through local and renewable energy sources and to promote a clean and sustainable transport system. The goal is to reach the previously mentioned European targets, and to drive the energy transition with a flexible, decentralized, demand-led and zero carbon system that manages both heat and power. EU energy transition plan is coordinated with EU climate adaptation plan to ensure resilient cities and supports the use of actions that generate co-benefits. Finally, the energy transition plan links to the Paris Agreement, to limit increasing temperatures, and to the New Urban Agenda and UN SDGs in several goals: Goal 7 Affordable and clean energy, Goal 9 Industry, innovation, and infrastructure, Goal 11 Sustainable cities and communities, Goal 12 Responsible consumption and production, Goal 13 Climate Action.

According to EU climate adaptation, mitigation and urban policies, there is coordination between measures, and it is clear the common vision for future urban developments, based on increased resilience, quality of life and health. Cross cutting goals can be identified in strategies of energy efficiency, to reduce emissions and to reduce probability of blackouts during heatwaves events, of standards and of regulations for buildings which have to be prepared for extreme events and to reduce carbon emissions, and of behavioral and awareness change.

The Green Deal (2019) is a fundamental part of EU strategy to tackle climate-related challenges and to implement UN 2030 SDGs, and it shows the EU effort to transform the economy towards carbon neutrality. The document, as well as all the previously mentioned policies, supports integration between adaptation and mitigation, however a guidance for this purpose does not exist yet. For example, in 2015, the initiatives Covenant of Mayors (initially only on mitigation) and Mayors Adapt were merged into Covenant of Mayors for Climate and Energy, highlighting the importance to adopt decarbonization and adaptation plans in municipalities. Integrating adaptation and mitigation is also acknowledged in the "Guidebook to develop a Sustainable Energy and Climate Action Plan" by the Joint Research Centre and in the new strategic document of the Joint Programming Initiative [JPI] (2019). According to the documents, the policies should ensure that neither mitigation nor adaptation being deprioritized in the cities' climate response plans.

From a policy perspective, there is awareness of the need for combined approaches between adaptation and mitigation and there is considerable action and participation among politicians and citizens, however, further effort is required to implement integrated approaches (JPI Urban Europe, 2019) and further guidance is foreseen to mainstream them.

5. Interactions in urban planning: case study of Stockholm

To further understand the interrelations between adaptation and mitigation in city planning and urban practices, we present the example of the city of Stockholm. The city was elected Green European Capital in 2010 but adopted the first environmental program in 1976 (City of Stockholm, 2014b). We examine this city to find out (1) the policy development of adaptation and mitigation and (2) the interrelations between them.

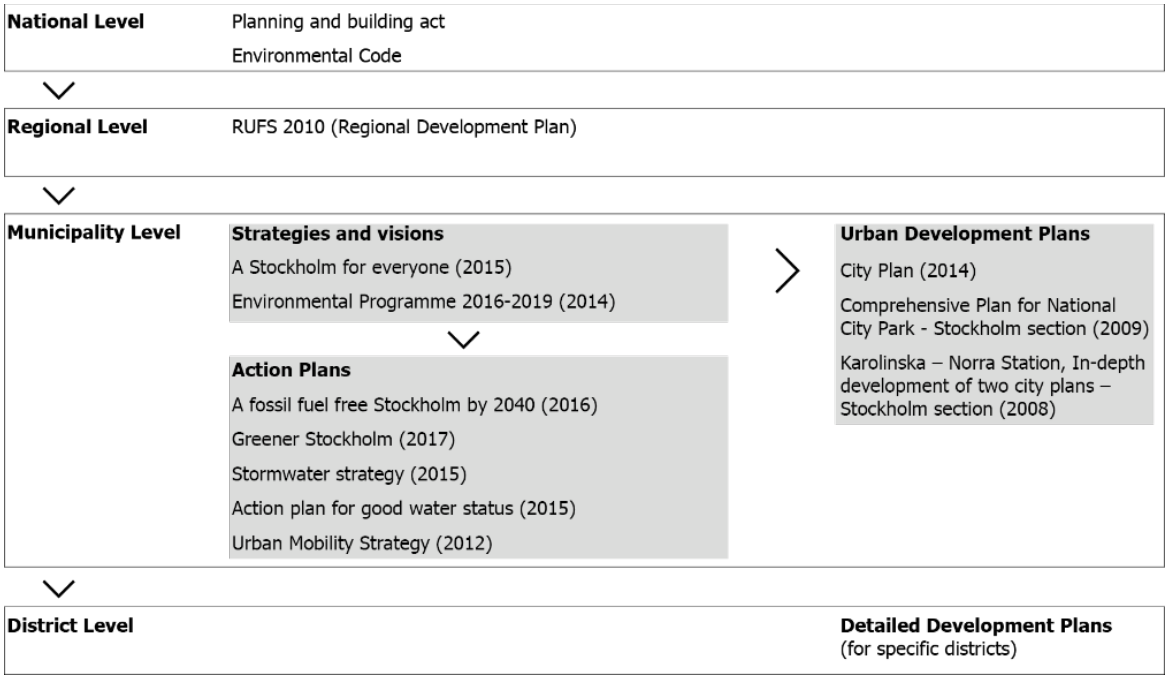

Fig.2 Cross-scale and cross-level structure of Stockholm policies influencing adaptation and mitigation strategies.

The city signed the Covenant of Mayors in 2009 and defined specific targets of emissions reductions within 2020, 2030, and of climate adaptation. In 2009, the city published "Stockholm Climate Initiatives", to set out the ambitious initiatives to reduce climate impacts. As mentioned in the "Action Plan for Climate and Energy" and in "Adapting Stockholm to climate change", the city needs to cope with warmer temperatures, increased precipitation and more frequent downpours, while preserving the quality of environment and the good status of water. The main effort of Stockholm is to combine the urbanization related to increasing population with the sustainable and environmentally friendly vision of the city. Hence, the City pointed out possible trade-offs between the need of densification, mitigation and adaptation, and declared the importance of preserving the green areas as a contribution to reduce the effects of future climate (City of Stockholm, 2009, p. 12, City of Stockholm, 2014a, p.27). The city of Stockholm updated its climate targets and implemented new programmes according to the vision "A Stockholm for everyone" and to the SDGs, defining the city goals for urban and environmental development. The former indicates the ambition to become climate-smart and resilient, while letting the city grow and be an attraction for more people. Specifically, it remarks the importance of creating new climate friendly neighborhoods, of adapting the existing built environment to cope with climate change, and of improving the blue and green infrastructure to ensure several ecosystem services. To fulfil this program, the city relies on currently poorly developed areas, such as brownfields, on the creation of a flexible structure

that can adapt to changes and on the coordination between different sectors. The latter (Stockholm Environment Programme 2016-2019) constitutes the backbone of the 2040 vision from the environmental point of view, by developing missions such as sustainable energy use, environmentally friendly transport, sustainable land and water use with targets and sub-targets and by keeping together climate mitigation, adaptation and energy goals. The structure of built environment and transport system must facilitate low carbon emissions, sustainable energy use, mixed-use development, slow mobility, preservation of ecosystems, healthy water and safety in vulnerable areas.

The vision of the city and the environmental program are further developed and deepened by specific Action Plans (e.g. Fossil fuel free Stockholm by 2040, Urban Mobility Strategy, Greener Stockholm, Stormwater strategy, Action plan for good use of water), and they are coordinated by a comprehensive document, the "City Plan".

As mentioned in the Planning and Building Act (chapter 3, section 2), the City Plan defines the direction of the long-term development of the physical environment and provides guidance on how to use, develop and preserve land, water areas and built environment. Moreover, the City Plan is further developed in detailed plans for specific areas, which define urban planning binding rules.

The structure of the urban development documents and environmental programs allows coordination between different sectors, city departments and scales (Fig.2).

The City Plan gives indications to avoid the conflict while meeting the demands of climate change and reducing energy impacts. For example, to avoid using cooling systems during summer, passive solutions such as screening of sun's rays and natural ventilation should be preferred to cool down the environment (City of Stockholm, 2014a, p. 12). It defines standards to avoid uncontrolled densification in existing neighborhoods and highlighted the importance of safeguarding green areas to achieve simultaneously several ecosystem services and sustainable stormwater management (City of Stockholm, 2014a, p.101).

(a) (b)

Fig.3 (a) Stormwater management in Hammarby Sjostad (Source: Madeleine d'Ersu) and (b) environmental and infrastructural model of the neighbourhood, developed by Fortum, Staocholm Water Company and the Stockholm Waste Management Administration (Source: Bumpling AB).

"One starting point for city planning is to improve the green infrastructure and to build green solutions, such as ecosystem services, into new urban environments. In high-density areas, it is important to ensure that different functions are met within the same space." (City of Stockholm, 2014a, p.27)

Further synergies may be identified in the Hammarby Sjöstad (Fig.3) and the Stockholm Royal Seaport districts projects, both proposing climate proof and climate friendly dwellings.

Hammarby Sjöstad is a former industrial area and, after remediation, it has been developed as a residential district that merges several infrastructure systems (e.g. technical, mobility, green and blue) in a sustainable way. Hammarby Sjöstad reduces emissions by lowering heat consumption, having efficient electricity systems

and using renewable energy sources (bioenergy and re-use of waste to produce heat and electricity). Besides energy, the district is designed to harvest and filter wastewater and stormwater, by creating simultaneously attractive open spaces, and its dense settlement structure is characterized by green courtyards and green roofs.

In Stockholm Royal Seaport, nature and urban environment will be merged to create an inclusive and healthy lifestyle and to reduce climate impact. To wave together urban planning issues and sustainability goals, the city proposed the Sustainable Urban Development programme (2017), a policy document that defines urban planning principles in each implementation phase and sustainable targets to monitor throughout the process. For example, buildings must have a low climate impact and be designed with at least a 100-year perspective and be energy efficient and have resource efficient operations. Moreover, blocks will be used to reinforce the green infrastructure in the area, through green courtyards and green roofs, to contribute to a sustainable stormwater management and increased microclimate comfort.

6. Discussion

As previously discussed, fostering an integrated approach between adaptation and mitigation is possible and convenient, due to the presence of several win-win solutions in practice, and due to the attempts to unify climate-related actions in urban environment in policy. Particularly, both literature and policy reviews identify unused areas' regeneration and building retrofitting as occasions to combine adaptation and mitigation strategies. Thus, if adaptation actions are easier to achieve in newly built areas, actions aiming at transforming already anthropized spaces require more efforts (Zucaro and Morosini, 2018). Moreover, a lack of coordination between different sectors and within different scales, leads to conflicts or trade-offs.

Considering cities and local communities as an ideal framework for implementation of measures, we seek to contribute to the integration of mitigation and adaptation by defining good practices and limitations in the current processes.

Choices about adaptation and mitigation are essential nowadays in cities to avoid serious impacts of climate change. Hence, a taxonomy of interactions between adaptive and mitigative measures is presented, by focusing on the drivers of synergies, trade-offs or conflicts.

To avoid negative interactions or to catalyze positive one, cross-scale and cross-level coordination is essential, and it requires strategic plans and a structured system of interventions. To implement these features in urban planning, an assessment of successes and gaps in the current processes towards an integrated approach is provided. The successes, both in policy and in practice, are driven by the shared vision of sustainable development, which helps to define priorities and to solve conflicts while considering environmental, climatic, and social aspects. Moreover, the coordination between different levels of governance and the presence of cross-cutting goals facilitates the common vision. Negative conditions of current processes appear in cases of silo-thinking or lack of cross-scale coordination, thus generating cross-scale, political or economic conflicts and leading to scarce balance of interests. Based on the analysis and according to several studies (e.g. Molinaro, 2020; Biesbroek,2009), the role of coordination and integration between mitigation and adaptation is related to spatial planning, specifically at the urban or metropolitan scale. However, a limitation highlighted in literature is the obsolescence of some systems of spatial planning, which are not capable of reflecting the complexity of urban challenges.

The results of this study show that models or tools for urban planning are necessary to connect different sectors and scales under the view of a long-term scenario, such as a city plan that coordinates different environmental challenges and cities priorities. Limited consideration of adaptative and mitigative actions in the urban plans and lack of information represent a significative gap in urban planning knowledge.

Cross scale coordination, from local to European policies, is needed to better manage conflicts between short term and long term social and economic conflicts with short term finances. Different planning departments'

and sectors' goals could be unified in a policy document that highlights priorities and clears conflicts or trade-offs. Moreover, the above-mentioned policies should be integrated in the urban development plans defining the binding requirements, to facilitate the transition from vision to action.

An urban programme that embraces these aspects helps to choose multifunctional solutions and to solve trade-offs. For example, designers should avoid adaptation strategies which rely on high energy use and should prefer solutions based on low carbon energy resources and on low levels of emissions (Barbhuiya et al., 2013). Similarly, they should propose mitigation strategies that acknowledge future effects of climate change (e.g. heavier precipitations, increasing temperatures) and consider the interrelations between the single building and the urban fabric in retrofitting projects.

Hence, despite the synergies between many solutions, prioritizing and evaluating solutions might be useful to solve possible conflicts. A recent study from Viguié (2020) showed that little effect is achieved in reduction of air conditioning use in Paris by creating parks and green spaces, a greater impact can be reached by improving building insulation, the greatest impact is a behavioral change. It is important to plan cross-scale interactions and combined urban and building design practices to effectively achieve mitigation and adaptation benefits.

Moreover, when defining future projections, it should be considered that the increase of temperatures will not be determined only by emissions, but also by future population growth and the relative urbanization. In their study, Garshasbi et al. (2020) proved that in Sydney plantation of trees will only compensate population growth. Therefore, to reduce annual energy needs, further strategies, such as increasing albedo of urban surfaces or water base technologies, are necessary, as well as building adaptation strategies.

This study could contribute to make local practitioners and decision-makers aware of how climate policy processes are influenced by scales and sectors interactions. The paper intends to highlight the interactions between urban planning and project practices, by focusing on plans and guidelines at the city level and on measures to transform urban surfaces. However, further studies are necessary on energy and climate implications in urban environment to better understand scale-interactions and to enhance solutions with synergies. To better understand limitations in current planning practices, examination of interrelations and coordination in more case studies, stakeholders' interviews and analysis of economic processes might be a useful asset.

Based on the results, upgrading regulations and guidance at the city level constitute the opportunity to develop new tools that will enable implementation of adaptive and mitigative solutions. An urban plan that combines adaptation and mitigation measures in accordance with the city vision is a good guideline to solve trade-offs between sectors and stakeholders. Moreover, it increases awareness about co-benefits of measures and guides in the definition of solution for specific areas.

7. Conclusion

The study discusses the relationship between adaptation and mitigation strategies and investigates the opportunities for integrated approaches in planning policies and design practices. Focusing on the studies in the urban field, the current state of research and the European policies are examined, to understand to which extent the interrelation between adaptation and mitigation has been studied and with which outcomes.

The paper illustrates an assessment of the synergies, trade-offs and conflicts between specific measures of adaptation and mitigation and reveals several win-win solutions with the use of green and blue infrastructures and sustainable building design. Based on the findings, it can be concluded that the local scale has a great potential to combine adaptation and mitigation strategies and to strengthen co-benefits for a more sustainable built environment.

Despite the opportunities to combine mitigation and adaptation strategies in urban environments, urban and climate policies show a lack of guidelines and coordination between policy sectors to achieve an integrated approach. For this purpose, more guidance for the processes and better awareness of interrelations between

solutions is necessary for designers. Recently, several cities are adopting joint plans which combine different environmental programmes or are supporting the regeneration of neighborhoods with adaptive and mitigative solutions, and they might constitute an example to facilitate a joint approach. To provide an example, the case of Stockholm is presented, showing the integration between urban development and environmental challenges in terms of urban planning. Based on the findings, examining interactions and coordination between urban planning tools provides knowledge to better understand the relations between decision making and climate-related practices. However, further studies are necessary to understand more in detail the limitations of current processes.

Further research of spatial, jurisdictional and management scales' interactions is therefore needed to foster an integrated approach that considers the interplay between policy and practice at the local scale. Particularly, it might be useful to develop methods and tools for integrated climate policy in the cities to overcome the separation between policies and align the needs of urban development and environmental issues.

Finally, experimenting implementation and evaluation solutions in which adaptation and mitigation are joint might help to mainstream and provide guidance for more integrated approaches.

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Image Sources

Fig.1: (a) Stefan Grossert and (b) Ossip van Duivenbode.

Fig.2: Authors' elaboration.

Fig.3: (a) Madeleine d'Ersu and (b) Bumpling AB.

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Project suggestions for post-earthquake interventions in Italy

From building reconstruction to the population resettlement

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Abstract
Over the past 30 years, post-earthquake emergency event management in Italy has far too often focused on the provision of temporary wooden housing modules to accommodate displaced residents transferred from their areas of origin to other places. This has led to losing sight of the central objective of resettlement in the areas of origin of the displaced population. Despite significant financial contributions allocated by the Central Government, unacceptable delays in reconstruction have almost always occurred.
This study is aimed at providing a set of practical suggestions, to make it possible for the population to lead an acceptable "coexistence" with the seismic risk in the high hilly and mountainous areas.
This paper also highlights some contents of the recent implementation urban plans (SUM Minimum Urban Structures), which are meant to serve as a dynamic tool for the revival of fragile areas. A few operational recommendations concern the criteria for the choice of the areas where temporary wooden housing modules are to be established in the transitional phase, near the city centre. Finally, the operational suggestions delivered by the study may provide an opportunity to raise the risk protection level and enhance the most important available resource: human capital.

Keywords
Innovative urban plans; Post-earthquake code of conduct; Risk protection tools; Different lifestyle in fragile areas.

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1. Introduction

The succession of major natural disasters has not resulted into a significant lifestyle "change" in the most fragile areas of the region. Furthermore, the current risk protection system is not yet suitable to modern man requirements. The concept of "coexistence with risks" – whatever their nature might be - is not yet deeply rooted. International studies on the recovery process of pre-existing conditions before the earthquake have not yet led to the definition of international protocols, nor to shared guidelines for a political and administrative post-earthquake management nor to the awareness and enhancement of human values underpinning a balanced regeneration of settlement models and minimum human coexistence requirements.
This is the framework in which this paper has been drafted, by collecting the results of a nation-wide research on the evolution of approaches to subsequent seismic experiences in Italy. A few major operational suggestions are aimed at the reconstruction and resettlement of the population ensuring the most advanced risk protection systems and a better quality of life.

2. Positive and negative aspects of the post-earthquake experiences

This chapter provides an analysis of a few positive and negative results of the studies that have been carried out following the most significant seismic events that have occurred in Italy. These studies concern the earthquakes that occurred in the following regions: Marche, 1930 (magnitude 6.0; 18 earthquake victims); Marche, 1972 (magnitude 5.4 to 5.9; no victims); 1997 (magnitude 6.0; 11 victims); Friuli, 1976 (magnitude 6.4, 990 victims); Irpinia and Basilicata, 1980 (magnitude 6.8, 2,735 victims); Umbria, 1979 (magnitude 5.9; no victims); 1984 (magnitude 5.6; no victims); 1997 (magnitude 6.0; 11 victims); Abruzzo, 2009 (magnitude 5.9; 309 victims); Emilia-Romagna, 2012 (magnitude 5.9; 27 victims); Central Italy, Marche, Umbria, Abruzzo, Lazio, 2016-2017 (magnitude 6.0; 298 victims) (Bedini & Bronzini, 2018).
The early studies on seismic microzonation date from the earthquake of Friuli (1976): the overlapping of areas at different geological and geotechnical soil capacity levels and different statistical probability rates to withstand seismic shocks of varying intensity. This experience has favourably influenced subsequent studies on vulnerability, earthquake standards, classification criteria of the affected areas. A special attention was paid to risk issues and risk mitigation, with contributions from different disciplinary sectors of expertise. The small size of the affected municipalities favoured the reconstruction over an average period of two to three years.
The post-eartquake reconstruction in the *Marche (1972; 1997)* was carried out simultaneously with the definition of a new PRG (General Regulatory Plan). The private reconstruction activities were included in the sector-specific detailed plans, which defined division and re-aggregation of individual public and private housing units, according to a collective interest and urban socialization vision, intended as a land regeneration strategy. The post-earthquake reconstruction, in this case, took a decade, and was carried out on the basis of a "single project". In this sense, the experience of Ancona earthquake of 1972 (Campos Venuti, 2012; Frezzotti, 2011) can be regarded as an example of full restoration of the historical city centre, thanks to the huge amount of funds that were allocated, which led to the transformation of the ancient villages perched on Guasco and Astagno hills into rational neighbourhoods. This intervention has led to a better sanitation of the neighborhoods and a network of paths and private spaces, closed between buildings, transformed into public spaces. The result is an excellent example of the redevelopment of the historic center.
The experience of *Emilia-Romagna* (2012) is a watershed in the earthquake approach. For the first time in Italy, a wide spread area was affected by the earthquake. In this case, a whole highly productive and active industrial and agri-industrial area was concerned, which fostered a multi-stakeholder approach with the involvement of social partners. The rapid reconstruction of public services was made possible by the timely implementation of the Emilia-Romagna Reconstruction Plan (Law no. 16/2012) (Nerozzi & Romani, 2014) entitled to exemptions from the ordinary urban management rules. The so-called 2015 Special Area Programs (PSA / SAP), implemented in 24 municipalities, in accordance with Regional Law no. 30/1996 (Franz, 2016),

and the historic town centre Plans reaffirmed the central role of historic urban fabrics, while the innovative Operational Plan (PO / OP) have enabled the design of a master plan, integrated with the financial programs for social and economic regeneration of the historic town centres (Isola & Zanelli, 2015). The rebuilding process has therefore been supported by a new regional law and a new Urban Plan, with the aforementioned Special Area Program (PSA / SAP). The Regional Law no. 30/1996 made it possible to share a major urban planning experience with the strong involvement of municipal authorities and the private sector.

Not positive results were reached instead during the 2012 experience in the smaller towns of the Ferrara province, featuring buildings and monuments of high historical value (Romanesque, high medieval and Renaissance heritage), but also in other small towns characterized by deteriorated and derelict minor historical town centres, very often occupied by low-income immigrant households, with no means to afford any redevelopment or refurbishment projects.

In *Umbria (1979; 1984; 1997),* the choice of opting for a "soft reconstruction" in 1997 (Nigro & Razzio, 2007) made it possible for its inhabitants to return to their homes in a relatively short time, provided that damages were limited. Thanks to the seismic microzonation, it was possible to distinguish areas with different geological and geo-morphological characteristics, to identify the seismic thrust. The Regional authority issued the Regional Decree no. 64/2010 setting out the guidelines for the definition of the so-called Minimum Urban Structure (SUM) aimed at the seismic risk reduction, pursuant to art. 3.3.d of the Regional Law no. 11/2005. The Regional Law no. 1/2015 has integrated SUM into the regulations as a structural urban planning tool, with the task of selecting functions, infrastructure, spaces, and strategic buildings to maximize earthquake safe conditions, during emergency and post-earthquake recovery of urban, economic, and social activities. SUM was therefore designed to identify the structuring lifelines, the main road infrastructures and their intermodal hubs at different scales, the pedestrian escape routes, the open spaces and strategic and safe buildings, the first aid waiting areas, the reception areas of the population. SUM was also intended to identify the critical elements of the urban system: urban gates of historical value, steep or narrow alleys, areas subject to hydrogeological hazard, buildings built closely along the streets, etc.

In the context of urban and territorial SUM, the Intermunicipal Emergency Plan (I-EP) extends the methodological principles of Limit Condition for the Emergency (LCE) to the territory (Di Lodovico & Di Ludovico, 2018).

In the *Irpinia and Basilicata (1980)* earthquake, planning did not play a significant role. The temporary structures that have been supplied have turned out of deficient usefulness and reconstruction took a long time, partly due to the large number of small urban centres involved.

In the *Abruzzo (2009)* earthquake, Central Government's urban redevelopment choices implemented in the wide historic town centre action of L'Aquila were totally devoid of urban and social cultural background. The Central Government's pseudo-innovative strategy was focused on the design of the so-called New Towns ("19 small neighbourhoods scattered in the middle of the countryside"). The reconstruction experience of the historic town centre of L'Aquila was defined by Campos Venuti as an "outrageous action" (Campos Venuti, 2016; Oliva, Campos Venuti & Gasparrini, 2012). Federico Oliva reinforced this negative assessment stating that the definition of New Towns (15,000 people hosted in 4,500 dwellings) was "a rather ridiculous and disrespectful attitude towards the town planning history, given their poor urban quality and size". The historic town centre of L'Aquila has been turned into a cage of metal scaffolding built around the "restricted area" of the Old Town.

Yet, during the same period, in Abruzzo (57 municipalities involved, within three provinces), an alternative revitalization model was designed as part of a university redevelopment project intended for local small municipalities, away from the limelight of the political and media propaganda, in juxtaposition with the negative reconstruction model applied in the historic town centre of L'Aquila. In the framework of this project, nine distinct homogeneous areas were identified, where a coordinated area-wide management programme pooling together a set of services (Di Ludovico & Di Lodovico, 2020) involving more municipalities, was implemented.

The Building Reconstruction Plan also featured a few Strategic Plan attributes, aimed at implementing a socio-economic and spatial programming activity. One again, the Minimum Urban Structure was applied relating both to the urban and regional level. Safe urban routes were identified, as well as protected areas and buildings where maximum protection was to be ensured. Conversely, the possible SUM hot spots and critical conditions were highlighted.

A special focus was placed on the integration of the Old City and the rest of the city centre, by enhancing the interconnecting spaces where safety and beauty could be reconciled, thus not only limited to the functional SUM elements: places featuring a set of formal, cultural, environmental and social values.

The urban and territorial SUM has therefore played a major role in serving as a reference tool, compared to the past, to inform people about where to stop safely, meeting points and escape routes and places, thus facilitating and accelerating the actions to be undertaken by the Civil Protection authorities. Hence, it has proved to be a useful tool in reassuring residents willing to return to their homes in the areas affected by the earthquake.

In *Central Italy,* the earthquake in 2016-2017 (August 24, 2016: epicentre Accumoli, Lazio, 298 victims; 26 October 2016: epicentre between Castelsantangelo sul Nera and Visso, Marche, no casualties; 30 October 2016: epicentre Norcia, no casualties) involved four regions, 10 provinces and 139 municipalities, for a total of about 8,000 square kilometers, reaching magnitude 6.5 with the shock recorded on October 30th, and razing to the ground valuable historic town centres[1].

3. Operational aspects of the 2016-2017 earthquake emergency

During the 2016-2017 earthquake (Istat, 2018), the affected population was accommodated in temporary housing solutions, according to three different forms of subsidy: the first one was applied in the early months of the emergency, through the accommodation of the displaced population in hotels and houses mainly located in tourist resorts along the coast; the second one consisted in granting cash contributions for the rental of other types of housing facilities (the so-called CAS, Autonomous Accommodation Contribution); the third one, which was completed over a period of about 30 months after the earthquake, consisted of temporary wooden housing modules built in non-built-up areas (referred to as SAE, "Emergency Housing Solutions"), in over 70 parcelling lots with variable surfaces, located in 28 municipalities within the area affected by the earthquake.

EARTHQUAKE IMPACT ON HOUSING SYSTEM: Municipalities with population in emergency housing solutions	N. Municipalities	Territorial surface (km²)	Resident population (on 31/07/2016)	POPULATION IN EMERGENCY HOUSING SOLUTIONS (June 2018)						POPULATION IN EMERGENCY HOUSING SOLUTIONS
				People with contribution for renting accommodation (CAS)		N. people in hotel	N. people in other accommodation facilities	N. people in emergency housing (SAE)	TOTAL population	
				N. people	N. households					
MORE THAN 50 % of the population	**9**	655,5	**13.965**	5.445	3.005	482	341	2.331	**8.599**	27,79%
BETWEEN 30% e 50% of the population	**7**	213,1	**4.874**	1.380	642	78	7	428	**1.893**	6,12%
BETWEEN 10% e 30% of the population	**21**	1.114,9	**62.881**	10.689	4.706	247	22	458	**11.416**	36,89%
LESS THAN 10% of the population	**49**	1.994,7	**266.753**	8.983	3.843	20	15	20	**9.038**	29,21%
TOTAL MARCHE SEISMIC CRATER	**86**	3.978,3	**348.473**	26.497	12.196	827	385	3.237	**30.946**	100,00%

Tab.1 Marche Region, the earthquake impact on the housing system. Summary Picture

[1] The Marche Region was the most damaged area of the four regions located within the "seismic area", with extensive damage in 86 out of a total of 139 municipalities involved (3,978 sq. km. of affected regional surface), with a very heavy toll: more than 104,000 damaged buildings, 54,000 evacuated buildings and 32,000 displaced persons, of whom 28,500 benefited from Autonomous Accommodation Contributions (CAS) since the beginning and about 3,400 people were housed in various accommodation facilities along the Adriatic coast. To avoid the depopulation of the earthquake-stricken areas and to bring people back to their homes, since August 2017, over 4,400 people have been temporarily housed in the so-called Emergency Housing Facilities (SAE), progressively built in 28 municipalities located in the seismic area.

MUNICIPALITY	Territorial surface (km^2)	Resident population (on 31/07/2016)	POPULATION IN EMERGENCY HOUSING SOLUTIONS (June 2018)						POPULATION IN EMERGENCY HOUSING SOLUTIONS	EARTHQUAKE IMPACT ON HOUSING SYSTEM: Municipalities with population in emergency housing solutions
			People with contribution for renting accommodation (CAS)		N. people in hotel	N. people in other accommodation facilities	N. people in emergency housing (SAE)	TOTAL population		
			N. people	N. households						
Arquata del Tronto (AP)	92,2	1.160	468	245	41		418	927	79,91%	
Camerino (MC)	129,9	7.008	2.965	1.791	239	305	18	3.527	50,33%	
Castelsantangelo sul Nera (MC)	70,7	274	69	42	11		108	188	68,61%	
Fiastra (MC)	57,7	552	208	94	7		130	345	62,50%	**MORE THAN 50 %** of the population
Muccia (MC)	25,9	915	331	155	16	10	396	753	82,30%	
Pieve Torina (MC)	74,8	1445	578	274	37	3	516	1134	78,48%	
Ussita (MC)	55,3	447	101	51	11		177	289	64,65%	
Valfornace (MC)	48,6	1058	375	182	46		225	646	61,06%	
Visso (MC)	100,4	1106	350	171	74	23	343	790	71,43%	
total	655,5	13965	5445	3005	482	341	2331	8599		
Bolognola (MC)	25,9	138	49	23	5		12	66	47,83%	
Caldarola (MC)	29,2	1806	464	214	32		253	749	41,47%	
Cessapalombo (MC)	27,6	508	163	80	11	7	20	201	39,57%	
Gagliole (MC)	24,1	632	215	88	3		4	222	35,13%	**BETWEEN 30% e 50%** of the population
Monte Cavallo (MC)	38,5	132	21	9			20	41	31,06%	
Montegallo (AP)	48,5	529	198	101	3		44	245	46,31%	
Pioraco (MC)	19,5	1129	270	127	24		75	369	32,68%	
total	213,1	4874	1380	642	78	7	428	1893		
Acquacanina (MC)	26,8	122	37	23				37	30,33%	
Acquasanta Terme (AP)	138,4	2885	753	356	19		6	778	26,97%	
Amandola (FM)	69,5	3623	487	225	3	13	2	505	13,94%	
Camporotondo di Fiastrone (MC)	8,8	557	122	43	2		17	141	25,31%	
Castelraimondo (MC)	44,8	4578	638	280	18		25	681	14,88%	
Colmurano (MC)	11,2	1260	181	78				181	14,37%	
Cossignano (AP)	15,0	976	94	41				94	9,63%	
Force (AP)	34,3	1321	203	83			14	217	16,43%	
Gualdo (MC)	22,2	812	189	76	1		20	210	25,86%	
Monte San Martino (MC)	18,5	757	91	33				91	12,02%	
Montefortino (FM)	78,6	1162	294	123				294	25,30%	**BETWEEN 10% e 30%** of the population
Montemonaco (AP)	67,8	586	145	72				145	24,74%	
Palmiano (AP)	12,7	189	22	12				22	11,64%	
Roccafluvione (AP)	60,6	1994	231	111				231	11,58%	
San Ginesio (MC)	78,0	3479	810	371	33	9	92	944	27,13%	
San Severino Marche (MC)	194,3	12716	2053	897	108		214	2375	18,68%	
Santa Vittoria in Matenano (FM)	26,2	1325	231	94				231	17,43%	
Sarnano (MC)	63,2	3280	576	245	52		43	671	20,46%	
Serrapetrona (MC)	37,6	954	168	70	11		25	204	21,38%	
Smerillo (FM)	11,3	366	60	24				60	16,39%	
Tolentino (MC)	95,1	19939	3304	1449				3304	16,57%	
total	1.114,9	62881	10689	4706	247	22	458	11416		

Tab.2 Marche Region, the earthquake impact on the housing system. Details of the most severely affected Municipalities

The earthquake hit over 30% of the homes in 16 municipalities, with over 50% homeless population in 9 municipalities, which were heavily damaged (Tab.1, Tab.2). In the municipality of Camerino as many as 3,500 inhabitants and the entire university population had to be evacuated.

A few years after the earthquake, the Municipalities are still facing the transition from the emergency phase, characterized by a mainly sectoral-operational approach, linked to the temporary nature of solutions, to the phase in which implementation urban plans are concretized[2]. These plans may envisage public and private building refurbishment interventions, related to building aggregates or individual structural units[3].

Ultimately, the earthquake further plundered territories that already did not have the minimum habitability requirements, in terms of accessibility and provision of basic utilities and services. The decision to build SAE temporary settlements was complex and potentially uneconomic in these foothills and mountain areas.

This choice was motivated by the desire to maintain the local community, in most contexts mainly made up of over 65 elderly people (Santagata & Scarola, 2019), and to fight against depopulation.

According to the *Sendai Framework for Disaster Risk Reduction* (2015-2030)[4] a multidisciplinary approach is required for an appropriate disaster risk management involving lifestyle, a proper natural and cultural heritage

2 Reference regulatory framework: Special Commissioner's Order no. 25: Criteria for the delimitation of urban centres and special interest centres that were most severely affected by the earthquake that occurred on August 24, 2016; Special Commissioner's Order no. 39: implementation planning guidelines related to reconstruction of historic town centres and urban centres that were most severely affected by the earthquake that occurred on August 24, 2016.

3 Reference regulatory framework: Special Commissioner's Order no. 19: Measures designed to restore and rebuild buildings severely damaged or destroyed by the earthquake that occurred on August 24, 2016, for residential use, according to anti-seismic rules.

4 The 2015-2030 *Sendai Framework for Disaster Risk Reduction* was adopted at the *Third World Conference of the United Nations* in Sendai, Japan, March 18, 2015. It is the result of consultations with stakeholders, launched in March 2012 and of intergovernmental negotiations held from July 2014 to March 2015, supported by the United Nations Disaster Risk Reduction programme, at the request of the United Nations General Assembly.

conservation and enhancement model, agri-forestry-pastoral management system, artisanal and industrial manufacturing techniques, urban and infrastructural growth design and planning schemes (Sargolini, 2017). The Disaster Risk Reduction dimension should become an integral part of the regulations enforceable by the Regional and Municipal authorities, integrating the risk "component" in the urban-regional project (La Greca, 2018).

However, it should be noted that «nevertheless a wide knowledge about natural risks afflicting Italian territory and an articulated regulatory framework, the available data about risks are not exhaustive, and risk reduction policies and multidisciplinary pro-active approaches are only partially fostered and applied» (Di Giovanni, 2016).

The *United Nations Office for Disaster Risk Reduction*[5] reiterates the main actions to be implemented:

- preparing individuals, communities and economic and social organizations to deal with natural disasters and related risks, by means of appropriate measures to strengthen the responsiveness and resilience of communities;
- take action in the post-disaster phase to build better, by seizing reconstruction as an opportunity to mitigate the impact of any future disasters. All this is summed up in the expression *Building Back Better* (Esposito et al., 2017), i.e. a principle that applies not only to buildings or physical infrastructure but also to a broader context.

4. Some results: design suggestions to address the unresolved issues in the post-earthquake approach

This paragraph analyses the best practices implemented in Italy in various post-earthquake experiences. These results are summarized in some design suggestions to be followed to cope up with the post-earthquake problems. This theme is not thorough in the extensive research literature on risk before and during disasters. As a matter of fact, only very few studies addressing the post-disaster, rehabilitation and reconstruction phase are available (Lin et al., 2020). The suggestions indicated fall within a more general context of vulnerability ad seismic hazard studies, which play a significant role in the comprehensive risk mitigation and emergency seismic planning (Liu et al., 2020), as clearly shown by Tira (Tira, 2017) in his explanation of the three components that constitute the basic structure of Risk (Hazard, Exposure, Vulnerability) (Tira et al., 2006).

Criteria for the definition of implementing urban plans

In this transition phase, it is interesting to compare the different experiences of application of criteria for the identification of Implementing Urban Reconstruction plans (Commissioner's Order no. 25[6]).

The benchmarking of various experiences implemented in the earthquake-stricken areas of the Marche region has pointed out three alternative choices in identifying the areas where actions have to be implemented through town planning tools:

- urban settlement fabrics with "unitary boundary definition" coinciding with the "red zone" boundaries (to be defined in the emergency phase) for the implementation of safety measures of the urban centres. These boundaries include urban settlement fabrics, buildings, open areas and public spaces, with a

5 The *United Nations Office for Disaster Risk Reduction (UNDRR)* was established in 1999 as a dedicated secretariat to facilitate the implementation of the *International Strategy for Disaster Reduction (ISDR)* and is mandated by General Assembly resolution of the United Nations (56 / 195), to serve as a focal point in the UN system for the coordination of disaster reduction and to ensure synergies among the Disaster Reduction Strategy activities of the United Nations system and the activities implemented by regional organizations in the socio-economic and humanitarian fields. It is an organizational unit of the Secretariat of the United Nations and is led by the *Special Representative of the Secretary-General (SRSG)* of the United Nations Special for Disaster Risk Reduction.

6 Commissioner's Order no. 25 dated 23 May 2017, "Criteria for the setting of boundaries of urban centres of special interest that are most severely affected by the earthquake that occurred on August 24, 2016".

unified and inclusive vision of the whole context. In these areas, it will be possible to apply a single implementation tool. Hence, the Implementation Plan can be developed by directly applying the criteria and guidelines set forth by Commissioner's Order no. 39[7];

- urban settlement fabrics with "partial boundaries" (present situation for about a third of the approved contexts). In these areas the implementation Reconstruction Plan includes only a portion of the settlement core and reconstruction must be coordinated with interventions complying with the Commissioner's Order no. 19[8] through the (voluntary or mandatory) identification of unitary building aggregates, Minimum Intervention Units (UMI), and specific interventions (Fig.1) concerning each single structural unit. In these contexts, the formulation of appropriate preventive actions (such as, for example, the realization of SUM) will necessarily be subject to the drafting of an additional urban planning instrument, such as, for example, DDR, Reconstruction Guiding Document, provided for by Commissioner's Order no. 39;
- urban settlement fabrics characterized by "discontinuous boundaries" (accounting for 10% of total approved boundaries): buildings, sections of urban fabrics, streets or open spaces. As a general principle, these landlocked fragments inside the restricted area will be subject to the provisions set out by Commissioner's Order no. 19 by means of projects for building aggregates, UMI or individual private building units undergoing reconstruction; or coordinating specific initiatives in compliance with general objectives and guidelines.

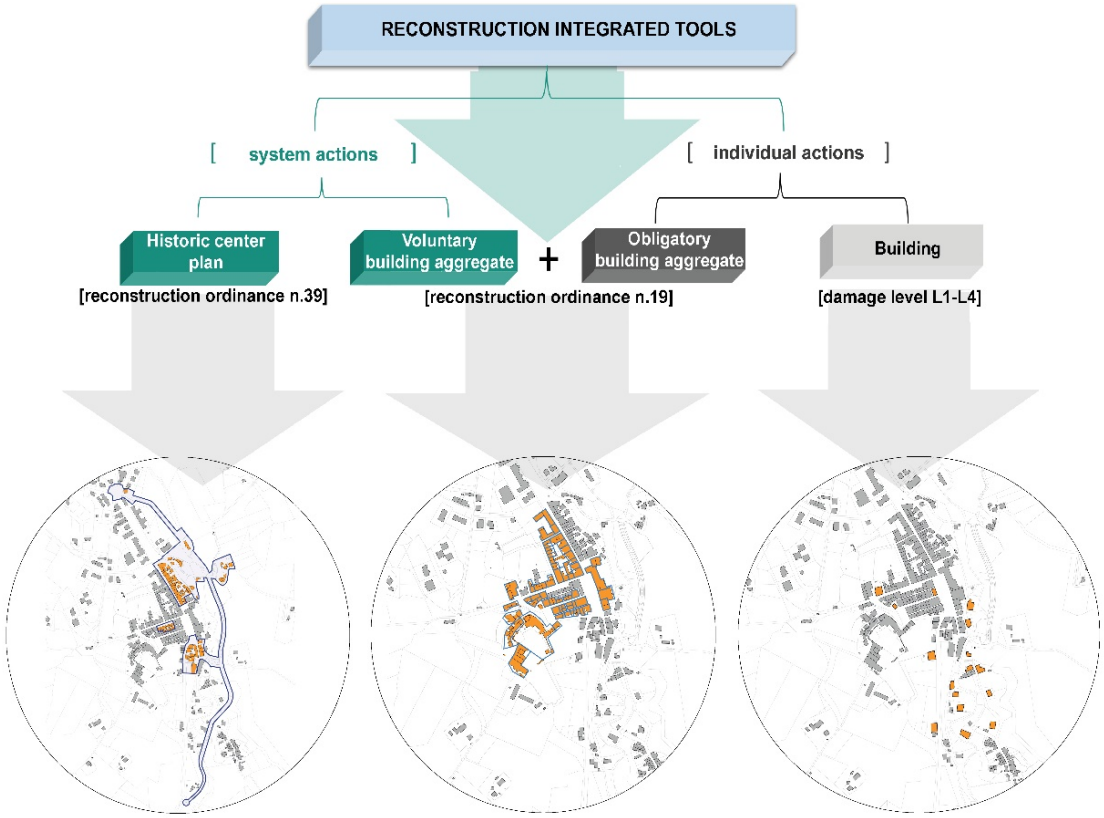

Fig.1 Reconstruction integrated tools: System-wide and specific interventions. Example applied in the Municipality of Caldarola, MC.

7 Commissioner's Order no. 39 dated 8 September 2017, "Guiding Principles for the implementation planning related to reconstruction work in town centres most severely affected by the earthquake that occurred on August 24, 2016". The Presidency of the Council of Ministers (published in the Official Journal, no. 227 on 28 September 2017, SO).

8 Commissioner's Order no. 19 dated 7 April 2017 on "Measures for the redevelopment and reconstruction according to improved seismic criteria of buildings for residential use, which were severely damaged or destroyed by the earthquake that occurred on August 24, 2016". Special Government Commissioner for Reconstruction in the municipal territories of the regions of Abruzzo, Lazio, Marche and Umbria affected by the earthquake that occurred on August 24, 2016.

A third critical element that stems from the uncoordinated use of boundaries in intervention areas (Commissioner's Orders no. 39 and no. 19) is given by the difficulty of synchronizing public action under the Implementation Plan with the private housing stock reconstruction action.

Criteria for the selection of the areas for settlement of emergency temporary wooden housing modules

To address the issue of the location of emergency temporary buildings, it is necessary to consider the "time" factor as an intangible component of the project, alongside the more deeply established concept of "place" (the context). Integrating the time dimension into the Plan means to design (or redesign) the cities in terms of "processes", according to the use-reuse-recycle loop, and plan intervention strategies in progressive terms. Time is a crucial component that marks the emergency stages of recovery and development. Time is also an intangible element of innovation of the urban structure, its relationship with its surrounding territory, its possible socio-economic and ecological-environmental regeneration. The so-called "temporary" interventions may, therefore, risk negatively affecting the overall quality of the contexts in which they occur. Such actions may change the existing social components and activate new spatial and functional relationships that defy any design intent.

These trends are particularly visible in the Italian areas affected by earthquakes, where the so-called "emergency temporary" accommodations stand the test of time and are rarely dismantled. Hence, housing facilities that are designed and built to serve as provisional accommodation solutions, end up by progressively becoming part of the urban landscape. Even when they shall be eventually removed, tangible signs of permanent change will remain in land use, caused by the foundation slabs, underlying utilities, technological and transportation infrastructures, open space setup. The set of emergency works and their poor integration into the existing town infrastructures raise questions about the effectiveness of a purely emergency-based approach. The so-called temporary interventions (in particular, housing, services, shops, schools) are often placed in areas that do not allow a functional, morphological, environmental and landscape integration with the existing contexts (Fig.2).

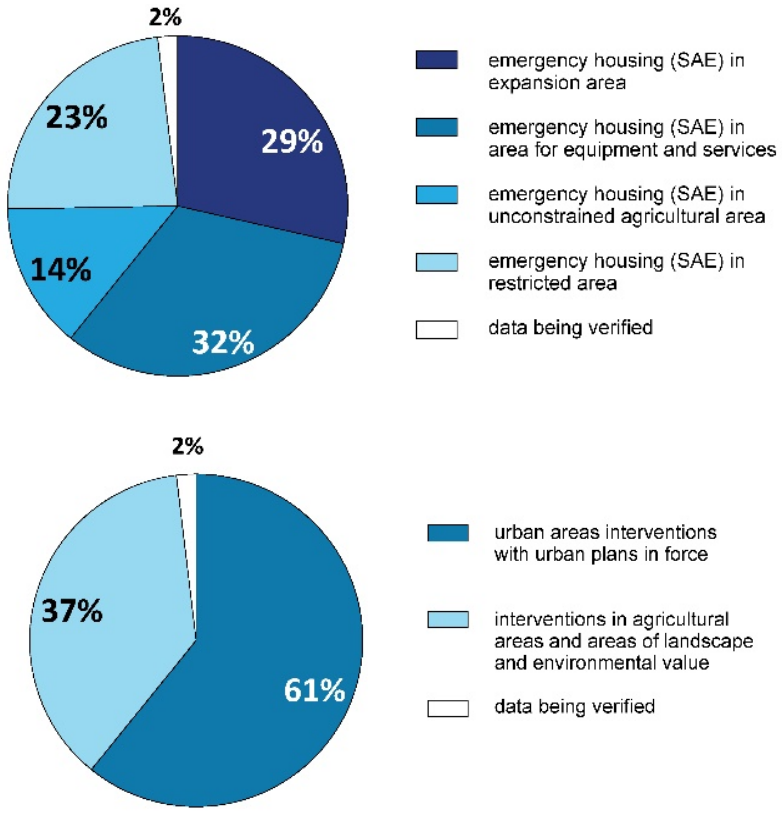

Fig.2 Percentages of urban areas in which the SAE areas are located

Some examples may be found in a few locations in central Italy where the projects, designed to be just temporary for a limited period of time, actually turned into virtually permanent solutions becoming an integral and structural part of the landscape and a physiological part of the towns themselves.
The goal would instead be to set up temporary housing areas according to new criteria and guidelines leading to a greater integration with the community and with the landscape. In the event of the occurrence of a future earthquake, it would therefore be necessary to assess in advance the identification and setting up of emergency preparedness areas (waiting, sheltering-admission, gathering), in addition to those guidelines already envisaged by the Civil Protection provisions set out by CLE (Limit Emergency Condition): accessibility to the areas, number of aggregate elements interfering with the area in question, first aid facilities, formal and dimensional information, service infrastructure, morphology and location of the area, type of soil, type of instability, possible landslides, groundwater, surface water, hazards and danger of flood areas. It is therefore necessary to design a stable prevention and early warning system throughout the territory and to identify equipped areas that may play a dual role: both during the ordinary daily-phase and in the emergency phase during a seismic crisis.
Ultimately, the new criteria should be able to ensure integration with the context and the landscape, in order to ensure a better level of connectivity with the existing environment, protect and enhance natural and historical heritage and check the compatibility between temporary functions and pre-earthquake daily functions.

Criteria for the correct localization of new temporary settlements close to small historical centres
After the earthquake of 2016, in some municipalities of Marche the new residential areas (in which building modules in wood partially prefabricated) were installed to accommodate the population affected by the earthquake, were located close to the historic town centres, in areas already defined by the Urban Plan as building areas. In this way, both a visual and functional relationship was thus ensured between the new and old settlements.

Criteria to enhance the quality and functionality of the axes connecting the historic centre with other urban districts
Some university studies (Colarossi et al., 2019) have proposed a reversal of the post-earthquake intervention strategy: during the slow regeneration process of the historical town centres affected by the earthquake, it is proposed to immediately start the priority redevelopment of the urban axes that connect the most severely damaged historic city centre to less affected neighbourhoods. These axes, protected in the event of new seismic occurrences, play an incentive role for the rebirth of the historic town centre, whose redevelopment is much slower.
These equipped interconnection axes will thus allow not only a faster economic recovery, but also have a socialization and environmental value.
Ultimately, this strategy aims to create structuring axes able to accelerate economic and social requalification of the access areas to the historic city centre, and to promote subsequently the reactivation of protected stretches of public and private areas that penetrate into the "red zone" with a gradual segmentation and reduction of the boundaries of the area delimited by metal fences and made inaccessible due to the danger of collapse.
Other studies, on the other hand, carried out by Università Politecnica delle Marche, point out that "there is a significant lack in the application of the Human Rights-Based Approach to disability in local disaster planning" and aim at "Implementing existing strategies and building new knowledge on accessible evacuation, communication and accommodation" (Gatto et al., 2018), in the event of an emergency, for the disabled.

5. Conclusions

An earthquake shatters the fragile balance of a territory and makes it necessary to rethink the lifestyle pattern rooted in these places. By examining the experience of previous difficult post-earthquake situations, it is clear that in the last major seismic event, there has been a general difficulty to seize the right opportunity to rethink existing settlement patterns (Di Ludovico et al., 2020). These territories were experiencing a crisis even before the earthquake due to the structural decline and aging of the population and activities, degradation of urban and rural housing, historical, architectural and artistic buildings.

These buildings are scattered across a wide territory and are characterised by a fragile settlement model, they are not adequately protected in the event of natural disasters and lack territorial infrastructure networks and safe first-aid facilities.

The tragic event of an earthquake can be rather seen as an opportunity to reduce vulnerability and build resilience. In this context, social capital plays an important role in generating and maintaining risk reduction behaviours (Monteil et al., 2020).

In any case, it should be considered that «disaster risk awareness and acceptability» must be «addressed with a view to the new hierarchy of risks (socio-economic, health, emerging) generated by the crisis» (Norton, Atun & Dandoulaki, 2015), among which the most relevant is that of the pandemic.

Ultimately, the post-earthquake phase should lead to a paradigm shift in the lifestyle of this wide territory based on: a permanent protection of the urban-territorial risk; a networked technological service system providing better services to the local community and businesses; a new functional relationship system between small towns in areas affected by the earthquake and urban centres outside of the earthquake-stricken areas (through transport incentives, cooperative firms, itinerant services for manufacturing activities, etc.) strengthening of cooperation relations and economic and social exchange between communities living in the mountain, hillside and coastal areas.

In conclusion, in the marginal territorial systems (Ventura & Tiboni, 2016) that are not easily accessible, such as inland areas, regional and urban planning should focus on mitigation of risks, seismic vulnerability and the consequent need for changing lifestyles. Therefore, the new strategic land use objectives should include future visions shared by many small towns, circular economic processes associated with new forms of governance based on advanced technological networks providing regional and supra-regional remote protection and assistance.

Finally, the lesson learned from the Italian experience shows that the defence from the worst man's enemy, namely devastating natural disasters, be they local or global, lies in the development and enhancement of the most important resource, namely: human capital.

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Image Sources

Fig.1 and 2: Authors' elaboration;

Tab.1 and 2: Authors' elaboration on Istat Marche data.

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Congestion toll pricing and commercial land-use: clients' and vendors' perspective

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Abstract
This study outlines the effects of congestion toll pricing on commercial land-uses (CLUs) through studying the temporary and permanent impacts of client behavior on the CLUs. In the case study of Tehran metropolis, Iran's capital, which has experienced congestion pricing for more than four decades, both clients and vendors' viewpoints were modeled using discrete choice models. Two types of questionnaires were provided to evaluate clients' and vendors' behavior in response to the traffic congestion zone charges. The clients of three businesses, including garments, electronics, and home appliances, were more sensitive to toll price changes. A 20-percent increase in toll prices led to a substantial client loss in the above businesses in the long run due to accessibility decrease in their utility function. Consequently, the vendors preferred to change their approach and sell different goods; then, they gradually tended to migrate outside of the congestion zone.

Keywords
Congestion toll pricing; Commercial land use; Discrete choice models.

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1. Introduction

Urban population growth has created numerous issues in large cities. One of the most prominent of the high number of vehicles on the highways within the central parts of cities has created adverse effects, such as various contamination types, commute disruptions, and public disquiet. Travel demand management (TDM) policies can be adopted to relieve transport systems that suffer from low levels of service (LOS) and mitigate mobility-related issues. Among these policies, congestion pricing is a measure that allows linking road transport externalities directly to travelers producing them (Cipriani et al., 2019). One of the most practical approaches to control travel demand in a particular area or route to reduce congestion and provide additional financial resources is congestion toll pricing (CTP) (Afandizadeh Zargari et al., 2016). In recent years many European cities have introduced congestion toll pricing strategies to control transport demand (Mariano et al., 2011). The social and environmental benefits of toll fees on private vehicles as a shape of the urban traffic management system are considerable and considered an essential sustainable mobility policy (Marins et al., 2014). Therefore, road pricing can be a beneficial tool to control traffic, reduce air pollution, and earn money for urban management organizations. However, the effects of this Travel demand Management (TDM) policy are not limited to the mentioned in the long-term. Economic influences of CTP could be further than the transport system by disturbing workers' spatial allocation (Vandyck & Rutherford, 2018).

In addition to the confident effects, does CTP have adverse effects? Can CTP affect people's daily transactions and change people's purchase behavior? Can congestion toll pricing affect the region's economic activities and change the region's spatial land use? Are these effects the same for all economic activities? How much should the toll cost change to affect the buying behavior of the people of Tehran from this area? To what extent do these preventive policies affect people's buying behavior and business activities? These are the questions that will be answered in this study.

The results from cordon pricing in the Oslo show that the population may tend to live, work, and purchase inside or outside of the cordon in the long run. While some researchers believe that proper pricing leads to more dense and populated cities, others consider congestion pricing as a centrifugal force in urban growth. Neither theoretical studies nor the research on executive actions on the relationship between transport costs and urban development provides convincing evidence to support whether road pricing and congestion have a centralized or decentralized impact (Löchl, 2006). Such studies have shown less importance in choice theory, but transportation plays a fundamental role in choosing an ideal location in both macro and micro approaches. There is a significant concern about the effects on the retail sector regarding any toll on the city's inner cordon because its shape is an essential part of an economy and a livable city. Another critical factor, maybe even the most crucial, is the way of generating revenue. In other words, factors such as assigning and collecting costs from users are among the most critical ones (Evans et al., 2003). Since congestion pricing policy changes the generalized cost in order to define accessibility in terms of network (Guida & Caglioni, 2020).Thus, it is reasonable to examine the effect of pricing on housing and business as a long-term issue shaping urban form.

2. Literature review

In some countries, policies of preventing unnecessary travel to the traffic-congested areas are carried out; however, the traffic flow changes caused by these policies affect the behavior of drivers and other users of the route (or zone) and have significant effects on the spatial dispersion of economic activities (Vandyck & Rutherford, 2018). The backbone of congestion pricing is to change the User Equilibrium (UE) traffic assignment to System Optimum (SO) (Mirzahossein & Zargari, 2018). The literature of this idea and the idea of downtown congestion pricing (DCP) made its first appearance in the minds of British and American academics in the 1950s and has spread to five cities since then: Singapore, London, Stockholm, Milan, and Gothenburg—with most activity occurring since 1997. Today, serious plans are afoot to adopt DCP in a handful of additional cities worldwide (Lehe, 2019).

De Vos' investigation of the effects of congestion pricing shows that road pricing in a multicenter urban area dramatically reduces the distance traveled by car in urban areas, but the use of motorways or highways marginally declines to a limited extent (De Vos, 2016). Additionally, road pricing has a significant impact on the income of people whose revenues depend on their daily travels (Abulibdeh et al., 2018). Road pricing can have a considerable effect on many levels of the hierarchy of behavior: Both short and long-term tactics, such as route choice, travel time, vehicle choice, destination choice, frequency of travel, and travel chains, as well as long-term strategic decisions, such as location choice, vehicle ownership, change in the share of public transport, choosing residence and employment locations, as well as commercial and residential construction (Deakin et al., 1996).

Eliasson and Mattsson vaguely describe the effects of congestion pricing. According to them, the effects also depend on how many complex interactions between different applications and what factors should neutralize the effects of road pricing. Additionally, they believe it is unclear to what extent the impact of reducing traffic density caused by road pricing is likely to be disrupted by the scattered residential location patterns (Eliasson & Mattsson, 2001).

Anas and Xu concluded that a general equilibrium model for calculating the overall result would be that road pricing impacts residential density and employment. However, they admit that their model does not consider cumulative economies that may focus on employment in separate centers (Anas & Xu, 1999). Tilema et al. found out that people generally prefer to pay higher housing costs and take longer travel times to avoid more travel costs (Tillema et al., 2005). Tilma et al. showed the cost of travel (such as toll and fuel) as an essential factor by using multinomial logit (MNL) models and mixed logit (ML). It also showed that the respondents (drivers in their study) are more sensitive to travel costs than higher rent prices. Moreover, travel time plays a smaller role in these decisions (Tillema et al., 2010). Whitehead has shown that the effects of road pricing on business depend on different causal chains used in other cities, depending on city scales and regional competition (Whitehead, 2002).

Zhong and Bushell showed that the impact of road pricing on the Potential of Job Accessibility (PJA) is precisely related to the zone's construction environment. They conclude that a higher number of jobs, better public transport conditions, and better street design with more intersections caused the region is affected by the adverse effects of the toll roads, and vice versa (Zhong et al., 2015).

Using the nested logit model, Eliasson and Mattsson showed that location allocations depend heavily on where the cordon of toll roads lie. However, they concluded that the overall effects of the location are small compared to travel patterns since people try to reduce the cost of pricing by changing their travel time, mode, and cost of travel (Eliasson & Mattsson, 2001).

In another study, Spiekermann et al. concluded that shipping costs had essential effects on travel behavior but had a marginal impact on land use. The reason is that there is considerable potential for the reorganization of housing and workplaces in existing buildings (Spiekermann et al., 2005). Zhong et al. state that higher population density and higher employment, together with better public transport conditions, would negatively impact road pricing in the region, and vice versa (Zhong & Bushell, 2017). While Quddus et al. 2007, who examined several retail stores in London, concluded that no effect on total congestion was achieved; however, there may still be a redistribution of sales from specific regions to other stores in central London (Quddus et al., 2007).

In a study in Trondheim, Tretvik found that 10% of clients changed their buying behavior by changing their purchase to or after the introduction of the cordon pricing (Tretvik, 2003), while the Trondheim Chamber of Commerce the predetermined result has concluded that pricing limits do not have any effect on business.

Daunfeldt et al. show that pricing in Stockholm (still) does not affect the retail revenue for shopping centers or stores in the area. Although, in general, long-term measuring effects (locations) in a cohesive way seem to

be generally complex. For example, economic cycles' domination affects economic and commercial activities (Daunfeldt et al., 2009).

Boussauw, Alert, and Whitlux also argue that pricing in the city's central area will increase urban densities and suburban growth and increase travel distances, thereby increasing the cost of suburban municipalities (Boussauw et al., 2013).

It is not simple to recognize how much experiences and conclusions from one city can be transmitted and generalized to other, as these effects to a large extent depend on the specific characteristics of each city, such as its space composition, the shape and capacity of the network, and the quality of the public transportation. Nevertheless, it is essential to know that in most studies carried out on transport and land use, more attention has been paid to the effect of land use on transportation, and less has been discussed about the effect of transportation on land use (Tillema et al., 2011), especially the behavioral process in these choice phenomena. In particular, when road pricing is coupled with the addition of new road and public transport capacity (Gupta et al., 2006; Löchl, 2006), the impacts of land use from road pricing depend heavily on its schemes, such as pricing schemes (the scope, and range of pricing).

In previous studies, the effects of congestion pricing on people's income and retail sales and relocation have been investigated using available data. Also, the effects of change of residence and change of job as well as people's shopping behavior using choice models have been studied. Most studies have focused on the effect of congestion pricing on driver behavior. But none of the studies have examined the effects of congestion toll pricing on commercials and clients by product type.

This paper investigates the effects of the Tehran congestion toll pricing (CTP) on commercial land uses (CLUs). Additionally, we examine the clients' behavior in these business applications concerning the price increase. This research's structure is as follows; the next section describes our methodology's framework, and the following section describes the data and the scope of the case study. In the fifth section, we analyze the models' results and the probability of CLUs' displacement. In the final section, the conclusion is presented by list numbers. A summary of the literature review can be seen in Tab.1.

No.	Author	Subject	Result
1	Deaken et al. 1996	Transportation Pricing Strategies for California: An Assessment of congestion, Emissions, Energy. And Equity Impacts.	Road pricing has short and long-term effects
2	Anas & Xu 1999	Congestion, land use, and job dispersion: a general equilibrium model	Road pricing impacts residential density and employment. However, their model does not consider cumulative economies that may focus on employment in separate centers.
3	Elisson & matsson 2001	Transport and location effects of road pricing: A simulation approach	A small toll circle causes displacement of households, workplaces, shops, and service centers outside the ring.
4	Whitehead 2002	Regional labor markets, commuting, and the economic impact of road pricing	The effects of road pricing on business depend on different causal chains used in other cities, depending on city scales and regional competition.
5	Tretvik 2003	Urban road pricing in Norway: Public acceptability and travel behavior	Clients changed their buying behavior by changing their purchase to or after the introduction of the cordon pricing.
6	Tillema et al. 2005	Road pricing and (re) location decisions households	People generally prefer to pay higher housing costs and take longer travel times to avoid more travel costs
7	Spiekermann et al. 2005	Spatial scenarios for the eastern Ruhr area	shipping costs had essential effects on travel behavior but had a marginal impact on land use.
8	Löchl 2006	Land use effects of road pricing: Aliterature review	Impacts of land use from road pricing depend heavily on its schemes, such as pricing schemes (the scope, and range of pricing).

No.	Author	Subject	Result
9	Quddus et al. 2007	The impact of the congestion charge on retail: the London experience	No effect on total congestion was achieved.
10	Daontfeldt 2009	Congestion charges and retail revenues: Results from the Stockholm road pricing trial	Pricing in Stockholm (still) does not affect the retail revenue for shopping centers or stores in the area.
11	Tillema et al. 2010	The influence of (toll-related) travel costs in residential location decisions of households: A stated choice approach	Rent price is more effective than travel time.
12	Tillema et al. 2011	Evaluating the effects of urban congestion pricing: geographical accessibility versus social surplus	In most studies, less has been discussed about the effect of transportation on land use.
13	Boussauw et al. 2013	Colouring inside what lines? Interference of the urban growth boundary and the political–administrative border of Brussels.	Pricing in the city's central area will increase urban densities and suburban growth and increase travel distances
14	Zhong et al. 2015	Distinguishing the land use effects of road pricing based on the urban form attributes	Impact of road pricing on the Potential of Job Accessibility (PJA) is precisely related to the zone's construction environment.
15	De Vos 2016	Road pricing in a polycentric urban region: Analysing a pilot project in Belgium	Congestion pricing reduces distance traveled in urban area more than highway.
16	Zhong et al. 2017	Built environment and potential job accessibility effects of road pricing: A spatial econometric perspective	Higher population density and higher employment, together with better public transport conditions, would negatively impact road pricing in the region, and vice versa
17	Mirzahossein & Zargari, 2018	A Combined Model of Congestion Toll Pricing Based on System Optimization with Minimum Toll	Backbone of congestion pricing is to change UE to SO.
18	Vandyck & Rutherford, 2018	Regional labor markets, commuting, and the economic impact of road pricing	These policies effect on spatial dispersion of economic activities.
19	Abulibdeh et al. 2018	Empirical analysis of the implementation of cordon pricing: potential impacts on travel behaviour and policy implications.	Road pricing has significant impact on the income of people whose revenues depend on their daily travels.
20	Lehe 2019	Downtown congestion pricing in practice	Reviews history of the DCP.

Tab.1 Summary of literature reviews

3. Methodology

Fig.1 shows a conceptual model for the presented model in this paper. It shows the relationship between congestion toll pricing and the (re)location choice decision.

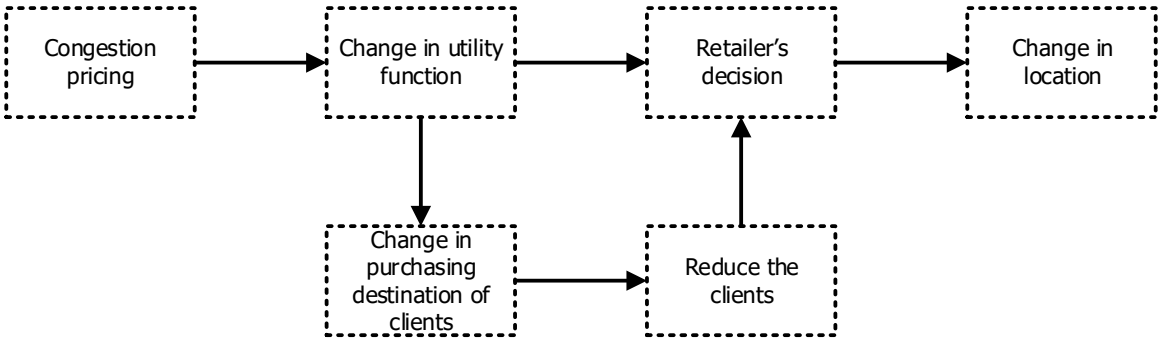

Fig.1 **Congestion toll pricing and commercial (re)location choice process**

The cost of traffic congestion identifies the number of clients attended to these CLUs. Moreover, as shown in Fig.1, to determine the impact of changing the cost of congestion on clients' behavior, this parameter is

considered an active factor in individuals' decisions in their choice process. Some scenarios are simulated by increasing the congestion cost to find the changes in the CLUs within the traffic congestion zone. First, the impact of increased traffic on the changes of the CLUs clients within the traffic congestion range should be measured. A revealed preference (RP) and stated preference (SP) methods are used to do this.

Their reactions to different prices are measured by asking clients about those ranges for different traffic congestion charges. Their decision to buy inside or outside the traffic congestion zone is examined. One of the most prominent advantages of RP is the capacity to show actual circumstances. In contrast, SP's most apparent benefit is the capacity to show individuals' feedback and behavior in a situation that has not yet occurred and simulated for them by the questionnaire. This method is widely used to examine and predict the impact of unfulfilled policies on people's behavior and decisions. Therefore, in this research, using the SP, we set the conditions for price changes as selective options for the respondents to express their decision in choosing these options with the assumption that these conditions are real.

As mentioned, to identify the effects of the traffic congestion zone price on the CLUs, it is necessary first of all to determine the behavior of the clients of these businesses, and then evaluate the results of these CLUs behavior against the changes in the number of clients caused by the traffic congestion charges. Therefore, in this research, two types of questionnaires were needed: one is to show the clients' behavior within the changing traffic congestion zone charges. Another is for vendors' behavior regarding their client's choices. In this study, we use discrete choice models to evaluate clients' behavior and, consequently, sellers' behavior. Discrete choice models describe decision choices among all available options. The underlying assumption of discrete choice models is that when an individual decides, his individual preferences for each option can be expressed in terms of desirability or attractiveness. Therefore, client behavior analysis that chooses between two options for buying inside or outside the traffic congestion zone at different price levels using a binary logit model and analyzing seller behavior in choosing three options; without modification, product change, and shifting beyond the scope of the traffic congestion zone is measured through a logit model. The general form of the logit model is given by equation (1). The probability of choosing the option i (i = 0,1), by the individual n (Pni), assuming the independent and identical Gumbel distribution (IID) for, is the following in the standard logit model.

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_{j=0,1} e^{V_{nj}}} \quad (1)$$

In this structure, any change in the probability of selecting an option or omitting and adding an option has the same effect on the other option. The ratio of the likelihood of choosing each alternative relates to another option independent of different possibilities. Binary logit models are the multinomial logit model that has only two choices.

Considering the second questionnaire (salesperson's behavior questionnaire) is based on the first questionnaire (client behavior questionnaire). Based on the first questionnaire, the CLUs that their clients are sensitive to the traffic congestion zone's price is investigated based on binary logit models. When the price increases, their clients diminish within the traffic congestion zone. The second questionnaire was designed exclusively for this type of CLUs.

4. Location and Data

Tehran is considered a populated metropolis with a long history of traffic congestion charging. Like many other major cities globally, in recent years, problems such as population growth, development of economic and social activities, land-use changes, and urban sprawling have challenged Tehran. The significant issues are the growth and expansion of transportation systems and the accelerated growth of car ownership. Finally, the city's increase in traffic has caused congestion, and reduced travel speed, noise, and air pollution are among other negative consequences.

One of the main strategies to deal with these problems, which has been designed and implemented in different countries for a long time, is creating a traffic congestion zone. According to this plan, entering the city's central areas is exclusive to specific vehicles to prevent congestion. The traffic area of the city of Tehran includes the central part of the city. Besides, major commercial and administrative centers and significant attraction points for daily travel are within the traffic zone marked in red in Fig.2.

At first, we tried to collect actual data about the traffic congestion zone's current condition; however, there was no previous data about Tehran's CLUs. Therefore, we provide the questionnaires to recognize the clients' and vendors' behavior regarding increasing the charges.

Tehran traffic plan is limited from 6:30 am to 7:30 pm. The average cost of entrance tolls for one day during the research is about 12500 Tomans and is constant throughout the day. However, drivers will be fined 20,000 Tomans for each entry and exit if they do not buy a permit to enter the area. No charges are levied on the emergency, military, law enforcement, taxis, and public transport vehicles. The official currency of Iran is rial, but the common unofficial currency in use is toman. For the sake of clarity for questionnaire participants, toman has been used in this article. A dollar is equal to about 4200 tomans at the time this research was conducted in late 2018.

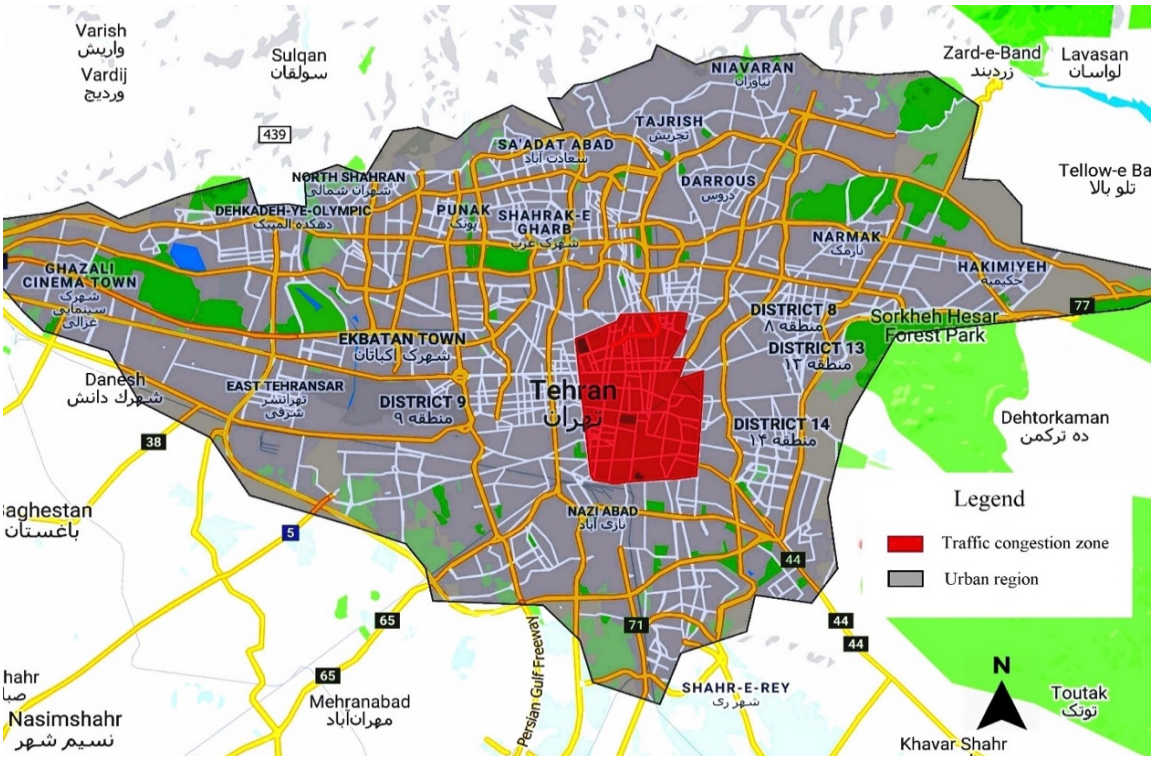

Fig.2. Tehran's map and position of congestion charge range

4.1 Client behavior questionnaire

The design process of this questionnaire lasted from March 21, 2017 to January 17, 2018. This process includes reviewing the characteristics of the area, the type of dominant CLUs, designing a pilot questionnaire, collecting initial information, checking the questionnaire's reliability and validity, and designing the main and final questionnaire. Also, during the process, the received information was evaluated by all relevant organizations and their results were considered in designing the questionnaire. The number of 436 clients' purchasing behavior concerning traffic congestion toll pricing was gathered between 17 January 2018 and 21 March 2018 on workdays, divided into four general sections using both (RP) revealed preferences and (SP) stated preferences. The first section includes the variables, such as the entry of the person by car, the type of entry,

the reason for entry, the frequency and time of entry, as well as purchases in the study period under the actual and prior pricing conditions, which is of the RP type.

The second part is regarding the SP type. It consists of two elements of the travel time perceived by individuals in purchasing in and outside of the zone under non-priced conditions and the choice of purchase for each item under the new pricing scenarios. The third part contains information about the features of and reasons for buying from the traffic congestion zone. Finally, the fourth part includes the individual, economic, and social information of the RP-type individuals. In other words, the toll price variable that is the deciding factor in entering the region, the SP variable, and other variables are used as RP in the logit model. Some RP variables are used as dummy variables and some as continuous and discrete variables in the logit model. In this research, the target community of drivers is those who own a car in their family. Because clients of these CLUs include one of the following:

1 . Those who had entered the area for the purchase of a commodity under former pricing conditions with their vehicle, but under new pricing scenarios decided to; a) do not buy from this area b) change travel mode, or c) continue entering the area with a private car;
2 . Those who did not buy a product from this area, but under new pricing scenarios, may use personal vehicles to enter the area or still do not buy from it;
3 . Those who used other travel modes (excluding private cars) to buy a product from the traffic congestion area and are not sensitive to the charge amount.

This study's remarkable feature is that the use or non-use of a private vehicle to travel to the area to buy a product does not matter and what is significant is to buy a product from the range with any vehicles. When collecting the questionnaire, clients were first asked, "Have they purchased from this area this year?" For trip purposes, they were asked, "What was the main purpose of their travel to this area?" Therefore, this study's target community is anyone who can use a private car to travel to the area to buy a product. The questionnaire has been designed for seven categories of current and best-selling goods in the Tehran traffic area, which are as follows:

1. Clothing, bags, and shoes;
2. Electronic appliances (tablets, mobile phones, laptops);
3. Home appliances (washing machines, meat grinder, TVs, carpets, furniture, chandeliers, and other decorative items);
4. Medicine and medical supplies;
5. Restaurants, fast food, and coffee shops;
6. Books and other cultural, artistic, and academic material;
7. Other goods: Any essential purchased items did not include the six categories above.

Results show that 158 responders from 436 ones entered the congestion zone by private cars. Also, the respondents' replies to the questionnaire under the new pricing scenarios for purchasing any product are 327 clothing stores, 146 electronics, 136 household appliances, 88 medicine, 86 restaurants, 92 books, and 63 other products.

The average age of all people is 36.8 years old. 244 respondents were men with an average age of 38.4 years, while 192 were women with an average age of 34.9 years (44% women and 56% men). Of the 436 participants, 284 were married, and 152 were single (65% married and 35% single).

The average family size was 3.8, while the average number of employed family members was 1.73, with car ownership of 1.247.

4.2 Vendors' questionnaire

As mentioned earlier, to find the relationship between the charging zone and the CLUs, a client questionnaire was first designed. We discovered the sensitivity of the clients of any CLUs to the traffic congestion zone.

Afterward, by modeling the client change, each product category was determined by the charge of the traffic congestion zone. To find the link between client reduction and the CLUs changes, a different questionnaire was needed to discover the relationship between two variables and ultimately to determine the relationship between the charge of the traffic congestion zone and the CLUs' changes. Therefore, another questionnaire was designed to investigate goods sellers' reactions, whose clients are sensitive to the congestion toll and lose their clients. The questionnaire consisted of three main parts.

- The first part related to the store features and the reason for selling within the traffic congestion zone that included questions such as the duration of the store in the traffic congestion zone, the average number of daily clients, the operation hours of the store, the store size, the store ownership status (rental or private), and the reason for selling the products in the congestion zone;
- The second part of the questionnaire, the SP part, contains three choices in three scenarios, with a different client reduction percentage. In other words, the only variable is based on which vendors plan to reduce their client number due to an increase in the traffic congestion toll. Sellers chose one option for each client rate reduction (a) unchanged, (b) change the sales product, and (c) select shutdown or relocate outside the traffic congestion zone;
- The third part of the questionnaire contains the sellers' individual and financial information, including age, gender, education, home address, and vehicle. The questionnaire was designed for three categories of clothing, electronics, and home appliances that were sensitive to the congestion toll pricing in urban traffic network to analyze the results of client purchasing behavior models.

The summary of the questionnaires for these three categories of goods gathered orally is presented in Tab.2.

Type of statistical society characteristics	Clothing	Electronic appliances	Household appliances
Total number of questionnaires	135	66	36
Average on-site history	5 year	10 year	17 year
Daily client average	66 people	37 people	12 people
Average opening hours of stores	9:30	9:15	9:30
Average closing hours of stores	21:20	20:45	20:30
Market share in option selection for 10% client reduction			
Unchanged	91%	91%	100%
Change the goods	4%	9%	0%
Shut down or change location outside of the range	5%	0%	0%
Market share in option selection for 25% client reduction			
Unchanged	51%	59%	59%
Change the goods	33%	27%	8%
Shut down or change location outside of the range	16%	14%	33%
Market share in option selection for 40% client reduction			
Unchanged	33%	41%	42%
Change the goods	9%	14%	33%
Shut down or change location outside of the range	33%	41%	42%
The reason for selling this type of goods in this zone			
More client	38%	32%	42%
Less rent	11%	14%	17%
To be known	64%	68%	58%
Near the house	20%	36%	8%
The zone is the sales center of this kind of goods	44%	82%	58%
Education			
Under diploma	2%	0%	8%
Diploma	27%	35%	42%
Associate	11%	20%	0%

Type of statistical society characteristics	Clothing	Electronic appliances	Household appliances
Bachelor	53%	45%	42%
Master	7%	0%	8%
Doctoral	0%	0%	0%
Other characteristics of stores			
The average age of vendors	30 year	34 year	41 year
Percentage of male sellers	49%	91%	91%
Married	40%	64%	75%
Head of the family	24%	67%	67%
Ownership of the stores	16%	14%	75%
Average stores area (m²)	29%	21%	32%
The average number of family members	3.94 people	3.74 people	4 people
The average number of family members employed	2.06 people	1.7 people	1.58 people
Has another job	9%	18%	8%
Owns a private car	34%	91%	67%
Average car prices (toman*)	18,000,000	32,000,000	48,000,000

* A dollar is equal to about 4200 tomans in 2018

Tab.2 Summary of vendors' questionnaires

5. Client Choice Models

Discrete binary logit models are used to choose the place of purchase items from inside or outside the congestion area. The results of binary logit models for purchasing goods in the traffic congestion zone are shown in Tab.3. For each variable in the Tab.3, the first row is a variable coefficient and the second row is P-value of the variable.

Variable	Clothing	Electronics Appliances	Home Appliances	Medicine	Restaurant	Books	Other goods
Constant	-0.8493 0.0058	-2.5536 0.0000	-1.9397 0.0000	-3.5512 0.0000	-4.238 0.0000	-5.5099 0.0000	-5.0282 0.0000
Price	-0.0645 0.0000	-0.0467 0.0000	-0.0590 0.0000	-	-	-	-
Peak2	1.1163 0.0000	1.3287 0.0000	-	-	1.0765 0.0001	1.1528 0.0000	0.5348 0.0430
Offpeak	1.5287 0.0000	1.3374 0.0000	-	-	1.6149 0.0000	0.9811 0.0234	-
Enter	-	-	-	-	-	-	1.1787 0.0000
Past	0.4805 0.0036	-	-	-	1.3787 0.0000	1.0337 0.0004	2.9514 0.0000
Lesstime	-	1.1181 0.0000	0.9625 0.0088	0.9690 0.0064	-	-	-
Eqtime	-	1.5045 0.0110	1.2167 0.0089	1.1721 0.0091	-	3.0256 0.0004	-
Prefer	-	1.1860 0.0002	-	-	-	-	-
Brand	0.6761 0.0031	-	-	-	-	-	-
Unique	-	-	1.9787 0.0000	1.8759 0.0000	-	1.2007 0.0000	1.5695 0.0007
Morestore	0.6334 0.0000	1.9882 0.0000	0.2804 0.0000	1.7304 0.0000	-	1.9380 0.0000	-

Variable	Clothing	Electronics Appliances	Home Appliances	Medicine	Restaurant	Books	Other goods
Cheap	0.6252 0.0000	-	-	-	1.4298 0.0002	-	-
Lowtime	-	0.5571 0.0398	-	-	-	-	-
Nearwork	-	-	1.2670 0.0001	1.2373 0.0001	1.4917 0.0000	0.9850 0.0020	-
Med	-	-	-	-	-0.9665 0.0004	-	-
Male	-0.5489 0.0037		-0.9351 0.0093	-0.9086 0.0103	-0.9421 0.0128	-0.9920 0.0047	
Low	-	-0.6584 0.0013	-	-	-	-	-
Teacher	1.1658 0.0075	-	-	-	-	-	-
Freejob	0.4697 0.0142	-	1.1698 0.0007	1.1433 0.0007	1.3032 0.0019	1.3824 0.0081	-
Student	-	-	-	-	-	1.5190 0.0007	-
Employee	-	-	-	-	1.1100 0.0015	1.7100 0.0001	-
pastE	-	0.6878 0.0062	1.2147 0.0002	1.1800 0.0002	-	-	-
$LL(\beta)$	-631.35	-352.02	-263.03	-273.92	-263.24	-225.63	-209.99
$LL(0)$	-906.63	-906.63	-906.63	-906.63	-906.63	-906.63	-906.63
$LL(C)$	-780.03	-509.1	-382.33	-382.33	-348.17	-375.18	-295.55
ρ^2	0.303	0.612	0.71	0.697	0.709	0.759	0.768
ρ_c^2	0.19	0.308	0.312	0.283	0.243	0.398	0.289

Tab.3 The results of binary logit models for purchasing goods in the traffic range

In Tab.3, the "Enter" dummy variable equals 1 if the person entered the range using the car in the year 2017 at the time of pricing, otherwise, it is marked with 0. The "past" dummy variable demonstrates if the person bought the product in 2017 with 1 and 0. "Lesstime", "Eqtime" and "prefer" are dummy variables showing (with 1 and 0) respectively if the travel time to the range to buy this product is less than or equal to the outside range and if the person prefers to buy from this range. The "Price" variable indicates the entry fee in the range of 1000 Tomans. The "Offpeak" and "Peak2" dummy variables show that time of congestion is for the evening peak. The "Brand" dummy variable means that the product store has a brand reputation. The "Unique" dummy variable shows 1 if the product is found only in this range; otherwise it equals 0. The "Morestore" dummy variable equals 1 if most of the product stores are in this range; otherwise it is marked 0. The "Cheap" dummy variable demonstrates if the product's price in this range is less than outside the range. The "Lowtime" dummy variable means that the purchase time of this product in this range is less than outside it. The "Nearwork" dummy variable means that person's workplace is close to the congestion zone. The "Young"," Med" and "Old" dummy variables respectively show the age ranges of less than 25 years old, between 25 and 56 years old, and over 56 years old with 1 and 0. If the responder is a man, the "Male" dummy variable is 1, or otherwise it is 0. The "Lowedu" dummy variable indicates associate educations and less. If the person has self-employment, "Freejob" dummy variable is equal to 1, and otherwise 0. The "Employee" dummy variable employement status and clerk job. The "PastE" dummy variable shows if a person has entered the range in 2017 using a car and has bought goods, with 1 and 0.

According to the models made to select the purchase destination within and outside the traffic congestion path, as shown in Tab.3, the price variable has been meaningful for the traffic area in three categories:

clothing, bags and shoes, electronics, and household appliances and reflects the sensitivity of the clients of these types of stores to the TCP. Variables such as "peak2", "morestore", "male", and "free job" are specified in most models with the same sign. In most of these types of goods, at peak hours (from 16 to 19 o'clock), there are more product stores within the scope of the traffic congestion charging, and being self-employed has a positive effect on the utility of shopping in the scope, and being male has a negative effect on utility shopping within the scope of the traffic charging zone.

We must see how much clients in these products are changing within the traffic congestion zone's scope at each level of pricing. To determine this, the product purchase probability function is used. In equation (2), P_{in} Shows the probability of purchasing the product by individuals inside the congestion area. In equation (3), Pex indicates the probability that the product will be purchased outside the traffic area.

$$P_{in} = \frac{e^{U_{in}}}{e^{U_{in}} + e^{U_{ex}}} \xrightarrow{U_{ex}=0} P_{in} = \frac{e^{U_{in}}}{e^{U_{in}} + 1} \quad (2)$$

$$P_{ex} = \frac{1}{e^{U_{in}} + 1} = P_{in} - 1 \quad (3)$$

If Ni is the number of clients under the price level *i* that is obtained from equation (4) and M is the number of clients under the previous pricing, then the percentage change in the number of clients P_i will be obtained at the price level *i* of equation (5).

$$N_i = P_{in} \times Observations \quad (4)$$

$$P_i = (\frac{N_i}{M} - 1) \times 100 \quad (5)$$

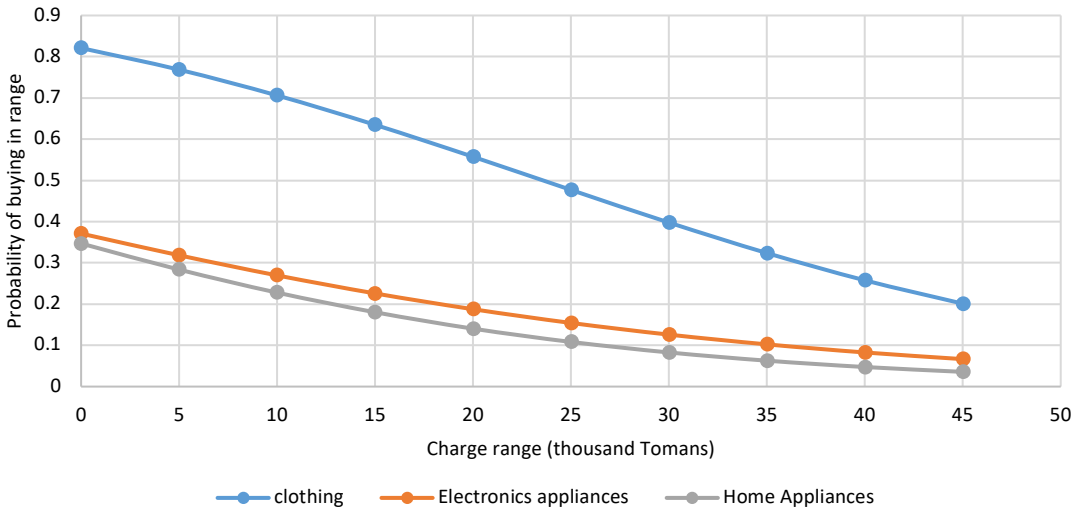

Fig. 3 Change in the client of each product category, based on the average price of the traffic range

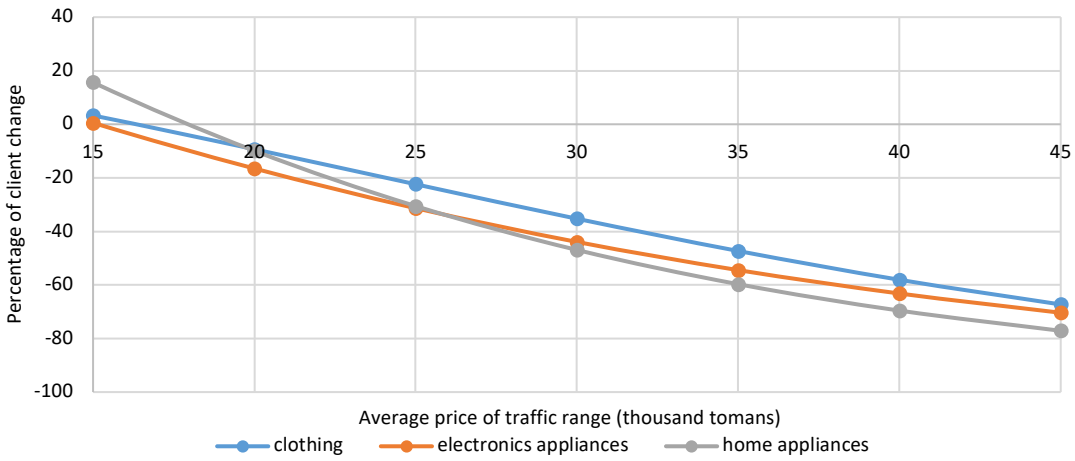

Fig.4 Percentage change in client per category of goods, based on the average price of the traffic congestion

By calculating and charting the price-percentage of the client change, one can see the effect of each level of pricing on the number of clients. The purchase probability chart of the traffic congestion zone for three categories of price-sensitive products is offered in Fig.3. The average toll charge- percentage chart of client change for price-sensitive products is shown in Fig.4.

Based on Fig 3, the probability of purchasing from the traffic congestion scope for each of the three categories of clothing, electronics, and home appliances decreases with the increase in the traffic congestion zone's price. However, this probability varies depending on the type of goods and the number of current clients. As the products of clothing, footwear, and shoes, which currently have more clients than the stores outside of the zone, are more likely to be considered more than the other two categories of household and home appliances. The average toll charge of the traffic congestion for respondents at the time of questioning was about 12,500 tomans. Based on Fig.4, despite the average increase in the traffic congestion zone's price, the number of clients reduced, these fluctuations of client numbers at different price levels are less than 15,000 tomans (+20%) for each kind of good. The household appliances category has the most sensitivity to the price and client changes. The electronic appliances are less sensitive, and the category of clothing, bags, and shoes that have the slightest changes to the traffic congestion zone's price sensitivity. For the traffic congestion zone with more than 15,000 tomans' prices, the level of client changes for each of the three categories is similar. However, these changes are more significant for the appliance category.

6. Vendors Choice Models

The multinomial logit models for examining the relationship between vendors and their clients are as follows. In these models for three categories of prince sensitive commodities, the dependent variable is the vendors' choice: without change, product change, and shutting down or shifting out of the traffic congestion zone. The results are offered in Tab.4. In this table, the first row is a variable coefficient, and the second row is P-value. Also, the symbols ** and *** indicate a significant level of 95% and 99%, respectively.

Based on the results shown in Tab.4 for the utility of changing the type of price-sensitive usage, which is depicted in Fig. 5, sellers can lose their clients significantly. Finally, with Fig.4 and Fig.5, we can map the changes in the CLUs sensitive to a congestion toll charge. As shown in Fig.6, the average price of 15,000 tomans (+20%) does not change any CLUs, even the average cost of 15,000 to 20,000 tomans (+60%) insignificantly affects the number of home appliance stores in the traffic congestion zone. However, with an average price of more than 20,000 tomans, almost these three types of CLUs are slipped and shrunk, while at the average cost of 25,000 tomans (+100%), the effect is very significant.

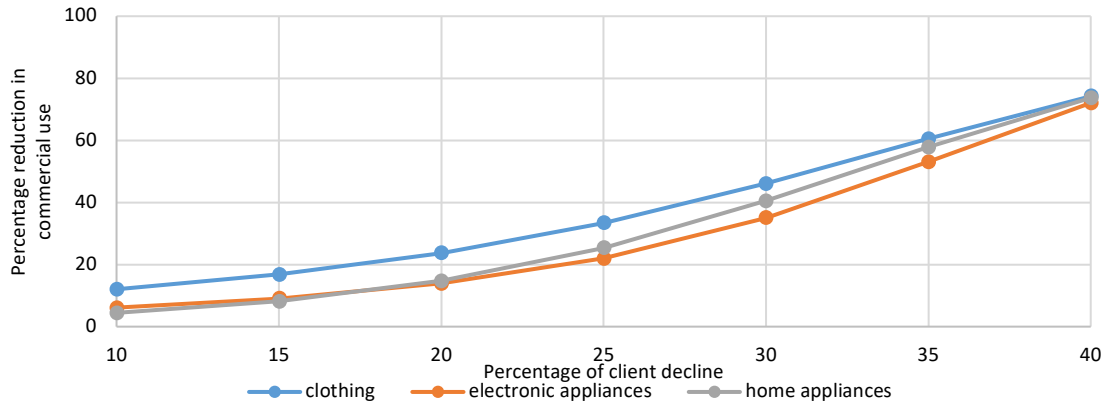

Fig.5 Percentage change in CLUs in terms of changing their clients

It should be noted that this reduction process may only be for these three categories of CLUs, and not all the CLUs, and it may even bring about an increase in other CLUs because of change in the product type, or even create a new opportunity for non-sensitive land-uses within the traffic congestion zone.

Alternative	Variable	Clothing	Electronic appliances	Home appliances
No change	Constant	3.906*** 0.0000	3.74*** 0.0000	13.155*** 0.0000
	Experience of 7 years or more in the range	0.929*** 0.0089	-	-
Change the goods	Constant	0.992 0.1001	1.3926 0.2397	8.208*** 0.0094
	Reduce client (%)	0.0575*** 0.0000	0.0688*** 0.0012	0.0919*** 0.0311
	Close to home	1.551*** 0.0000	-	-
	Store area less than 20 square meters	-	-3.14*** 0.0001	-
	Store area larger than 30 sqmore significanteters	-	2.625*** 0.0005	-
shut down or change place outside the range	Reduce client (%)	0.150*** 0.0000	0.193*** 0.0000	0.204*** 0.0000
	Having another job	- 2.3889*** 0.0008	-	-
	Known store in this range	- 0.7823*** 0.0123	-	-
	There is more client in this range	-1.037*** 0.0008	-2.1845*** 0.0009	-
	This range is the sales center for this product	-	-1.536** 0.0286	-
	Store area less than 20 square meters	-	-0.981*** 0.0015	4.856*** 0.0005
	Store area larger than 30 square meters	-	-	5.661*** 0.0001
	Age under 29 years	-	-2.308*** 0.0003	-
	Have a university degree	-	-	4.015*** 0.0008
Specifications	LL(β)	-289.15	-110.99	-46.45
	LL(c)	-385.96	-179.44	-84.96
	LL(0)	-118.65	-217.52	-444.93
	ρ_c^2	0.25	0.381	0.453
	ρ^2	0.35	0.489	0.6

Tab.4 Results of multinomial logit models for sellers

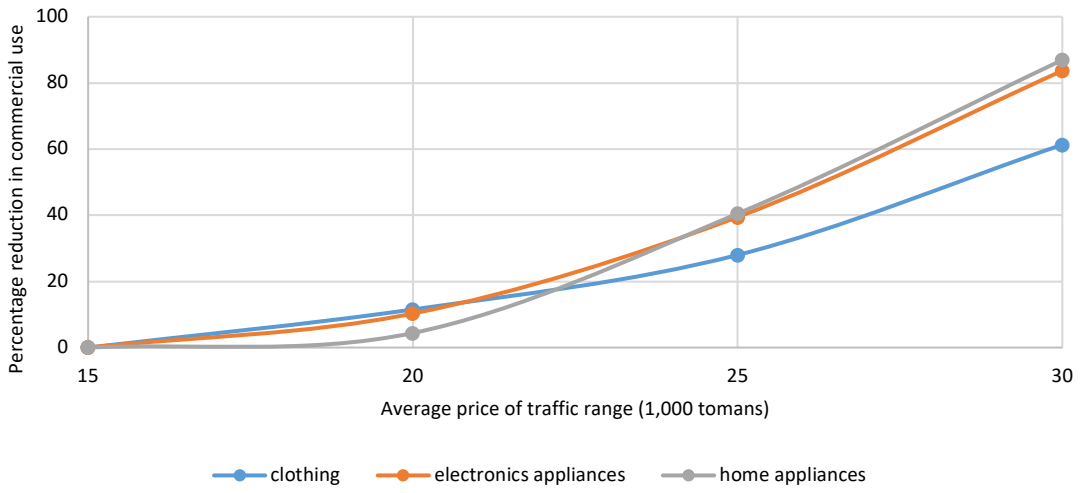

Fig.6 Percentage reduction in commercial land uses into the range under the average price of the traffic range

7. Conclusion

One of the most effective ways to decrease travel demand and its adverse effects on the urban transportation network is congestion toll pricing (CTP). This study investigated the diverse effects of congestion toll pricing policies on commercial land-uses in the Tehran congestion zone. The pricing policy will undoubtedly affect drivers and other users' behavior, including vendors and customers, related to their future choices in the long-term. Therefore, changing road pricing policies has direct and indirect effects. Its direct effects are on users who use personal vehicles, and its indirect effects are usually on activities and land uses, especially the decision to relocate the economic activities. As toll prices rise, clients in the area who use private vehicles will decrease, and this is one of the positive effects of road pricing to control traffic congestion and reduce air pollution. However, with the decline of clients in this area, in the long run, those commercials whose customers have decreased, their income will decrease, so some will have to relocate. The relocation of commercials, which leads to a change in the region's economy, is one of the long-term and adverse effects of road pricing. It means urban policy makers should be aware of this phenomenon and compensate for it by improving the neighborhood infrastructures that increase the public accessibility, leading to higher shares of sustainable mobility like active and public transport. These results are justifiable in the continuation of Masoumi and Moeinaddini researches in regard of socio-economic factors of urban form (Moeinaddini et al., 2012; Masoumi, 2013). Notwithstanding, these changes will not be the same in all vendors. The CLU clients who were sensitive to traffic congestion charges were recognized by designing a client-purchase-behavior questionnaire and were classified by a binary logit model. Another complementary questionnaire based on a multinomial logit model identified the vendors' responses to this customer reduction. The results were as follows:

- Congestion charging has reduced the demand for certain goods (apparel, bag and shoes; electronics; and home appliances) inside the congestion toll pricing zone;
- A 20-percent increase in congestion charges reduced the three retail categories' sales above, demonstrating the price sensitivity range;
- An increase of 60 percent or more will result in a substantial decline in sales (falling in the critical range for commercials);
- When the clients of the three price-sensitive retailers dropped as a result of the congestion price increase, the vendors initially began selling different products in the same price range and, in the long-term, changed their location to the outside of the traffic congestion zone.

Therefore, urban decision-makers should be careful that by implementing the road pricing plan in a metropolitan area, traffic congestion and air pollution are reduced. Still, they may cause changes in the area's economic activities. Decision-makers in Tehran's urban area will use this study's results to find out how much the tolls increase will change the purchasing behavior of the people and consequently change the location of commercials in the region. If they use these results, they will determine which activities and commercial land-use within Tehran's CTP zone will change if tolls increase. Also, the impact of accessibility on clients' choice and its role in reducing the adverse effects of pricing policies could be investigated in future research.

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Recycled aggregates in constructions. A case of circular economy in Sardinia (Italy)

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Abstract

The paper is the result of an ongoing research, considering the use of raw and recycled materials in the construction sector. In particular, the idea is considering such use within a Circular Economy framework, analysing its potentials in the case of the closed market of Sardinia Island (Italy), identifying potential clusters and their 'optimal' shape. In the paper, we highlight a theoretical framework for circular economy, adapting a classical model of industrial location to the construction sector. We build a georeferenced database of activities related to the extraction, processing and disposal of materials related to construction, as a result of the MEISAR Project - https://meisar.org/en/. Such a result is presented in a tool named MEISAR_Map; we then propose a method, based on spatial analytical techniques, namely point pattern analysis, for delimiting spatial clusters. The closed market of Sardinia is analyzed and, in particular, the case study of the new football stadium in Cagliari, which involves the demolition of the existing stadium and the use of "secondary" raw materials for the construction of the new Cagliari stadium.

Keywords
MEISAR; Circular economy; Green economy; Recycled aggregates; Sustainable planning.

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1. Introduction

The circular economy has become a new comprehensive and radical approach compared to the classic production model, opposite to that based on the over-exploitation of resources, instead focused on self-regeneration, in which the materials of biological origin are destined to be reintegrated into the biosphere, and the integrated ones must be used to be regenerating the biosphere (Ellen McArthur Foundation, 2019). The circular approach means re-evaluating and modifying the production cycles (Irache, 2020).

In particular, the circular economy is in contrast to the linear, traditional and classical economy, that does not consider neither the origin of resources nor the destination of waste (Migliore et al., 2020; see also Pirlone & Candia, 2016).

The principles of the circular economy also find application in the construction sector (not bio-based) characterized by high consumption of natural raw materials to a high production of waste (the so-called CDW - Construction and Demolition Waste; Hossain et al., 2020).

Furthermore, these principles are also applied to two main territorial scales: 1) The concept of urban mining sees the city as a mine of materials that can be reused; 2) the products and materials of individual buildings can be recycled at the end of their life cycle.

There are currently various strategies for the application of principles of the circular economy in construction, synthesizable: End-of-life Approach (selective demolition end of life management of demolition waste) and design approach (design for disassembling in the design of the new). In fact, the construction industry - globally - is responsible for 40% of CO_2 emissions and produces a third of all waste, ranking among the most polluting industrial sectors in the world. In Europe, approximately 30% of the 2.5 billion tons of waste produced is attributable to the construction sector (Migliore et al., 2020; Ruiz et al., 2020). In this framework, the circular economy of construction through a renewed balance between the 3Rs - Reuse, Recycling and Recovery - aims to promote the sustainability of the construction and demolition processes of buildings[1].

Through the application of the principles of circular economy, it is therefore possible to approach in a new way also for the relaunch of the construction sector in accordance with Agenda 2030, and the recent National Recovery and Resilience Plan - Next Generation Italy).

In this sense, the cities represent the privileged place to implement new circular economy models based on the enhancement of materials and goods and on the extension of their life cycle. In particular, approximately 60 million tons of construction and demolition waste are produced in Italy every year, approximately 43% of the total waste (Ispra, 2019). These are easily recoverable waste due to their substantially homogeneous nature, and not very dangerous for the environment: since they are inert materials, they are also by definition those with the least contamination problems.

Although the private construction market has been in crisis for at least a decade, the public works market instead shows a gradual and constant growth (CRESME, 2020).

The construction and demolition activities are therefore mainly attributable to initiatives of the Public Administration, such as Municipalities, Metropolitan Cities and the Regions. The potential markets, both for the natural aggregates (NA) and the recycled aggregates (RA) are closely linked to the actions of the Municipalities, the metropolitan city and the Region. In this framework, an important test will be given by the demolition of the Sant'Elia Stadium in Cagliari (Italy), intended to make room for the new stadium defined by the winning concept of the ideas competition (2019).

[1] *Reuse* of waste means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived; *Recycling* of waste is defined as any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes; *Recovery* of waste means any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy. From: Eurostat Glossary of Waste https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Waste

On the occasion of the competition of ideas, the collaboration with DICAAR (Department of Environmental Civil Engineering and Architecture, University of Cagliari, Italy) was born for the times of sustainable territorial planning and among these also the management of CDWs, converged in the MEISAR Project research.
With the MEISAR project, the concrete of the old stadium was therefore characterized to evaluate the possibility of recovery after selective demolition. In particular, the characterization of the concrete of the Sant'Elia Stadium - beams and foundation blocks - with sampling - in accordance with the law - to evaluate the mechanical performance of the concrete, highlighted the good performance quality, so much so that it could be used as recycled aggregates (RA) for the production of structural cement (Pani et al., 2019).
The demolition will produce a high quantity of materials that, after being treated in the suitable plants, can be put back on the market as secondary raw materials (RA).
Through the MEISAR project, and in particular with the MEISAR Map, the geospatial representation of the CDW production sector was developed through a Weber theoretical model, described in paragraph 3.2.
With this study, we intend to investigate management and environmental issues to extend the knowledge theory in the construction sector. To this end, we intend to stimulate the "latent and emerging entrepreneurship" model (Caiazza et al., 2020) in an insular context such as Sardinia through the MEISAR Map. In particular, the aim of this paper is to identify the clusters of aggregates in geospatial terms to encourage a circular economy in the construction sector.
The rest of the paper is organized as follows. In paragraph 2, a literature review is performed, focusing on circular economy. In paragraph 3, Materials and Methods are presented and particularly: in paragraph 3.1 we focus on the materials, as the geographical database and the MEISAR_Map, containing an update of CDW recycling plants, CDW landfill, concrete production plants and quarries. In paragraph 3.2, the Weber Theory and its modifications are presented. Paragraph 3.3 tackles Point Pattern analysis and in paragraph 3.4, the methodology for the identification of the clusters is presented. In paragraph 4 we comment on the results obtained from the application of the methodology, in particular we identify the regional circular clusters of Sardinia and of the circular cluster for the construction of the new stadium in Cagliari Stadium. Paragraph 5 hosts Discussions and Conclusions.

2. Literature review

The results and perspectives of the report "Resource efficiency and the circular economy in Europe (EEA Report n. 26/2019) and Assessing air quality through citizen science" (EEA Report n. 19/2019) highlight how the transition to the circular economy is the only way to the reduction of the anthropogenic impact on ecosystems (Angrisano et al., 2019; Pilogallo et al., 2019; Shirgir et al., 2019; Bianconi et al., 2018). The development and increase of innovative initiatives and investments in the construction and demolition waste recycling infrastructures of the (European Commission, 2018) highlights the convergence of economic objectives with environmental ones. Finally, the detailed assessment of EU waste management plans (Deloitte, 2017) highlights how reuse is the prevailing solution in all national and regional waste management plans confirming that Construction and Demolition Waste - CDW - reuse policies are shared. In this sense, one of the pillars of the circular economy - the construction sector - is the recovery of materials, obtained through the replacement of natural raw materials with secondary raw materials (Eberhardt et al., 2020). The circular economy of building activity fits into this synthetic framework, with the recovery of materials, obtained through the replacement of natural raw materials with secondary raw materials (Eberhardt et al., 2020).
However, waste deriving from the building activity, due to their heterogeneity and in the absence of a prior selective demolition and appropriate management actions, is little reused, despite the objectives of the Community policies aiming, by 2020 to reach the threshold of 70% reuse of these products (Legambiente, 2015). However, it should be noted that the use of RA is influenced by the geographical context (Balletto et al., 2015; Balletto, 2017).

In particular, Sardinia is an example of a closed market for natural inert materials and recycled inert materials (Delvoie et al., 2019).

An interchange of such materials is in fact impossible - or at least quite difficult - given the difficulties in transport of such bulky materials from the island to the mainland and therefore moving materials to other Italian regions, as well as of sending waste from demolitions towards these same destinations. Building constructions and demolition need proximal locations of prime - and secondary - raw materials as well as for waste landfill (de Larrard & Colina, 2019; Balletto et al., 2018). Extraction of prime materials (resources), processing, waste disposal, processing of recycled (second) materials, re-inserting them into the production process must happen within the regional territory (Balletto et al., 2019). Another restriction regarding construction is given by the fact that concrete batching products must reach their destination from the processing plants within a range of 30 km (Renner, 1947).

Over such a distance the products are degraded and their quality is reduced (Pasini, 2013). In this geographical context, the MEISAR Project was developed within the University of Cagliari to support collaborative R&D activities for the development of new sustainable technologies, new products and Services. The MEISAR project aims to contribute to knowledge in the preparation and use of concrete with Recycled Aggregates (RA) deriving from the treatment of CDW and the related verification of economic and environmental sustainability, through experimental research carried out in collaboration with companies operating in the construction sector. It involves, in fact, a cluster of companies comprising both the recycling plants for construction and demolition waste and prefabricated concrete companies. In this sense, the MEISAR project aims to give a high added value to the Recycled Aggregates (RA) allowing their use as valuable raw materials for the concrete, including structural ones. In other words, the RAs are configured as a real alternative to the natural aggregates (NA) deriving from the extractive industry of natural materials (Pani et al., 2010a; Pani et al., 2010b; Pani et al., 2013a; Pani et al., 2013b). In fact, at present, the RAs have had a marginal reuse in particular referred to fillings or road substrates, while they are not used as an alternative to the NA for the production of concrete.

In fact, through the MEISAR project the economic and environmental applicability of the RAs was assessed, with reference to the case study of the Cagliari stadium, which represents a very interesting case on the possibility of creating a circular economy regime on the construction market in Sardinia.

3. Materials and Methods

The research is developed within a theoretical framework of circular economy of the RA, reviewing a classic model of industrial location adapted to the current situation. In particular, the authors adapted Weber's Theory (Weber, 1909) to a circular economy approach applied to concrete production (Balletto et al., 2019), to highlight possible clusters on Sardinia Island. This work involved several steps. The first, important step required the realization of a suitable, georeferenced database, useful for locating plants related to the construction materials' production chain in space, in order to have the spatial distribution of the potential markets. This work resulted in a mix of detailed desk research, integrated by direct contact and data taken from a set of selected companies participating in the MEISAR Project. A second step required the definition of a theoretical model, capable of putting the second raw materials in construction within a geographical location framework. This implied revisiting the traditional Weber's theory of industrial location within an updated situation, in which materials and waste become tightly integrated and interconnected, thus creating a dynamic situation in which places of raw material extraction, processing, waste management and re-processing often coincide.

After considering the original data (MEISAR_Map) and the theoretical framework (modified Weber's theory) a further, third step implied the identification of the clusters in the, nearly ideal from the theoretical and practical points of view, case of Sardinia - that, being an isolated context, results particularly interesting in examining a 'bulky' market as that of constructions. This step involved performing a point pattern analysis on the spatial distribution of plants in the territory, considering the areas with the higher concentration and therefore

providing hints for identifying potential 'circular economy markets' in the Island. A final, fourth step represents a planning proposal for the identification of the markets in the island.

3.1 Materials. The geographical database and the MEISAR_Map

The data collected were organized into a geographical database, in order to make them available for further elaborations. In particular, a dataset was created with different sources summarized for geocoding points were used as starting points then integrated and corrected using ad hoc refinements.

The research activity required both fieldwork and desk activity to obtain an original database. In particular, the recycling plants involved in the MEISAR project were asked to fill in a form containing their parameters and correctly geocoded. The different datasets then presented as layers required also different kinds of analysis from different sources. The landfills were derived from the 'Sardegna Ambiente' website, the Autonomous Region of Sardinia website dedicated to environmental issues. Data were updated and organized in forms, containing coordinate pairs in the Italian Gauss Boaga Rome 40 reference system.

The work carried out was then organized and shared in a project called "MEISAR_Map", based on a Google My Maps platform. In this sense, MEISAR_Map constitutes the geographical tool for the collection, archiving and visualization of the territorial data of the MEISAR project (Balletto et al., 2019).

The MEISAR_Map does not appear as a proper GIS - Geographical Information System, however the preparatory work implied a deep and intense work on building, organizing and elaborating geographical data from multiple sources, realized by means of the QGIS platform, an open-source cross-platform desktop geographic information system application that supports viewing, editing, and analysis of geospatial data.

With reference to the data realized and loaded onto the MEISAR_Map, we georeferenced the locations of the companies belonging to the MEISAR cluster, as well as all the players at regional level involved in the different processes of production, use and disposal of natural and recycled aggregates.

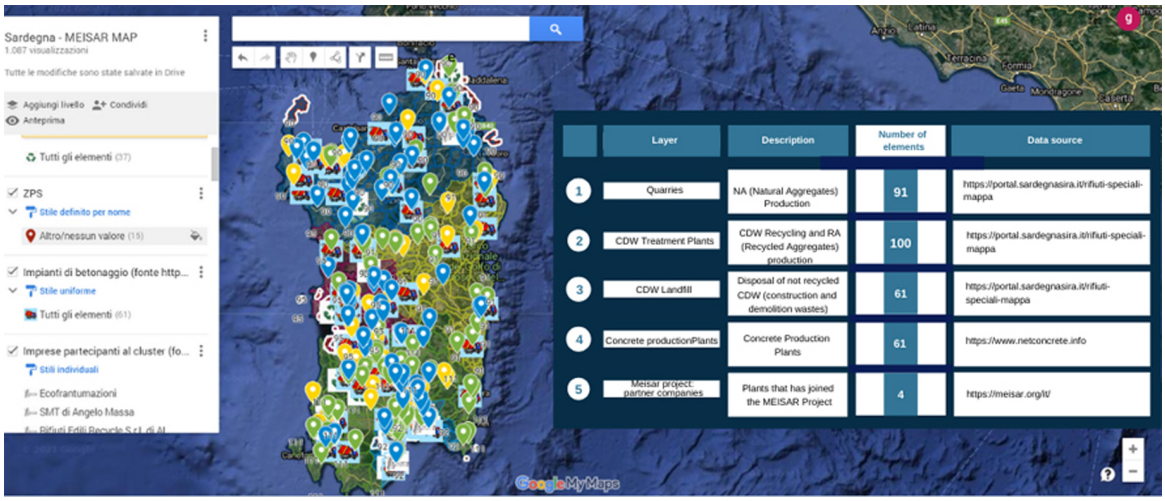


Fig.1 The MEISAR_MAP and a sample of the data realized. See http://bit.ly/MEISAR_MAP

In particular, the data loaded onto the MEISAR_Map include quarries, CDW treatment and CDW landfill, concrete production plants and partner companies of MEISAR Project (Fig.1). The MEISAR_Map is a support for territorial and geographic analysis useful for defining strengths and weaknesses on the management and reuse of CDW to stimulate policies and actions aimed at improving the sector of building.

3.2 Weber Theory in a circular Economy Framework

The classical model

Dealing with an opportunity of reinserting materials coming from construction and demolition waste, as RA, we realized it was important to insert this into a theoretical model, observing similarities with the standard

Weber formulation (1909). Weber argues that the location of industrial plants is strongly linked to the distance (between the source of production materials and the end market) and the production function of the industry. According to Weber, the optimal location of production plants depends on transport costs related to distance to and from places of origin of materials and energy, other than to and from the final market (s). The model was used particularly to explain the industrial location in the historical context of the Ruhr basin in the years of the Industrial Revolution in Germany. It however entered into a linear economic scheme, typical of the neoclassical theory: extraction of resources -> processing / production -> distribution into the final market. Within such a scheme, space entered as the origin of resources and destination for waste, without focusing on their impact. We hereby considered the possibilities for such a model of incorporating the basics of circular economy, particularly in terms of the basic change in the concept of resources. While Weber differentiated places of origins of materials, production plants and markets, with the possibility of production plants to be put in close proximity to materials extraction sites or markets, the consideration of a circular economy framework becomes interesting as the same production sites and markets become potential recycled materials sites.

In the basic Weber model, as in the 'Theory of the Location of Industries' (1929), some assumptions are made, among them, the fixed location of all input suppliers and markets, and that the manufacturing industry would choose the best location capable of minimizing the total sum of incoming and outgoing transport costs. In its most simplified formulation, the industry uses a single input localized in a given point of a homogeneous plain, and sells its output in a single market localized on the same plain. The technology presents constant returns of scale and does not allow input substitution.

Weber considers localized materials – having a fixed location in space – that can be divided in 'pure' – completely entering into the final product – and 'gross' – losing weight, and therefore creating waste, and entering only partially into the final product. Other materials are defined as ubiquitous – or non-localized – that are equally distributed and accessible in space.

Transport costs can be organized in assembly costs – transport costs of raw materials from the place of origin to the production site – and distribution costs – transport costs of products to the market. Transport costs are a constant multiplied by the ton-km - no terminal costs are present; ton-km costs are the same for inputs and outputs. The firm is 'price taker', holding a perfect knowledge of all the information necessary for accurately computing transport costs.

The target is the location bringing to minimizing the sum of the total transport costs. This happens, in the simplified Weber model, with only two points – materials and market – by minimizing the following formula:

$$T = t * w_r * d(R) + t * w_m * d(M)$$

where:

T = Total Transport Cost (in Ton-Km)

w_r = weight per unit input

t = transport cost in € per ton-km

w_m = weight per unit output

$d(R)$ = Distance RF (resource site – production site)

$d(M)$ = Distance FM (production site – market site)

The production plant F will be located in a point among the resource site R and the market site M.

Such location will depend on the weight of raw materials with respect to the final product. Weber define a Material Index MI such that:

MI = weight of localized materials / weight of final product

Pure Materials: MI = 1

Gross Materials: MI > 1

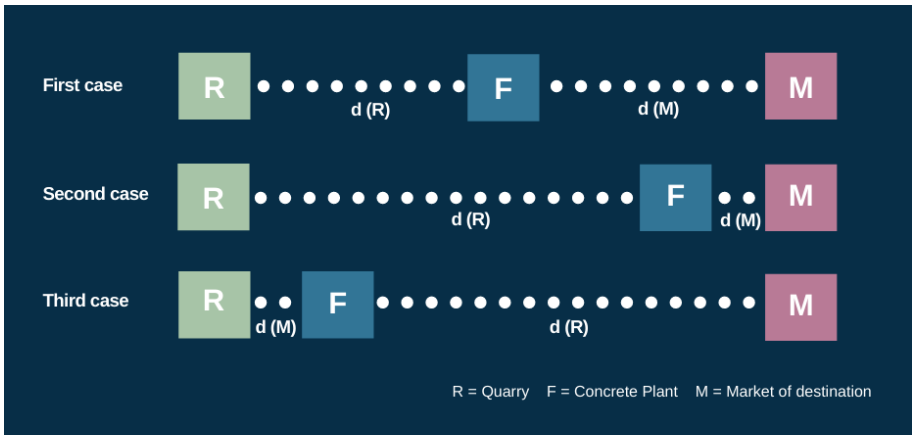


Fig.2 Location à la Weber in the simplified model, Source: Weber (1929). Elaboration by Balletto, Borruso and Mei (2019)

In the case in which materials are pure and are used completely in the final product, no waste will be generated, and therefore the location will happen in an intermediate point between R and M (1st case, Fig.2). In the case of gross materials (MI>1), location will happen in proximity of the resource site R, to minimize waste transport cost (third case, Fig.2).
An extreme case will be that of the location in proximity of the market M (2nd case, Fig.2) in the case in which the final product is realized mainly by ubiquitous materials in proximity of the market itself (i.e., adding water, considered ubiquitous, in a soft-drink plant).

Weber Model in a circular framework

The Weber Model in a circular economy framework foresees a change of paradigm, as the classical sites of Resource extraction (R), Market (M) and production (F) now are flanked by the potential presence of a further site of Second, recycled resources extraction/creation (R2).
In the case of construction materials, R indicates the generic site(s) of extraction of resources, as quarries, source of AN as 'first' materials. M is the market – in one of the simulations hereby presented, the Cagliari Calcio Stadium. F is the site(s) of concrete production (batching plants).
Four scenarios are possible in the modified Weber model.
- Scenario 1 ('classic'). Production is localized in proximity to quarries, where extraction of natural aggregates take place. Batching plant is localized in proximity of resources, recycling of construction and demolition waste is not foreseen.
- Scenario 2, market place M is considered also as a second site of origin of materials (R2), together with quarries (R1). Location of batching plant F remains in proximity of prime materials but R2 becomes important for extracting second materials. In such cases, however, as these need processing, a transport of second prime materials from the place of extraction to the processing site, still located in R1, and then to the market M can be hypothesized.
- Scenarios 2 and 3 are extreme cases as based on hypotheses foresee the dominance of prime materials (NA) in the first case, and second prime materials (RA) in the second case.
- Scenario 4 (and others, future ones, hereby not presented) identifies a case à la Weber, where the batching plant could be located in a site F in an intermediate position where the cost function of prime materials (first and second: NA and RA) is minimized, not necessarily, therefore, foreseeing a location of patching plants in proximity of resource sites.

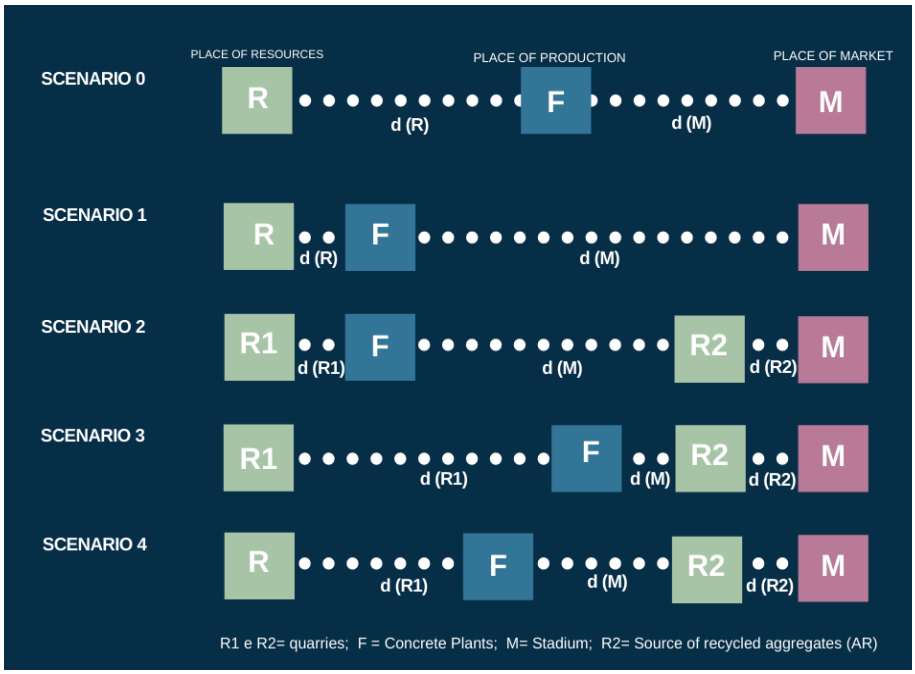


Fig.3 Scenarios of the modified circular Weber Model, Source: Weber (1929). Elaboration by Balletto, Borruso and Mei (2019)

3.3 Point Pattern Analysis. Density estimation

From a spatial point of view, the different locations related to the construction sector can be defined as a point pattern, as the different activities considered can be simplified as points in space, simplifying them according to their spatial coordinates.

Therefore, a point pattern analysis becomes important for understanding the spatial distribution of the phenomenon and provides some hints concerning the possible clustering of the different elements belonging to the distribution pattern. As observed, above, the starting point for the analysis has been the geographical database represented in the MEISAR Map.

The different activities (i.e., quarries, batching plants, waste disposal and treatment plants, etc.) were considered as 'events' in space considering their geographical position (Battino et al., 2012; Thurstain-Goodwin & Unwin, 2000; Borruso, 2006; 2008; Borruso & Porceddu, 2009; Danese, et al., 2009; Murgante & Danese, 2011; Gatrell, 1994; Levine, 2004).

The logic behind the function, is that of a general formula where a three-dimensional moving window is placed over every point - or some form of discretization of a point, that is a grid cell in a spatial tessellation of the region - of the study region and and samples all the events of the point pattern, assigning weights depending on the distance function and using weights stored in the point event database (Gatrell, 1994).

$$\lambda\ (s) = \sum_{i=1}^{n} \frac{1}{\tau^2} k\left(\frac{s - s_i}{\tau}\right) \qquad (1)$$

where $\lambda\ (s)$ is the density estimation of the point pattern measured at location *s*, while s_i represents the observed event. *k( )* is the kernel weighting function and the parameter τ is the radius of research of the function, or bandwidth, to be centered in locations, and searching for events is to be computed into the density function (Levine, 2004).

In a GIS environment, the density function is expressed by means of a grid of cells, whose values represent a probability or density function, with a smooth variation among neighbouring cells, therefore approximating a 3D distribution.

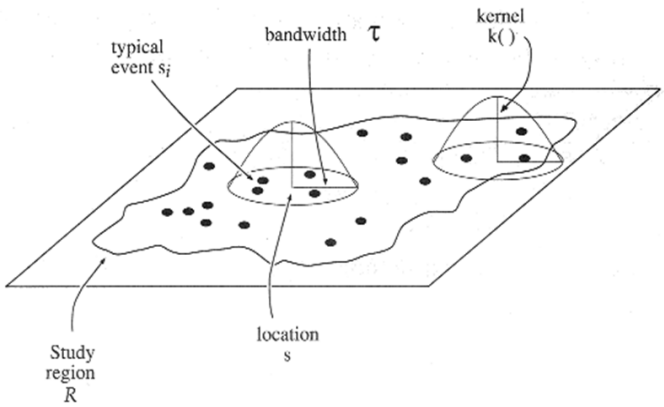


Fig.4 Point pattern analysis. Kernel Density Estimation, Source: Elaboration from Gatrell (1994)

3.4 Identification of the circular clusters of the aggregates in Sardinia

The above-described methods are relevant to propose a way for detecting clusters in a circular economy framework. Different steps were considered for obtaining an image of the closed study area of Sardinia, where clusters could be detected.

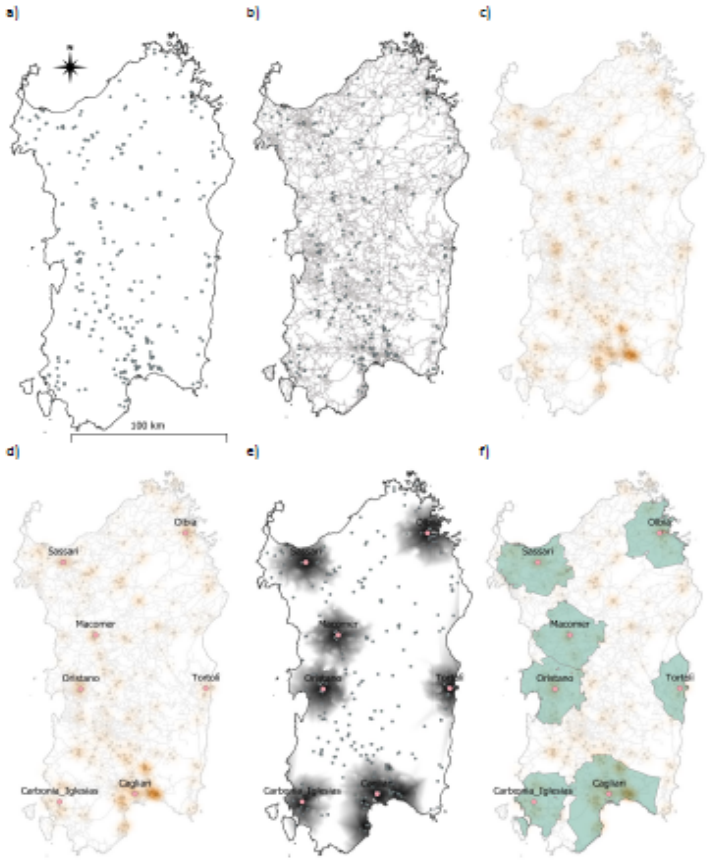


Fig.5 Forming the Circular Economy Clusters. Elaboration Borruso 2021, source: Dataset of MEISAR_Map. a) scatterplot of data from the MEISAR_Map; b) data plus street and road network; c) Kernel density estimation on MEISAR_Map dataset; d) highlights of the major clusters detected; e) 30km - catchment areas of the clusters; f) areas of the major Sardinian clusters detected.

The MEISAR_Map represents the starting point for observing the basic spatial distribution of the overall dataset, namely the spatial locations of quarries, batching plants, treatment plants and disposal sites (Fig.5a), also considered within the road network system (Fig.5b). Such a geographical dataset represents a scatterplot of the data, usable for a further point pattern analysis, as a Kernel Density Estimation, where the events are

weighted according to their proximity and concentration (Fig.5c). The presence of peaks in the distribution helped in highlighting the geographical centre of the clusters, possible via the quantitative KDE analysis helped by a visual analysis (Fig.5d). The area of the proposed cluster was then elaborated from a network service area analysis using a 30km radius over the Sardinia Region road network (Fig.5e). For the Cagliari area, the clusters were merged considering a set of contiguous sub-clusters. Seven major circular economy clusters will be detected, as it will be presented in the Results paragraph.

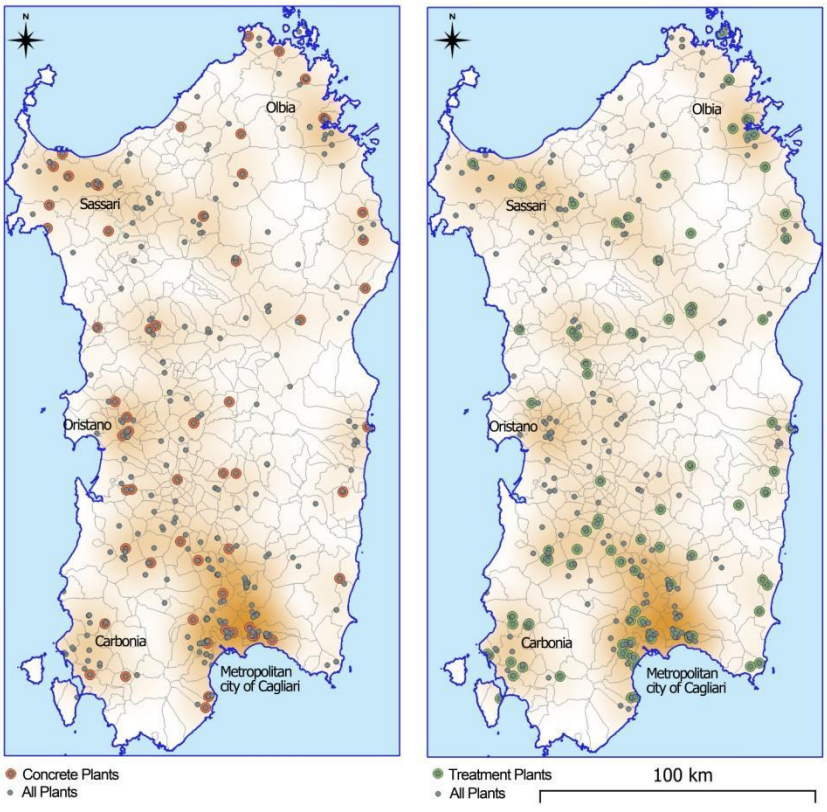
4. Results

The data from MEISAR_Map were elaborated in a GIS environment, where it was possible to build more complex elaborations such as 'Density maps'. In particular, Fig.6a shows the density of the concrete mixing plants, Fig.6b that of the CDW treatment plants, Fig.7a that of the CDW landfill and, finally, Fig.7b that of the quarries of aggregates. The distribution of the elements in the density maps shows that all the elements (quarries, CDW treatment, CDW landfill, concrete production plants and partner companies of MEISAR Project) analyzed show a greater density in the same geographical areas.

However, it is necessary to specify the main factors that influence the spatial pattern (Fig.6a, 6b, and 7a, 7b):

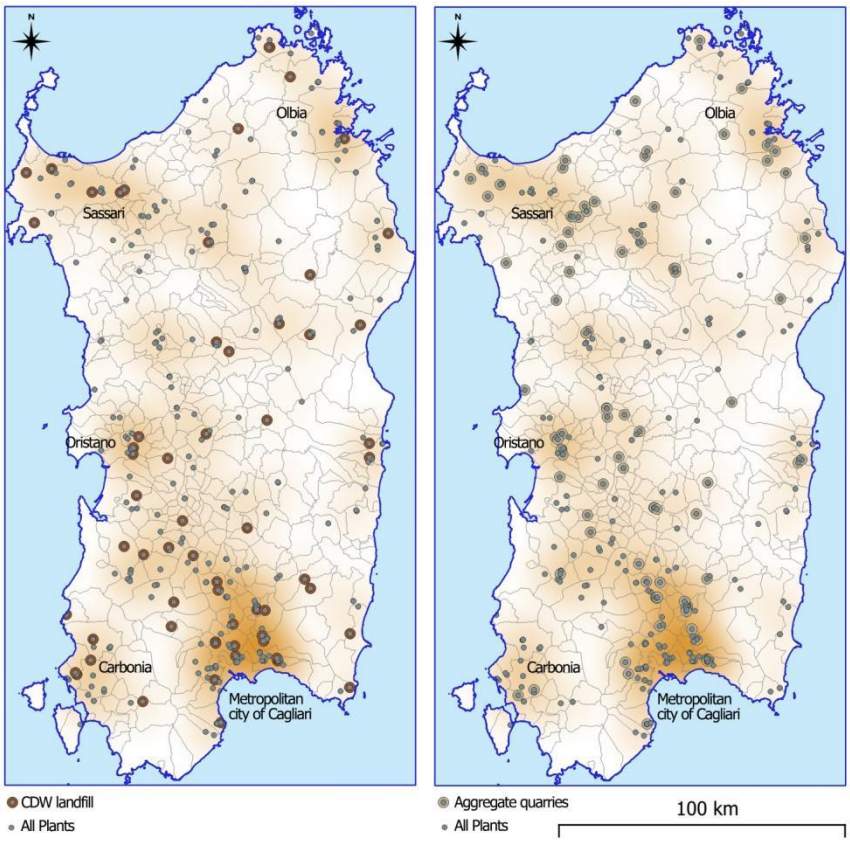
1. The transportability of ready-mixed concrete;
2. The transport costs of the CDW which defines the transportability radius of the waste from the place of production to the place of treatment;
3. Construction market.

In particular, there is a technical limit to the transportability of ready-mixed concrete which establishes the maximum distance between the production point and the point of use in 30 km, so that the optimal characteristics of the concrete are guaranteed. The 30 km limit was also defined for the maximum distance between the CDW production site and the treatment plants in Sardinia.



(a) (b)

Fig.6 (a) Location and density of concrete plants and (b) Location and density of CDW treatment plants



(a) (b)

Fig.7 (a) Location and density CDW landfill and (b) Location and density of quarries

This limit is economic, since the low value of the aggregate material does not allow economically compatible transport for longer distances. Finally, the low level of infrastructure of the road system in Sardinia, as well as the absence of rail freight transport, confirms this limitation. In particular, Sardinia ranks 20th in Italy for road freight transport (Istat 2017).

In order to visualize a first spatial organization of areas of major concentration of activities, a hot spot density map was performed over the point datasets to visualize clusters. Such maps provided a first visual impact of the areas hosting the major concentration of such construction-related facilities.

Through the visual analysis of the density maps, Fig.6-a, 6-b, 7-a, 7-b it is possible to identify the parts of the regional territory characterized by the circular economy process of the aggregates, allowing the use of RAs as a substitute of the NAs also for the production of concrete.

The areas of greater density in Fig.6 and 7 correspond to the main urban areas of the Sardinia Region, in particular, the metropolitan area of Cagliari and those of Sassari, Carbonia-Iglesias, Oristano, Macomer, Tortolì and Olbia.

Many areas of Sardinia are characterized by low population and little building activity, as well as by the excessive distance between urban centers - potential places of origin of the CDW market - and the places of production of RA and concrete. This spatial organization in the urban economy is defined as an industrial cluster: a group of companies, strictly interconnected within an economic process in this case of a circular type (Korhonen, J. et al 2018).

The C_clusters are territorial areas in which all the elements useful for the development of an RA market are concentrated. In fact, in the C_clusters there are recycling plants that transform the CDW into RA and concrete plants with NA production quarries which will satisfy the missing share of aggregates. Finally, the C_clusters are located - confirming the above - in correspondence of one or more urban areas closely connected with the main transport infrastructures. This is not possible in territories characterized by the absence of C_clusters,

for which the natural fate of the CDW is the landfill or, in the worst cases, abandonment (Fig. 8 and Tab 1). In other words, the C_clusters constitute the most favorable territorial areas to activate circular economy processes much desired (Mei et al., 2019; Balletto et al., 2019; Pani et al., 2019) and consistent with the recent procurement code public in Italy (Law 11 September 2020, n. 120).

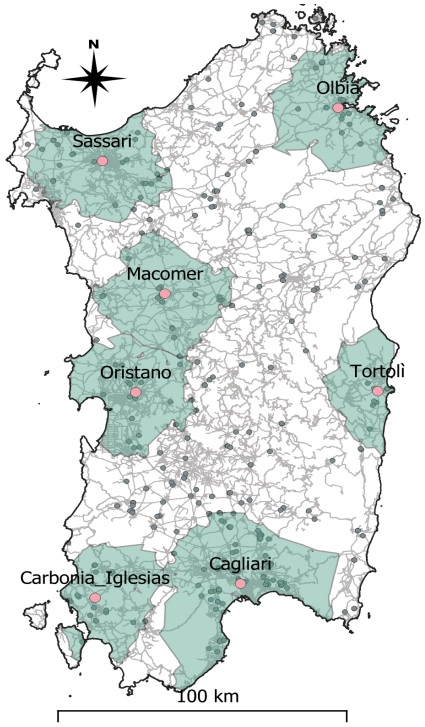


Fig.8 Sardinia Circular Cluster

Tab.1 Principal Dataset of Sardinia Circular Cluster, data elaborated from MEISAR_Map

	Area (km^2)	Quarries	CDW treatment plants	Concrete plants	Landfill	Total	% Sardinia	% Cluster
Cagliari	2102.29	22	23	34	16	95	27.07	42.79
Carbonia-Iglesias	1070.41	2	11	5	5	23	6.55	10.36
Oristano	1304.89	12	1	8	5	26	7.41	11.71
Macomer	1426.03	3	9	4	1	17	4.84	7.66
Sassari	1369.84	13	6	9	4	32	9.12	14.41
Olbia	1255.78	6	9	4	1	20	5.70	9.01
Tortolì	739.20	2	3	2	2	9	2.56	4.05
Total	9268.44	60	62	66	34	222	65.25	100.00

4.1 The case study of the Cagliari stadium within the island context of Sardinia

The state of obsolescence of the old stadium has reached the point of total non-usability, which has led Cagliari Calcio to start the authorization process for the construction of the new stadium (2018). The case is interesting as the new sports facility will be built in proximity to the existing one, and the demolition / construction process will take place in a condition of spatial and temporal proximity, with interesting implications in terms of CDW production, their treatment and reuse.

In this sense, with the help of the companies participating in the MEISAR project, concrete was produced with RA in different percentages of use (30%, 50% and 80%) to replace NA. In particular, the tests on recycled concrete (workability values at 14 and 28 days, compression,) gave the following encouraging results: recycled

concrete produced with coarse recycled aggregates, even when the replacement percentages of natural aggregates reach 80 %, as demonstrated by the equivalent mechanical performance of ordinary concrete. In fact, the performance of recycled concrete is not related to the mechanical characteristics of the mother concrete (Pani et al., 2019). Following this positive evaluation, the authors, in order to reach the goal of using RA - coming from the demolition of the old stadium - have developed intra-disciplinary evaluations (environmental, geographical, chemical-mineralogical) which led to the quantification of about 9,000 cubic meters of CDW, which correspond to approximately 18,000 cubic meters of RA.

By doing so, approximately 50% of the concrete requirement for the construction of the new stadium will be met, which from the project results in approximately 35,000 cubic meters. The benefit will not only be environmental but also economic. In fact, the price of RA is lower than NA, which can be estimated at about half.

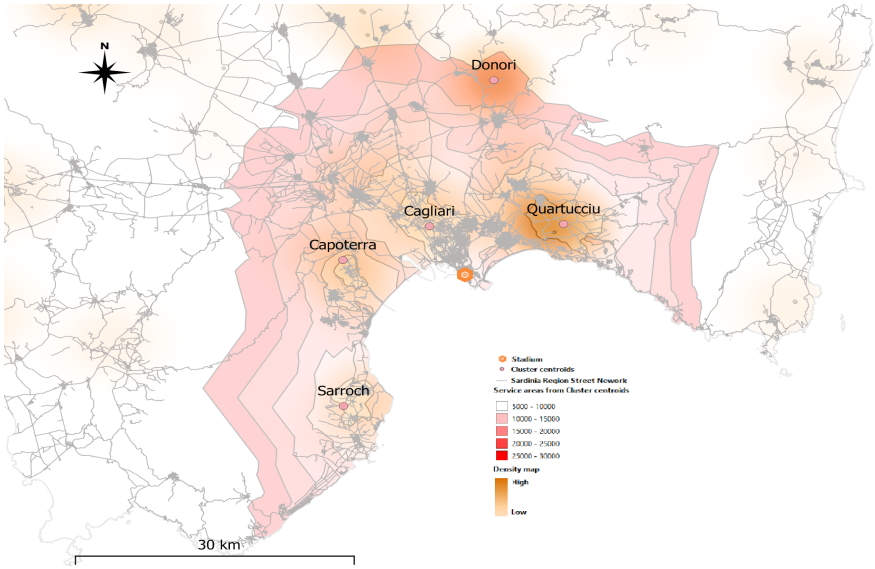


Fig.10 C_Clusters in the Cagliari Area. Data from MEISAR_Map; Sardinia Region (Street network); Elaborations by Giuseppe Borruso

Within the Cagliari C_cluster, aggregated flows will thus be generated from the place of origin (CDW source) and destination (installation), passing through the place of transformation (transforming CDW into RA for concrete). In particular - in the case study - new stadium - the place of origin and that of destination coincide, while the transformation sites are adjacent to the urban center of Cagliari and meet the requirement of a distance of 30 km (Fig.10).

Furthermore, the Cagliari Cluster originates from the merging of the 5 sub-circular clusters (SC_clusters): Sarroch, Capoterra, Cagliari, Quartucciu and Donori. The five SC_cluster meet both the design requirements and the principles of circular economy. The choice of the SC_cluster will then be guided by the market laws, by the production capacities (quantitative and qualitative) of RA and by the public procurement requirements for the construction of the new Cagliari stadium.

5. Discussion and conclusions

The construction sector, particularly in some geographical circumstances, can be considered as an ideal case study for proposing its transformation from a linear to a circular economy process. The general case study referring to Sardinia appeared particularly interesting for CDWs.

This is due to two main reasons. On the one hand, insularity makes the Region a closed system from the point of view of raw materials, primary and secondary (aggregates in particular). On the other hand, the main activity deriving from public works makes the use of recycled aggregates interesting from a design point of view.

In such a macro-context, the microanalysis of the case study - new stage - appeared interesting, also because they are closely related to each other.

In this sense, it is an interesting case in that a triple situation coexists. First of all, the former stadium is destined for demolition and reconstruction; secondly, a research project (MEISAR) on materials is already underway, involving local universities, public bodies and private companies engaged in construction innovation. Thirdly, a project was set up for the construction of the new stadium, after a competition was won by a consortium (Sportium), whose purpose is, among others, to work and build in the direction of sustainability, which includes the application of BIM modeling to minimize and optimize resources and production, in line with a circular economy framework. In particular, therefore, with this paper we evaluate a case of application of the principles of Circular Economy referring to the construction of the important public building of the new Cagliari Calcio stadium. This construction involves the total demolition of the current stadium, recovering the material deriving from the demolition to use it for the production of concrete for the new stadium.

The complex territorial assessment that led to the development of the MEISAR Map and the density maps has therefore made it possible to identify the circular clusters (C_clusters) of the Sardinia Region, characterized by a range of about 30 km, the result of the compromise between market value of natural and recycled aggregates and related shipping costs (Neto et al., 2017).

Furthermore, the metropolitan city, in fact, has an active and more developed building market than the rest of Sardinia. The metropolitan role played by Cagliari as the regional capital in attracting people for higher-order services and opportunities - public offices, residential spaces and commercial activities, higher education facilities favors the construction market and with them also the processes of circular economy. Transport infrastructures also favor circular economy processes. In the specific case, the five Sub-circular clusters identified are able to guarantee the supply of recycled aggregates for the concrete necessary for the construction of the stadium according to the criteria of the circular economy.

The case of the stadium has highlighted how the tools that promote knowledge of the characteristics of recycling aggregates such as MEISAR_Map constitute important applications for the diffusion of their use in the circular economic transition, made even more necessary by the health emergency, which highlighted the urgent need for a new ecologically sustainable Anthropocene (Mundula et al., 2019; Murgante et al., 2020).

In this sense, the circular economy, at the various levels of implementation, poses various operational challenges on the production process from a spatial point of view, as well as of course of architectural composition and realization (Della Torre et al., 2020; Bottero et al., 2017).

In particular, the demolition and reconstruction of the Cagliari stadium for the way it was designed will activate a circular economy process, which will develop between the five sub-circular clusters based on the market offer with the same technical characteristics of the recycled aggregates. Finally, the use and implementation of MEISAR_Map has contributed to the practical evaluation of the processes that can be potentially activated in the ambit of the circular economy referred to CDW, opening up a little explored theoretical discussion field for closed markets such as Sardinia (Balletto et al., 2019).

In this sense, research will continue to identify the main actions both with specific prescriptions in the urban plans and through bonuses in the form of tax breaks, similarly to what is implemented for actions on energy saving (Obe et al., 2019).

In summary, it intends to contribute both to the theoretical discussion and to the research applied to application case studies according to the objectives of the 2030 Agenda and the much-desired ecological transition.

The research is also ongoing to tackle other, more operational aspects of the circular economy applied to the construction sector. In particular, in a first stage we tackled the theoretical and methodological aspects of the industrial location model. At present, and as a future research, we are working on the possibility of quantification of the RA needed in the construction sector, in case of demolition and construction – i.e., with

reference to the demolition of the old Cagliari stadium and the realization of the new one –, and also in terms of the carbon footprint impacts. That would allow us to examine the potential not only in terms of materials actually put again into the economic production process, but also in terms of the impacts related to carbon emissions in the different scenarios.

Authors Contribution

The paper derives from the joint reflections of authors. However, the following paragraphs can be so attributed: Paragraph 1 has been realized by Milesi A. and Mei G., while Paragraph 2 is meant to be attributed to Balletto G. and Milesi A.; Paragraph 3 has been realized by Borruso G. and Paragraph 4 has been realized by Balletto G and Milesi A. Paragraph 5 Was realized by Balletto G and Borruso G.

Acknowledge

This research was funded by the project "Materials for Sustainable Building and Infrastructure - Recycled Aggregates (MEISAR)", financed by the Autonomous Region of Sardinia (POR Sardegna FESR 2014/2020 - ASSE PRIORITARIO I - "RICERCA SCIENTIFICA, SVILUPPO TECNOLOGICO E INNOVAZIONE" Azione 1.1.4 Sostegno alle attività collaborative di R&S per lo sviluppo di nuove tecnologie sostenibili, di nuovi prodotti e servizi. REALIZZAZIONE DI AZIONI CLUSTER "TOP-DOWN") that wants to develop an eco-sustainable chain of concrete constructions by enhancing recycled aggregates.

Data Availability

Some or all data, models, or code that support the findings of this study are available from the corresponding author upon reasonable request. Some or all data, models, or code generated or used during the study are proprietary or confidential in nature and may only be provided with restrictions. Specific data concerning MEISAR – i.e., information concerning companies involved in the MEISAR project – are considered proprietary and confidential. They can be made available after contacting authors and evaluating the level of detail required. Datasets used are summarized and available through the MEISAR_MAP http://bit.ly/MEISAR_MAP. The origin of data organized there is public and elaborated by authors. The procedure and origin is described in the text. Images and maps were realized by authors from data originally collected, together with geographical data made available through Sardinia Region geodatabase.

Glossary

CDW (Construction and demolition waste): Wastes from construction and demolition activities. They represent one of the largest waste streams in the European Union (500 kg per capita in 2014);
RA (Recycled aggregate): the recycled aggregate is defined as a mineral aggregate resulting from the recovery of waste of inorganic material previously used in construction;
NA (Natural aggregate): Aggregate of natural origin used for the production of concrete. The natural aggregate comes from natural deposits, such as in the case of inert materials of alluvial origin, from rivers and is obtained by crushing the rocks;
All Plants: The mix of plants of natural and recycled aggregates in the circular economy (quarries, CDW treatment and CDW landfill, concrete production plants and partner companies of MEISAR project);
C_Cluster (Circular Cluster): The C_clusters are territorial areas in which all the elements useful for the development of an RA market are concentrated. In the C_clusters there are recycling plants that transform the CDW into RA and batching plants for the production of concrete together with NA production quarries which will satisfy the missing share of aggregates RA.

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Bicycle and urban design. A lesson from Covid-19

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Abstract
The central role of the car in city mobility has led to a decreased capacity for people to choose another alternative form of mobility. In recent decades, some cities have set policies where cycling has become increasingly important. Urban mobility policies in response to Covid-19 have reinforced this perspective. Throughout the analysis of urban bicycle studies, the paper investigates the role of mobility for society and the design of our cities? What the role of sustainable mobility, in particular how the bicycle is addressing the Covid-19 emergency. During and after this emergency, the use of the bicycle addresses urban quality and liveability for spaces. The research studies the urban policies of 5 cities: Barcelona, Bogota, Brussels, Milan and Paris and analyses the measures implemented during the first lock down, since February 2020 to May 2020. In all cities studied, the bicycle modal shares and the bicycle infrastructure has increased. Covid-19 allowed the bicycle to prove it is the safest, most efficient urban mode of transport. The action carried out, in the cities studied, affected not only on the hard aspects reshaping the cities with permanent and temporary solutions but also on soft aspects acting on people's perception and use and choosing how to move. Transport studies and policies involving bicycles are not just 'about cycling', but about sustainable, productive, and prosperous cities.

Keywords
Bicycle urbanism; Urban design; Covid-19 and city.

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1. Introduction

Recent studies reveal the statistical correlation between Covid-19 mortality rates and long-term exposure to fine particle matter. Long-term exposure to air pollution increases vulnerability to experiencing a more serious Covid-19 consequences (Wu et al., 2020). There is an urge to intervene in order to counteract climate changes and the alteration of ecosystems that might trigger new and unexpected threats to human health, such as of Covid-19 (Setti et al., 2020).

Combustibles used for transportation generate more than half of the nitrogen oxides emitted in the world and an abundant proportion of particle matter, posing a significant threat to human health, particularly in urban areas (World Energy Investment 2017, Watts et al., 2019).

In 2005 the World Health Organisation released the *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide* (WHO, 2005) the guidelines indicate values PM2.5: 10μg/m^3 annual mean; 25μg/m^3 24-hour mean; PM10: 20μg/m^3 annual mean 50 μg/m^3 24-hour mean[1].

In 2016, an estimated 4.2 million premature deaths were caused by air pollution; 91% of the world population was living in areas where the WHO guidelines' levels were not satisfied, and more than 83% of cities did not meet the WHO guideline regarding environment PM2.5 concentrations (Watts et al., 2019)

In 2015, during an informal meeting, the ministers for transport adopted a declaration on cycling where they engaged in integrating cycling into multimodal transport policy, including smart mobility, stressing the need to promote physical infrastructure and behavioural change programs. EU Member States developed an EU level strategic document on cycling various, among them several states developed and implemented policies to increment targets for cycling, France's target to triple by 2024 and a vast number of states envision doubling cycle use by 2030 (Küster, 2019).

During the Covid-19 lock-down[2], in order to allow people to move around cities to reach their workplaces, essential daily needs or provide assistance to vulnerable people. The World Health Organisation (WHO) has released technical guidance on moving around during the Covid-19 outbreak. The guidance promotes cycling and walking to limit physical contact to prevent and slow down the pandemic. *Whenever feasible, consider riding bicycles or walking; this provides physical distancing while helping to meet the minimum requirement for daily physical activity, which may be more difficult due to increased teleworking, and limited access to sport and other recreational activities* (WHO, 2020).

Since the beginning of the Covid-19 pandemic, several scholars (Fenu, 2020; Kang et al., 2020; Lai et al., 2020; Pisano, 2020) have been trying to investigate the dynamics of the pandemic in urban and rural areas to understand the consequences of Covid-19.

According to Sharifi and Khavarian (2020) there are four major themes explored by researchers:

1. environmental quality;
2. socio-economic impacts;
3. management and governance;
4. transportation and urban design.

Murgante et al. sustain that the policies based on urban regeneration, sustainable mobility, green infrastructures, and ecosystem services play an important role in enhancing a more sustainable scenario that can support the quality of public health (2020). Furthermore, architects and urban designers role is fundamental to introducing new solutions to guide the development of urban spaces towards more inclusive

[1] PM10 is particulate matter 10 micrometres or less in diametre, PM2.5 is particulate matter 2.5 micrometres or less in diametre. PM2.5 is generally described as fine particles. By way of comparison, a human hair is about 100 micrometres, so roughly 40 fine particles could be placed on its width. PM10 represents the particle mass that enters the respiratory tract and, moreover, it includes both the coarse (particle size between 2.5 and 10 μm) and fine particles (measuring less than 2.5 μm, PM2.5) that are considered to contribute to the health effects observed in urban environments.

[2] February-May 2020

and socially results (Melone & Borgo, 2020). This crisis highlights the need for a significant reflection on the value of the urban environment and how it is managed (Angiello, 2020; Sharifi & Khavarian-Garmsir, 2020).

Fig.1 Who Covid-19 guidelines.

The research is placed within the context of transportation and urban design. In more general terms, the paper questions: what is the role of mobility for society and the design of our cities? What is the role of sustainable mobility, in particular of using bicycles addressing the Covid-19 emergency? During and after this emergency the use of the bicycle can give answers addressing urban quality, liveability for spaces in our cities.

2. Cycling as a transport mode

Walking and cycling are most typical forms of active transportation. Cycling as a mode of transport is an not expensive, health-improving, environmentally friendly and an alternative to automobile (Karanikola et al., 2018; Chen et al., 2012). In economic studies, extensive literature shows the impact of cycling on health, resulting in financial benefit. The shift from car to the bicycle could save 150g of CO_2 per kilometre. The car compared to the bicycle saves 1 kilogram of CO_2 every 7 km. Dutch people, within five years, prevented 1.41 million tonnes of CO_2 each year through cycling. This saving is equivalent to 54.4 million trees being planted each year (UN ENVIROMENT, 2019).

The administrations in many cities are undertaking the process of creating more bicycle-friendly urban environments (Fishman, 2016).

Survey data from the Eurobarometer 422a in 28 EU Member States published in 2014, shows that 8% of all trips made are done by bicycle: the highest figure being for the Netherlands (36%), Denmark (23 %), Hungary (22 %), Sweden (17%) and Finland (14 %). Belgium (13%), Germany (12%); Slovenia 9%, Czech Republic 8%, Romania, Poland, Lithuania and Slovakia 7%; Latvia, Croatia and Italy 6%; Estonia (5%) France, Austria Bulgaria 4%, Spain and UK (3%), Luxemburg (2%), Greece and Ireland (2%), Cyprus and Portugal (1%), Malta (0%) (E.C., 2014).

The Dutch experience is significant as almost 50% of the population made a cycling day trip of an hour or more. 22% of the bicycle day trips are undertaken on a Sunday and 19% on Saturday. The majority (59%) of the bicycle day trips are started directly from home or you cycle to the starting point of the route (26%). In 8% of bicycle day trips, the car is used to go to the starting point of a route. In 2018, bicycle hubs were used in 13% of bicycle day trips. That is almost 25 million bicycle day trips using junctions. Junction use is highest among cyclists who travel between 40 and 75 kilometres, during over 40% of bicycle trips of this length,

junctions are used. A city bicycle is used during 44% of the recreational bicycle tours and an electric bicycle during 32% of the bicycle tours (Fietsplatform, 2019).
In 2016, around 12.4 % of Americans cycled on a regular basis and this has now increased by over 10%. (Statista, 2018). During 2016 in Europe, approximately 19.6 million bicycles were sold; Italy was the first county with a production al 2,339 (x1000) followed by Germany and Portugal (CONEBI, 2018).

3. Bicycle framework and urban design

The advent of the car profoundly changed the fabric of the cities. Before the advent of the car, the streets had a public dimension, civic sense, social and commercial interaction, a diversity given by the people. According to Norton, in American cities, this change has been radical, where the need for the sociality of people has been overshadowed to give space to a physical transformation that had to respond to motorists' needs(Norton, 2011). The car destroys urban life; it is an extremely useful instrument of deculturization, anti-civilization (Lefèvre 1968).
The battles of Jane Jacobs in the seventies for a city on a human scale during the Urban renewal In NYC against Robert Moses could be considered the foundation for a new reflection on the street.
Jane Jacobs battle in New York, for Washington Square Park in 1955 and the Lower Manhattan Expressway is significant. She fought against the new constructions, which, if built, would have expelled thousands of people and changed the life of an entire neighbourhood (Jacobs, 1992).
Starting from Jane Jacobs several reflections as taken place.
Our society once created many different types of streets. A street was not just a conduit for moving cars and trolleys through, but also a place in its own right for socializing, entertainment, commerce, and for civic expression. Pedestrians (and their natural allies, the cyclists) ruled.
Streets have always held a particular fascination for those interested in the city. Streets are the terrain of social encounters and political protest, sites of domination and resistance, places of pleasure and anxiety. Located at the intersection of several academic disciplines, the street is also the focus of many theoretical debates about the city concerning modern and, more recently, postmodern urbanism (Fyfe, 2006).
Rethinking the role of streets and public spaces as sites of collective culture would enable concepts of democracy and difference to be reconstructed so that diverse identities and cultures could intersect as sites of creative cultural production; places where multiple perspectives can accommodate and support young people as valid and valued producers of social capital (Malone, 2002).
Citizens prefer vivacity and a lively street than a desert street (Gehl, 2011) and cycling can provide benefits of contributing to the vitality and liveability of a city, beyond personal health, environmental quality, and even help the economy (Gehl, 2011).
Bicycling is often associated with concepts of sustainability due to its energy-efficiency, and it does not release carbon emissions (Meitz & Ringhofer, 2017).
Auge associates the bicycle to an emancipatory role in the first part of the nineteenth century, as one of the instruments for the liberation of women who had dared to face sexist sticks of all kinds (Augé & Parlato, 2010).
"Bicycling allows the user to explore their spatial surroundings and offers constant opportunity
for spontaneous interaction with other users and the surrounding environment." (Brömmelstroet et al., 2017).
Beyond the social aspect of cycling, the infrastructure plays a crucial role as cycling levels are directly related to bikeway networks or aspects of the network. As suggested by different studies (Buehler & Dill, 2016), cycle infrastructure design can encourage more cycling (Hull & O'Holleran, 2014).
The urban design for cycling differs from that of motorists and pedestrians. There are several similarities between general principles of good urban design and a form of urban design that would engage with more dimensions of the cycling experience such as layout, facilities, processes and detailed design (Forsyth & Krizek, 2011).

3.1 Bicycle urbanism

In the last few decades, studies and research are increasingly addressing the subject in terms of improving transportation, improving personal health, and reducing environmental impact. Recently research reveals that cycling is recognised as an urban design phenomenon, which focus on measurable neighbourhood design qualities such as: street grids, cycle lanes, setbacks and the presence of urban greenery. Many of the debates about cycling have concentrated on bicycle facility design, culture, and only a few considered urban design and planning. The more detailed design aspects affecting cyclists are not yet completely developed in research and study as they are for pedestrians (Liu et al., 2018; Liu et al., 2018)

Several books approach the concept of bicycle urbanism as a way to read and operated within the city (Colville-Andersen, 2018; Bruntlett & Bruntlett, 2018; Berney, 2018).

A new concept emerges in the debate between professionals and academics in the realm of bicycle urban planning. Remarkable is the action Mikael Colville-Andersen founder and ex CEO of Copenhagenize and Marco te Brömmelstroet cycling professor in terms of scientific diffusion and research.

The first authors to introduce the concept of bicycle urbanism where Lorenz and Bufton (Lorenz & Shannon, 2013). They explain their concept by the following definition, engaging the concept of Bicycle Urbanism in several ways:

- As a holistic concept behind our understanding of future urban mobility;
- As an approach for research on urban life in cities;
- As an approach in urban design/planning and landscape architecture.

Bicycle urbanism and cycling urbanism beyond the rhetorical character can indicate an approach to urban planning and design inspired and oriented by the multiple-use practices of the bicycle and, more generally, of pedal vehicles (Bozzuto, 2016).

3.2 Advocate and activism

According with Aldred *Cycling has always been constructed concerning social movements and social identities, and so the politics of cycling varies depending on the relationship of cycling to politics more broadly* (2012).

Former New York City transportation commissioner, Janette Sadik-Khan argues that the transformation can occur without a huge financial intervention as there are "do-it-yourself" fast solutions, which are easy-to-implement and highlight the importance of being smart and creative (Sadik-Khan & Solomonow, 2017).

The urban activism that has manifested itself in the last decade has been an expression of a right to live the city differently, manifesting the right to the city and mobility through a "peaceful struggle". These are a part of urban activism that arises in contrast to a model of the neoliberal world.

Critical Mass is a spontaneous international urban movement born in San Francisco in 1992, campaigning for bicycle and sustainability. Nowadays, it has spread 300 cities across the world, and it is growing continuously. On a monthly basis citizen meet and "occupy" city streets to celebrate cycling, demonstrate their collective strength and send a clear message to politicians / society, not as protests or organised demonstrations. Critical Mass has a positive impact on changing people's travel behaviour and in legitimises the efforts of formal advocacy organisations (Blickstein & Hanson, 2001). Critical Mass has an impact on the progress of formal bicycle advocacy (Blickstein & Hanson, 2001). Critical mass also inspired other similar organizations that evolved in different forms: Courteous Mass and Clitoral Mass (Lydon et al., 2015)[3].

In recent years, several guerrilla cycling actions were promoted globally. Guerrilla cycling is a form of protest carried out by local organisations demanding better transport planning, infrastructure and advocating for safer streets. These actions are economically efficient and straightforward to implement; from pop-up bike lanes to

[3] See https://www.facebook.com/CourteousMassDayton/ http://www.clitoralmass.org/403.shtml

painted potholes and tactical traffic calming[4]."Guerrilla Wayfinding "started as a technically illegal practice in the streets of Raleigh, North Carolina promoted by *Matt Tomasulo* that from 2012 created the association Walk [Your City][5] and supports other municipalities willing to replicate the project. It is a tactic that has spread to many cities around the world, more than 100 communities have ordered signs through their website (Lydon et al., 2015). The purpose of the project is to make people realise that services and places ~~are~~ can be accessible on foot or by bicycle in less time than what we believe[6].

4. Covid-19 and bike

Several cities around the world have set up temporary cycle lanes to facilitate going by bicycle, and thus offer an alternative to public transport and cars. Among them, the most significant examples are Bogota, Berlin, Philadelphia (*470% cycling), New York. Some indication suggests many people are converting to cycling as a safe option to face the emergency. Chicago and Philadelphia saw numbers of users in their bike-share programs nearly double in March 2020. (WRI,2020) and even London published exceptional guidance for cyclists[7].

	Country	Car	Public transport	Walking
1.	Italy	-85%	-90%	-88%
2.	Spain	-82%	-90%	-90%
3.	France	-78%	-88%	-86%
4.	United Kingdom	-70%	-85%	-63%
5.	Belgium	-63%	-76%	-49%
5.	Netherlands	-52%	-78%	-58%
6.	USA	-45%	-76%	-56%
7.	Germany	-46%	-61%	-46%

Tab. 1: transportation data between March-April 2020 Source: OCPI analyses of data from Apple.

In China, Wuhan and Huanggang suspended public transport entirely to contain the virus. According to the analysis of the Wuhan War Epidemic Cycling Report, the anti-epidemic cyclists' riding indicators showed "three increases and one decrease": The average distance of a single ride was 1.42 kilometres, an increase of 22.4% compared with that before the closure of the city; the average time for a single ride was 8.8 minutes, an increase of 29.6% compared with that before the closure; a single ride over 3 kilometres accounted for 7.5%, an increase of 130.8% from before the closure of the city. The average cycling speed was 10.2 km/h, which is 4.7% lower than before the closure and 4.1% lower than usual.

4.1 Cities and cycling policies

In the first phase of the pandemic, many cities have adopted measures to facilitate the use of bicycles. The choice of case studies focused on 4 European cities and one South American city. The selection method was based on a qualitative analysis of these cities' previous policies in terms of sustainable mobility. Simultaneously, the measures adopted by these cities presented within them a temporal character but were embedded within an existing policy, adding a level of planning. Furthermore, these actions have a long-term vision that goes

5 See: https://walkyourcity.org/

7 See:https://lcc.org.uk/pages/cycling-advice-2020

beyond the emergency. This condition allows the research to analyse the case studies in their immediate emergency condition and wider urban planning and mobility.
The five case cities selected for the study are: Barcelona, Bogota, Brussels, Milan, Paris. These cities have all, in recent years, developed a dynamism concerning the themes of cycling and have implemented urban policies to promote cycling.

BRUSSELS (BELGIUM)

The *Région de Bruxelles-Capitale* (Brussels-Capital Region) has a population of 1,218,255 inhabitants, in an area of 1,575 km^2, with a density of 7,500 inhabitants per km^2. It is constituted of Brussels and 18 contiguous municipalities.[8] The municipality of Ville de Brussels covers an area of 32.6 km^2 with a population of 185,103 which implies a density of 5,596 inhabitants per km^2 and 15 % of the population of the metropolitan area[9]. Brussels launched in 2018 Le plan d'action Vélo 2018-2024 (Ville de Brussels, 2018). The plan has the ambition to give cycling a key role within urban mobility, in line with the objectives formulated in the Good Move regional mobility plan: increase in the modal share of cycling, in particular for trips from 2 to 5km; (1) tripling of bicycle journeys by 2030 and doubling them by 2020 to 2024; (2) The ambition to significantly strengthen the competitive position of the bicycle among the modes of transport. (3) The ambition is to act quickly and with determination, for a tangible impact by the year 2024.

Fig.2 circulation plan Pentagon Brussel

Moreover, since June 2015 the city of Brussels has developed a new circulation plan for the 'Pentagon Brussels' city centre *Plan de circulation Pentagone* (Technum, 2014). The circulation plan has the following main

8 https://www.cittametropolitana.mi.it/portale/territorio/index.html

9 https://ibsa.brussels/chiffres/chiffres-cles-par-commune/ville-de-bruxelles

features: (I) Doubling the pedestrian zone, by fixing new borders for the new pedestrian A comfort zone will be integrated to the existing one; (II) A new city bicycle network. Local cycle routes integrate the existing regional cycle routes within the Pentagon. The pedestrian zone and the surrounding neighbourhoods will be more accessible by bicycle through the cycling facilities provided on the City's cycling network. The City has proposed to STIB that it provide parking for bicycles in the Bourse metro station. (III) New local bike routes are added to the existing regional bicycle routes in the Pentagon (IV) A bicycle parking will be made at the Bourse pre-metro station. Investing in bike racks and bike boxes.

Since June 2019, Belgium introduced six new regulations concerning cyclists updating the road code.

(1) lateral distance to overtake a cyclist = 1.5 m outside built-up areas (and always 1m in built-up areas) (2) drivers of tricycles / quadricycles 1m wide = cyclists (3) "full green light" system for cyclists (4) directional cyclist orange light (= B22 / B23) (5) maximum age for riding on the sidewalk = ten years (compared to 9 previously) (6) speed-pedelecs will also be able to ride two abreast on the road.

This new law also increases the maximum speed of autonomous displacement machines, such as electric scooters and single wheel to 25 km/h.

Brussel and Covid-19

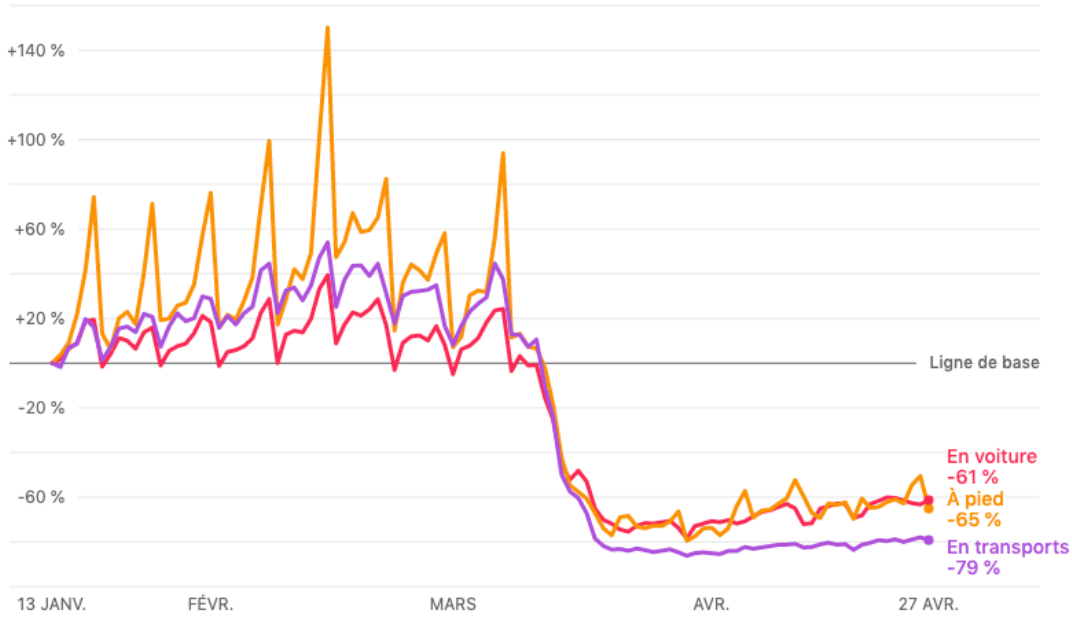

Fig.3 Brussels: mobility data during first lock down Covid-19. En Voiture=By car; En transports=public transportation; A pied=by foot

Brussels has set out a mobility «*plan de mobilité pour le déconfinement*.» proposing 40 km of bike lanes on major roads.

Seven Brussels municipalities have a mobility plan Ixelles, Anderlecht, Brussels-city, Watermael, Evere, Schaerbeek, Saint-Gilles has accepted the invitation of The Minister of Mobility Elke Van den Brandt (Groen) to give more space to pedestrians and cyclists.

Furthermore, *the entire perimeter of the city located inside the Little Belt will pass into the meeting area. Concretely, pedestrians and cyclists will have priority and will be able to circulate on the roads, and no longer only on the sidewalks or cycle paths. The circulation of motor vehicles is authorised, at a maximum speed of 20 kilometres / hour. The same rule applies to trams and buses."*

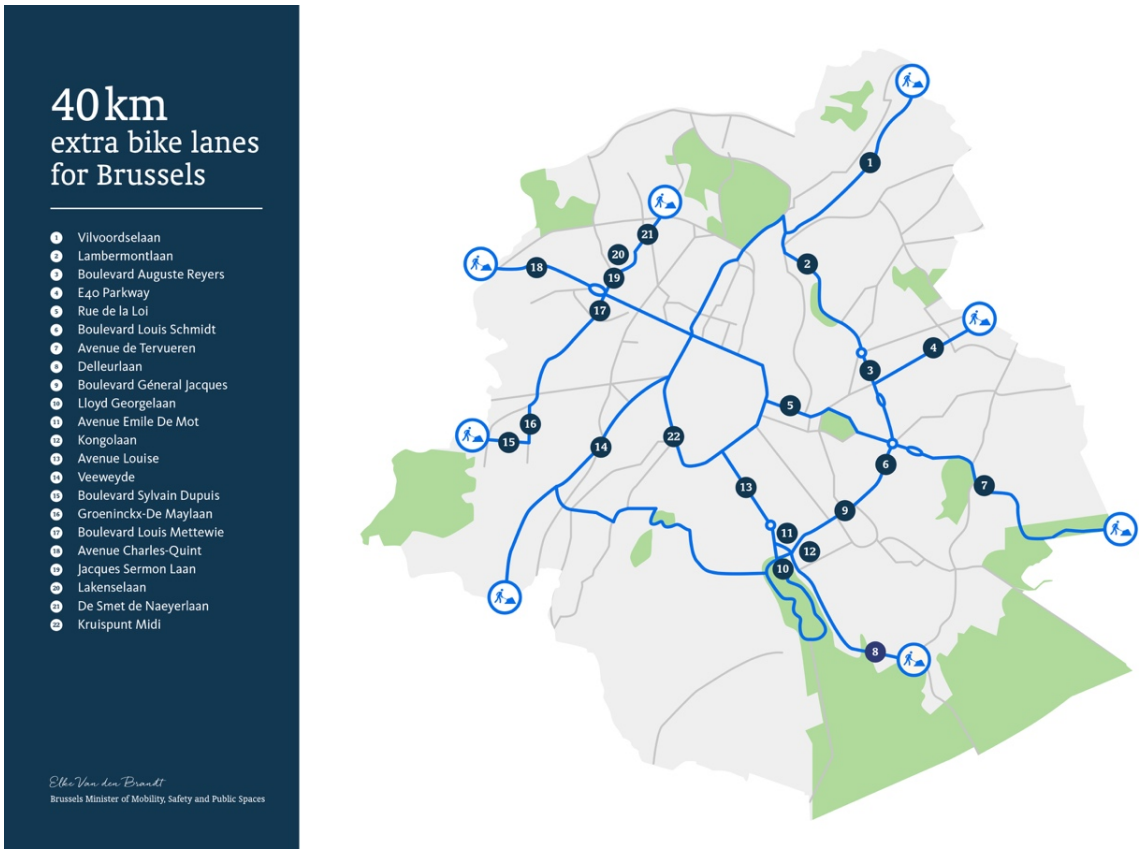

Fig.4 bike lanes Brussel Covid-19

Brussels has planned different types of measures among them: 51 km of bike lanes, of which 34 have been constructed so far; concerning traffic reduction were announced 40 km, of which 23 have been implemented. The number of active cyclists has increased by 87%, and Belgium is now studying to increase its cycling highway plans connecting towns and cities. The Flemish government, in March 2021, announced a total investment of 150 million euros for cycling, divided in proportion to the number of inhabitants. For each municipality, there is a planning right of approximately € 22 per inhabitant. Local authorities whom themselves invest € 44 / inhabitant in their cycling infrastructure can therefore receive the full amount.

BOGOTA (COLOMBIA)

Metropolitan Area of Bogotá is an administrative structure that include the Capital District of Bogotá and 17 of the surrounding municipalities; it has a population of 11'167'000 inhabitants and surface of over 4'042.01 km^2 and a density of 2'763 inhabitants per km$^{2.}$

The municipality of Capital city covers an area of 1'587 km^2 with a population of 7'412'566 inhabitants, which implies a density of 4670.8 inhabitants per km2. [10]

Since 2000 Bogotá is a leading city in urban cycling, in Latin America and in the world, implementing public policies to transform infrastructure and fostered a bicycle culture. Currently there are more than 880,000 daily trips in this form of transport: children go to school, police patrol the streets, mechanics earn a living in their workshops, athletes get up early to conquer the hills and executives arrive at their offices.

On the city website you can read *"we promote a culture of sustainable mobility that, instead of thinking about how many vehicles are mobilized, takes into account the number of people who manage to move using the same space, but in other means of transport. Therefore, giving rise to the bicycle is one of the main strategies that we have implemented in the city."*

10 https://www.dane.gov.co/files/varios/informacion-capital-DANE-2019.pdf

Every Sunday, the Colombian capital of Bogotá shuts down 75 miles of streets and highways, handing them over to cyclists, runners and walkers. Known as La Ciclovía, the initiative has inspired similar events across the world.

Bogota and Covid-19

Fig.5 bike lanes Covid-19 Bogota

Bogota provided at the beginning 35 kilometres and then 80 kilometres of temporary bike lanes and six connections on vehicular bridges for exclusive circulation of cyclists. *These temporary bike lanes are implemented taking into account that the bicycle is the means of transport considered as one of the most hygienic alternatives to get around today, since it avoids close contact and crowds. This measure seeks to decrease the use of the massive public transport system to contribute to its operation under conditions of efficiency and sustainability, to generate parallel corridors to those of TransMilenio and more connections in the cycle routes network*[11].

[11] https://planbici.com/distrito-dispondra-35-kilometros-de-ciclovias-temporales-durante-el-aislamiento-preventivo-obligatorio/ https://www.movilidadbogota.gov.co/web/bogota-en-cuarentena

MILAN (ITALY)

The Area Metropolitana di Milano (Milan Metropolitan Area) has a population of 3,279,944 inhabitants, in an area of 1,575 km^2, with a density of 2,081.64 inhabitants per km^2. It is constituted of Milan and 133 contiguous municipalities[12]. The municipality of Milan covers an area of 101.353 km^2 with a population of 1,406,242 which implies a density of 7,741 inhabitants per km^2 and 43 % of the population of the metropolitan area[13].
In November 2018, the City Council approved The Urban Plan of Sustainable Mobility (PUMS) containing the strategies and guidelines on the future of mobility in Milan.
The PUMS introduces the concept of 'privileged cycling routes', a series of interventions and disciplines towards "cycling priorities". To implement bike paths and signage are planned: pedestrian cycle; pedestrian areas where bicycles are allowed to circulate; zone 30 where speed moderation ensures safety; Restricted Traffic Zones; realisation of the opposite direction of travel cycling in the roads that have the appropriate characteristics to accommodate it.

Fig 6 bike lanes plan Milan

Milan and Covid-19

Milan mobility data during Covid-19 -78% car use – 86% pedestrians.
The municipality of Milan released the document *"Milano 2020. Strategia di adattamento"* (Comune Milano, 2020a) to develop a strategy for "Phase 2". It presents some immediate or planned actions. It is conceived as an open document to observations and contributions from across the city. The strategic plans highlight the redefinition of "the use of roads and public spaces, increase the non-polluting surface movements (walking, bikes, light mobility) and develop areas that will allow commercial, recreational, cultural, sporting developments, respecting the respective physical distances. *Improve air quality as a precautionary measure for health and well-being policies and consolidate the development of sustainable mobility, promoting and drastically increasing individual mobility means, such as bicycles, scooters and electric motorcycles, also in sharing." Improve and diversify the offer of mobility, making the most of the potential allowed for public transport and promoting the use of bicycles, scooters, sharing and individual public transport. Make a decisive leap towards the use of bicycles and scooters, extending the cycle network and encouraging sharing mobility systems. Encourage the use of motor vehicles, especially electric scooters*

12 https://www.cittametropolitana.mi.it/portale/territorio/index.html
13 https://www.tuttitalia.it/lombardia/provincia-di-milano/34-comuni/popolazione/

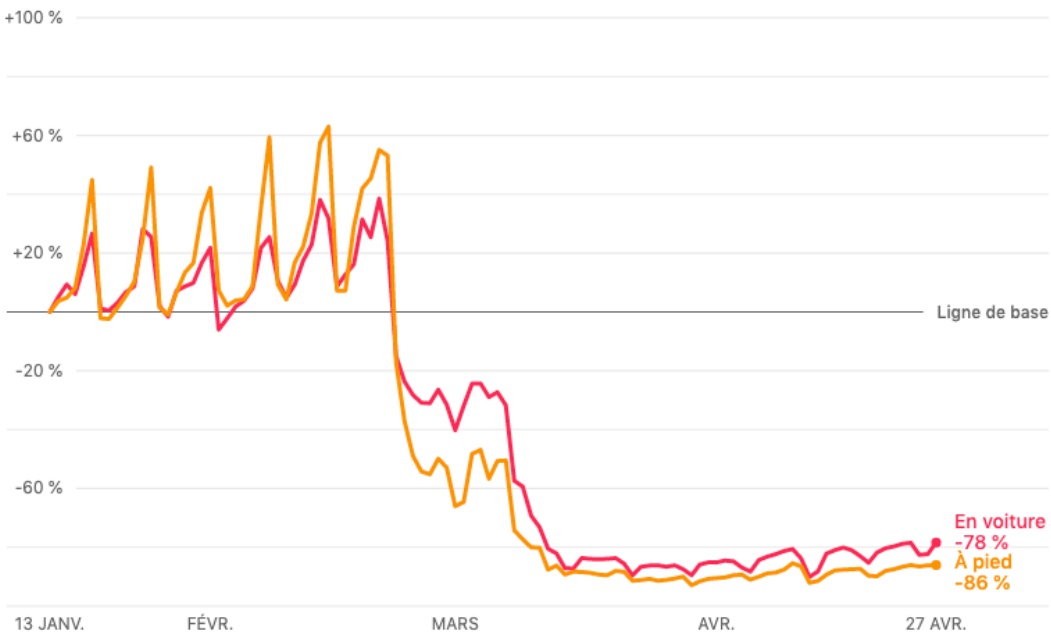

Fig.7 Milan: mobility data during first lock down Covid-19. En Voiture=By car; En transports=public transportation ; A pied=by foot

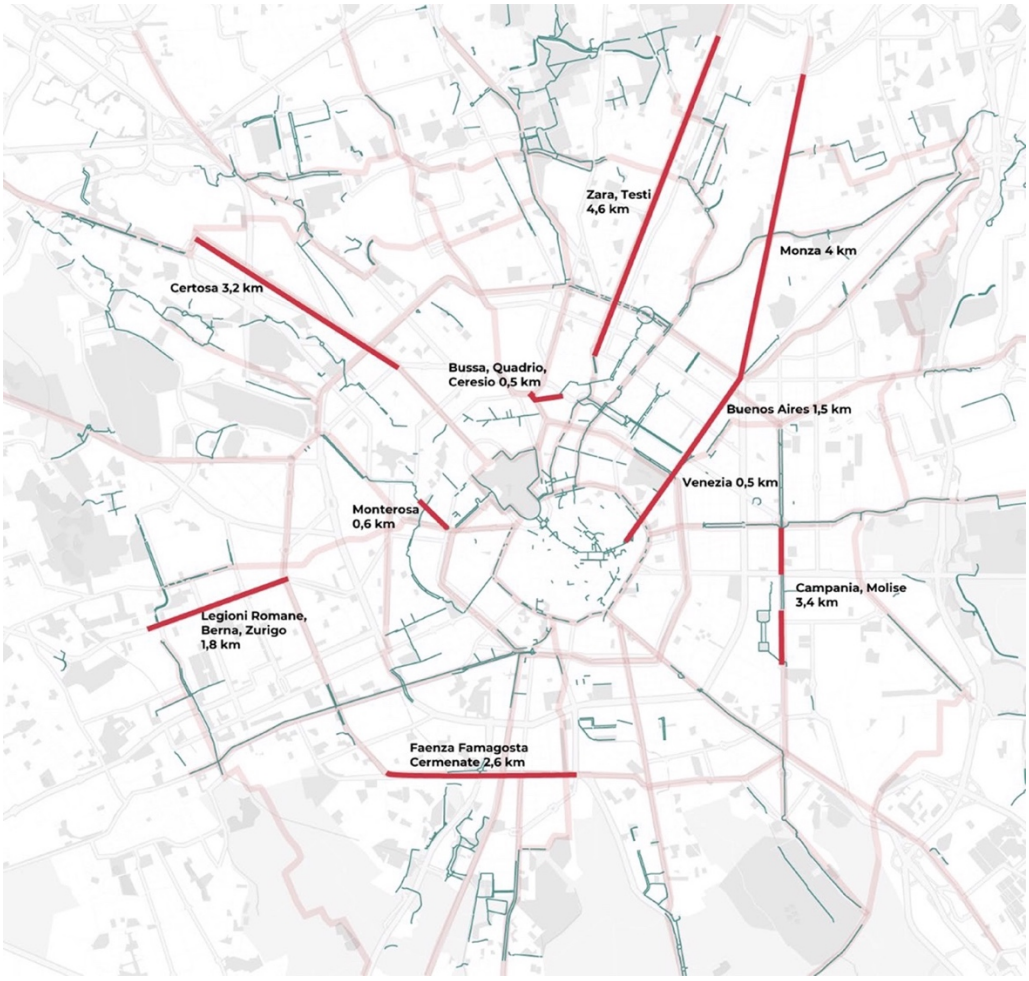

Fig.8 bike lanes plan Covid-19 Milan

Moreover, the "*progetto ciclabilità*" (Comune Milano, 2020b) is part of the interventions promoted by the municipality for phase2 Covid-19 for the reorganisation of the times and services of the city with the aim of

containing contagion and facilitating travel. To limit the number of cars on the road and congestion and limit the possible increase in city air pollution, the city of Milan aims to encourage the use of bicycles, normal or pedal-assisted, and electric scooters, both private and shared, but also of electric scooters. The plan provides for the construction of 35 kilometres of new cycle paths which will add to the current 220 km and new parking spaces for bikes and motorbikes. The extension of the cycle network will cover routes along the main radial and circular routes of the city connecting the existing cycle sections.

The plan is implemented through the following interventions:

- the construction of about 23 kilometres of cycle paths, with light interventions of tracks throughout them (such as) road signs and markings drawn on the ground;
- establishment of 30 zones to encourage the safe use of bicycles;
- urban redevelopment.

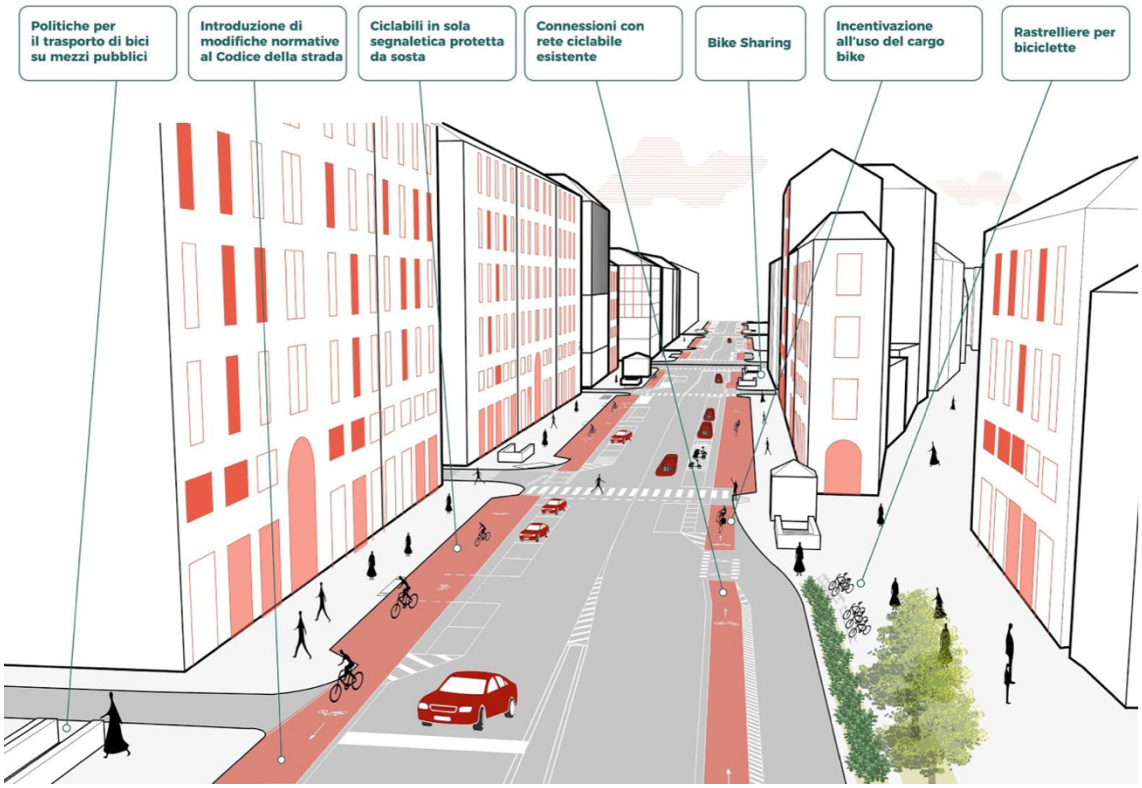

Fig.9 New emergency cycle route in Corso Buenos Aires.

Milan has developed different measures among them: 35 km of bike lanes of which 5,5 have been implemented so far; concerning traffic reduction were announced only 0,25 km of streets reallocated for public use all implemented. It is estimated an increase of cycling of 122% in the last months.

BARCELONA (SPAIN)

The Àrea Metropolitana de Barcelona (AMB; "Metropolitan Area of Barcelona") has a population of 3,239,337 [14] in an area of 636 km^2, with a density of 5,093.3 inhabitants per km^2. It is constituted of Barcelona and 36 contiguous municipalities. The municipality of Barcelona covers an area of 101.353 km^2 [15] with a population of 1,328,952 inhabitants16, which implies a density of 13,312.12 inhabitants per km^2 and 41% of the population of the metropolitan area.

14 https://www.amb.cat/en/web/area-metropolitana/coneixer-l-area-metropolitana/poblacio

15 https://www.bcn.cat/estadistica/angles/dades/timm/tterr/a2018/S01.htm

16 https://opendata-ajuntament.barcelona.cat/data/en/dataset/est-padro-domicilis-sexe

In 2015, Barcelona launched the program Bicycle Strategy for Barcelona (Ajuntament de Barcelona, 2015), in, in continuity to the Barcelona Urban Mobility Plan (PMU 2013-2018) (Ajuntament de Barcelona, 2014)[17] the planning tool for defining the action lines to govern mobility with the strategic aim of continuing to move towards a more sustainable, efficient, safer, healthier and fairer mobility model. Bicycle Strategy for Barcelona planned to implement 308 km of cycle lanes by 2018, increasing of 165% the network of 116 kilometres in 2015.

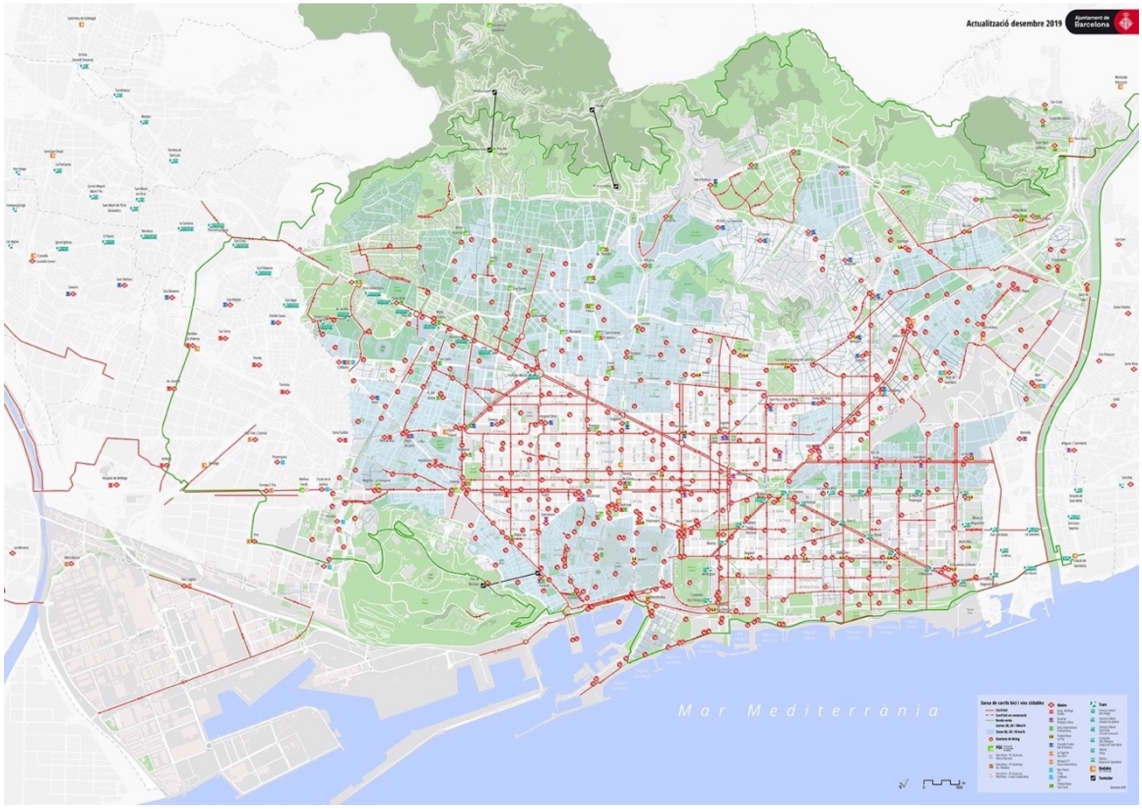

Fig.10 bike lanes plan Barcelona

Currently more than 209 km have been created and the number of cyclists increased by almost 50%. from approximately 140,000 daily users to 200,000 current users[18].

More than 20 associations are involved to work with the planners and municipality to monitor the implementation of the initiatives proposed, which include initiatives to raise awareness and promote the use of bikes that will be launched in coordination with the various players involved, who will be jointly responsible for them. *Bicing* is the public bicycle sharing system and is available since 2007. With a fleet of 6,000 bicycles spread across 424 stations it attracts over 47,000 users per day on average. 100,000 annual subscribers as of February 2016 (Braun et al., 2016)**.**

Barcellona and Covid-19

Barcelona mobility data during Covid From -80% car users -85% public transportation – 90% pedestrians .

Barcelona's administration identifies bicycles as essential within the Covid-19 context for short- or medium-distance journeys. Bicycles are contemplated as an alternative way of getting around during the day and the

[17] The next Urban Mobility Plan (2019-2024) presents a new mobility model that follows the line of the
[18] https://www.barcelona-metropolitan.com/living/cycling-in-the-city/

most efficient means of transport in terms of energy. They minimize contact between people, and they enable safe distances to be maintained.

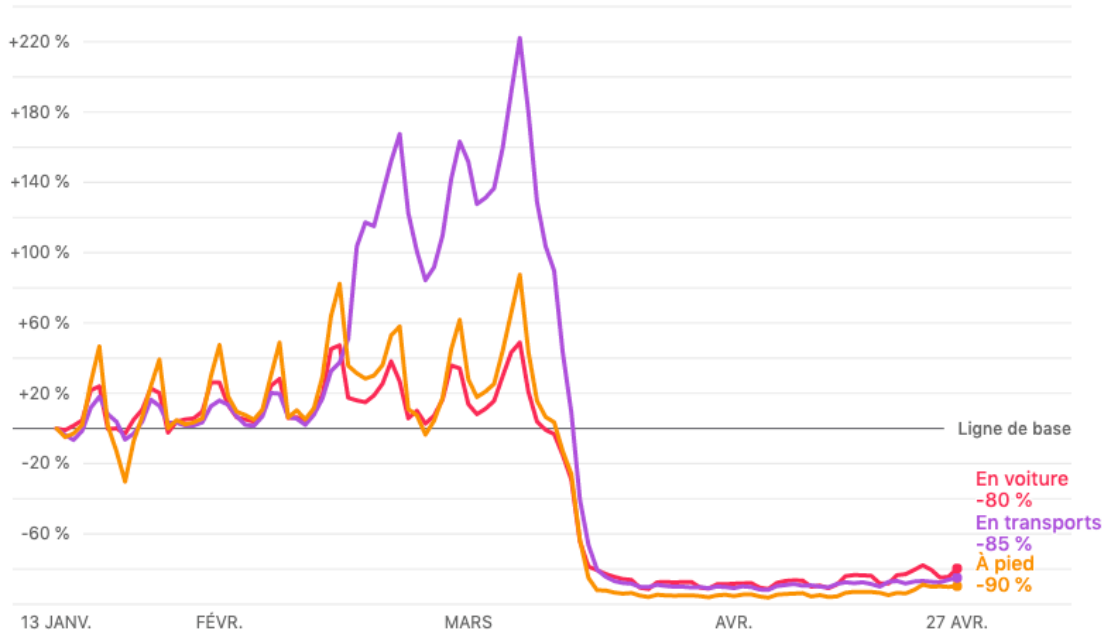

Fig.11 Barcelona: mobility data during first lock down Covid-19. En Voiture=By car; En transports=public transportation; A pied=by foot

They established initial and short-term measures:

INITIAL MEASURES

- Start up and expand the Bicing service. The Bicing service is being reactivated, with 57 more stations now operational and preventive health measures for both users and maintenance personnel in place;
- Create 21 new kilometres of cycle lanes. New cycle lanes are being created, which means reducing traffic lanes in the city and on roads connecting it to the rest of the metropolitan area.

SHORT-TERM MEASURES

- Promote respect for cyclists in streets declared 30 km/h zones. Signs will indicate cyclists have priority in these streets and an awareness-raising campaign will promote respect for cyclists there among car drivers and motorcyclists.
- Finish and distribute definitive licences for bike-sharing and scooter-sharing operators. The aim is to encourage shared bicycles and motor scooters, which come under the umbrella of sustainable mobility, for individual use[19] Ajuntament de Barcelona (2020a) (2020b).

Barcelona has budgeted €4.4 million to implement different types of measures among them: 21km of bike lanes that have been completely implemented and concerning traffic reduction. They announced 12km of streets reallocated for public use all implemented. Bicycle use has now risen to 10% above pre-pandemic levels. Furthermore, this action is part of a bigger plan of the super-block programme, of which cycling mobility is an essential component to decrease car usage by 25% in 2024.[20]

PARIS

Paris metropolitan area *"Métropole du Grand Paris"* is an administrative structure created in 2016, it is the inter-municipal authority and a public establishment of inter-municipal cooperation bringing together 131

[19] https://www.barcelona.cat/mobilitat/en/news-and-documents/new-sustainable-mobility-model-new-public-space
[20] See: https://ajuntament.barcelona.cat/ecologiaurbana/sites/default/files/en_gb_MESURA%20GOVERN%20SUPERILLES

municipalities including Paris with a surface of over 814 km², 8 times the area of Paris. It has a population of 7,057,905 inhabitants and a density of 8,668.1[21].

In 2015, Paris launched the program Plan vélo 2015-2020 (Ville de Paris, 2015) to bring up to 15% the journeys by bike. The plan intended to improve the air quality as well as the comfort and safety of the city's daily cyclists to make Paris become "the cycling capital of the world". By 2020, the municipality aspired to triple travel by bicycle (225,000 in 2015). One hundred and fifty million euros of investment, the main objectives of the plan are: to double the length of the bike lanes from 700 km to 1,400 km. 15% modal share, 7,000 bicycle airlocks, 2500 bicycle traffic signs; 10,000 additional parking spaces, 4 Véligo stations planned in 2015 35% of bicycle journeys in Vélib'.

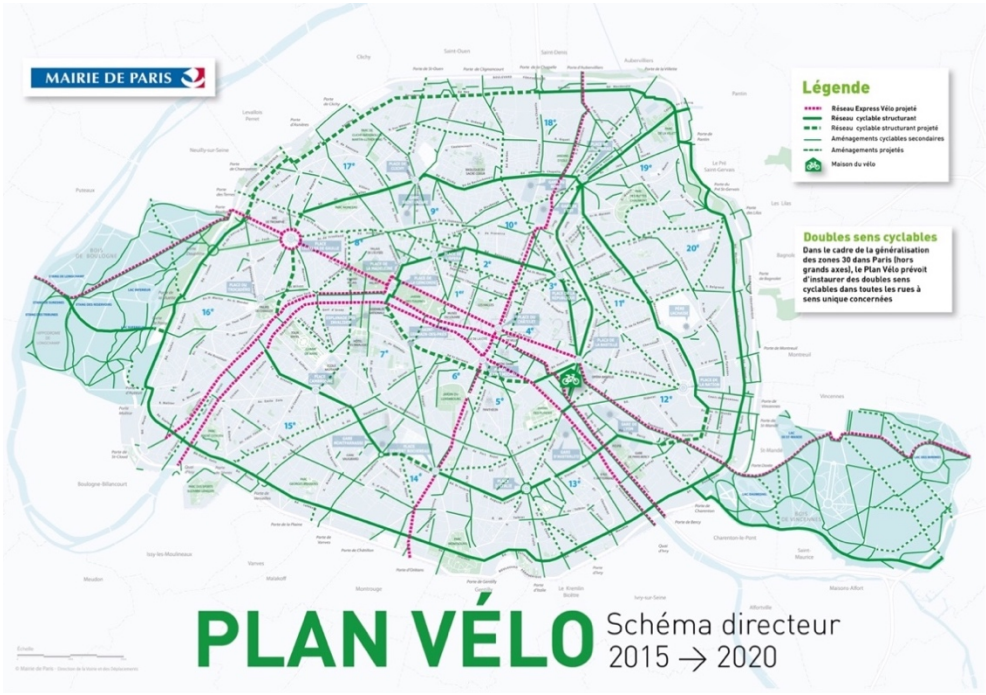

Fig.12 Plan Vélo Paris 2015

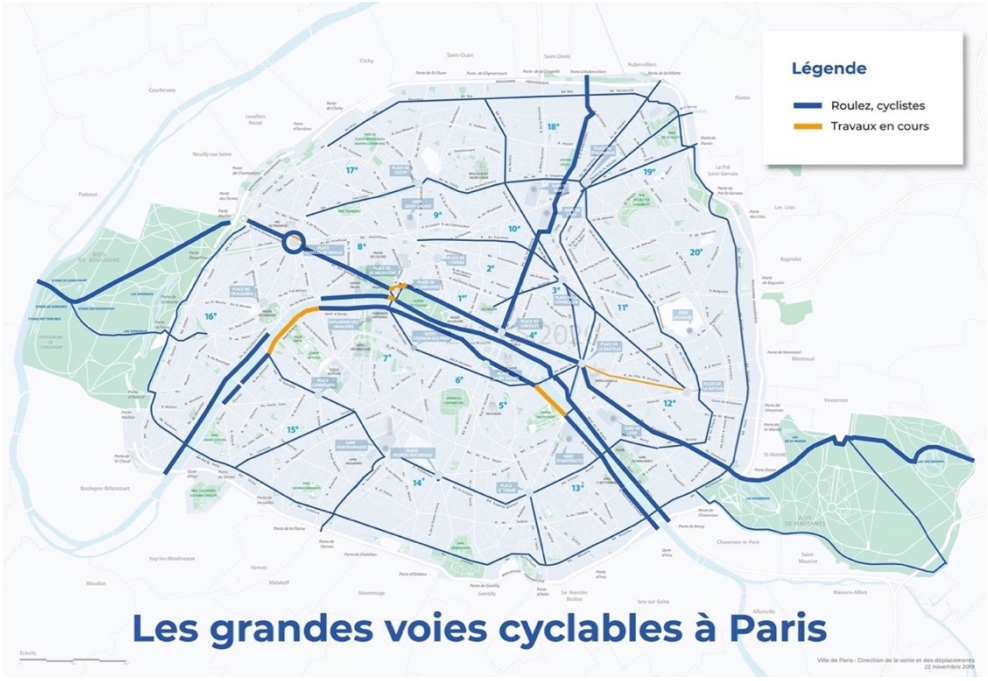

Fig.13 Plan Vélo state of realization 2019

[21] https://www.insee.fr/fr/statistiques/1405599?geo=EPCI-200054781

Today 55% of planned bike lanes have been completed. the association *"Paris en Selle"* created a Bike Plan Observatory, with a map designed to follow the development and progress of the network of bike paths showing only new cycling infrastructure. Some cycling infrastructure is carried out under different programmes (Participatory Budget, road renovation in connection with the LAURE Act, other projects).

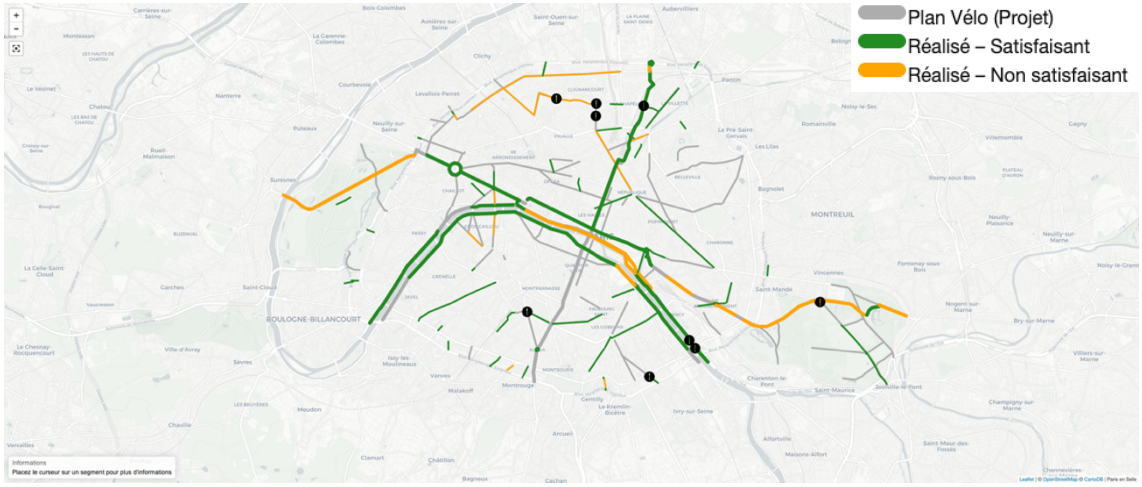

Fig 14 Plan Velo state of realization 2019 *https://planvelo.paris/*

Since January 2016, France introduced new regulations concerning cyclists updating the road code

- The possibility of circulating inconsistently on all streets limited to 30 km/h or less is extended, provided that the city council does not prevent it;
- Cyclists no longer have to stick to the right edge of the lane: they can now use the centre of the lane too;
- Parking on bicycle paths is prohibited and the fine for transgressors is € 135;
- Restrictions on cycling in pedestrian areas in both directions are eliminated, always at the person's pace and if not prevented by the police or the city council.

Paris and Covid-19

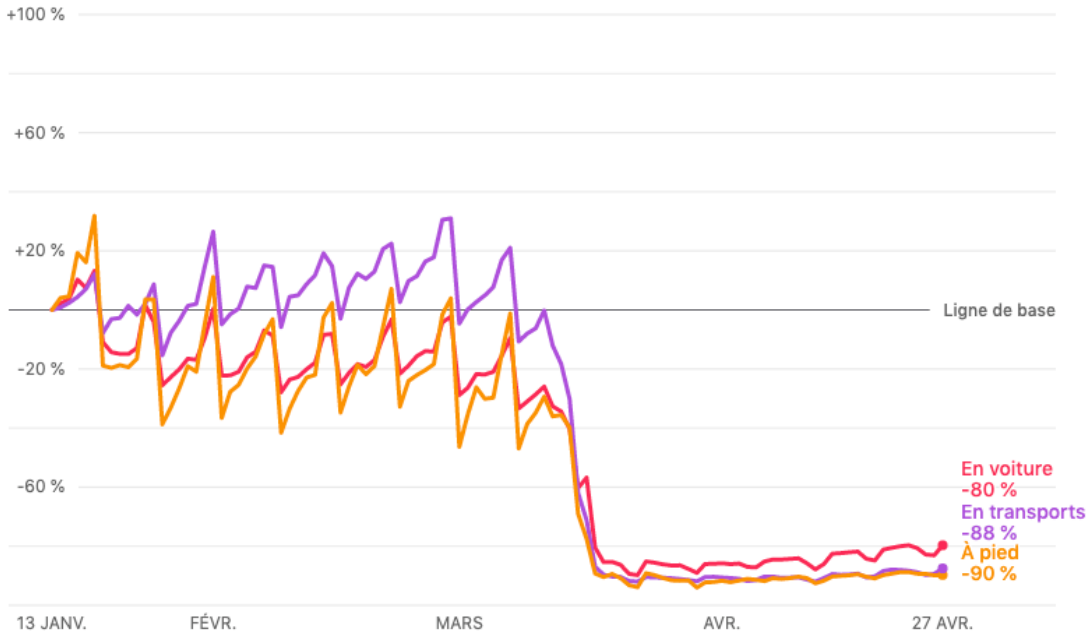

Fig.15 Paris: mobility data during first lock down Covid-19. En Voiture=By car; En transports=public transportation ; A pied=by foot

Paris mobility data during first lock-down Covid-19: -80% by car -88% public transportation – 90% on foot (Apple, 2020).

Fig.16 Plan Velo state of realization 2019 (plan observatoire)

The Prime Minister announced on the 28th of April concerning transport, that the City of Paris encourages the use of alternative mobility in order to limit the influx in public transport where maintaining social distancing can be complicated. Ile-de-France called also *région Parisienne* ("Paris Region") will invest 300 million euros to support the Regional Bike Express Network (RER V)[22] an existing project developed with the technical support of *l' Institut Paris Region*. The RER V, for 'regional bike express network' establishes 650 km of cycle paths throughout Greater Paris via 9 separate lines. The total amount for the project was estimated at 500 million. At the origin of the project, the collective Vélo Ile-de-France, signed agreements with the department of Val-de-Marne and the *Métropole du Grand Paris*. The *Vélo Collective Ile-de-France* is composed by 33 cycling associations, in more than 80 municipalities representing 4,000 members.

Paris has planned different types of measures among them: 71.3 km of bike lanes of which 29.23 have been implemented so far; concerning traffic reduction were announced 4.31km of streets reallocated for public use all implemented. Since spring 2020, cycling is estimated to have grown by 70%. The proportion of women cycling has risen to 41%, and 62% of residents approve temporary cycle lanes to become permanent, something Hidalgo committed to last year[23].

5. Bicycle and antifragility

The belief that urban planners and planning should be capable of dealing with the future and transform the world has proved to be a failure. Predicting is difficult; the forces acting in the city's transformation are defined by processes and dynamics that have nothing to do with planning.

A right attitude is to think of bringing out more essential cities and citizens, favouring urban antifragility.

22 See: https://rerv.fr

23 https://road.cc/content/news/6-10-users-pop-bike-lanes-paris-new-cycling-280681

Antifragility diverges from categories such as resilience, robustness or adaptability. Robust or resilient systems are the ones that can sustain shocks and recover. Adaptive systems are those that can respond effectively after a shock. Antifragile ones do not respond or react but feed on them.
The anti-fragile urban planning should construct urban anti-fragile systems that deal with improving instability; they should operate (to do what?) and should refrain from operating (what better not to do?) in order to:

- promote and strengthen the anti-fragile of cities and the territory;
- make the same choices, actions and interventions antifragile, i.e. those with little to lose and much to gain from the unexpected and the unpredictable (Blecic & Cecchini, 2016).

The notion of antifragility is essential because planning that works in the direction of anti-fragility can be useful and build the conditions to avoid iniquity and ugliness and favour the right to the city.
One way of anti-fragile intervention on the city is to think of modular, reversible interventions, exploratory, autonomous, experimental ones that design and carry out concrete, unprecedented, unusual, anticipatory; "tactical" interventions capable of producing immediate results, but oriented towards visions and strategic objectives even in the long term (Blecic & Cecchini, 2016).
The bicycle interpreted as a planning tool for antifragile planning could lead the paradigm shift for the construction of future scenarios for our cities, where people spontaneously coordinate to make that future possible (Blecic & Cecchini, 2016). Understanding the antifragility as *something that gains from disorder (Taleb, 2012) antifragile means to examine its possible responses to stressors, perturbations and volatility, and to place those responses somewhere along a harm-gain dimension* (Blečić & Cecchini, 2020).
The tenets of antifragile planning could be summarized: (1) the via negativa, (2) the shared vision and the 'coordination by means of future' and (3) the space of the projects.
The shared vision is of the set of different freedoms which compose the right to the city. The bicycle carries with it the freedom to move, choosing how to move, in an entirely accessible city. The freedoms of movement can be outlined in terms of design possibilities, with reference to the spatial dimension, we could see some possible actions. Blečić e Cecchini (2020) argue the practice of construction not as a prediction, but rather of a process: *"the construction of meaning and shared knowledge of possible futures, which the agents participating in the process of scenario construction can appropriate, in order to mobilize for action and for collective coordination."* The bicycle in this sense empowers the citizens to act simply cycling realizing a *"private transformation."*
So the 'space of the project' could be actually daily constructed, recurring of the simple act of cycling that express within the right of mobility future, agents can effectively coordinate, sometimes spontaneously, to make that future possible (Blečić & Cecchini, 2020).

6. Conclusion

The Covid-19 crisis has heavily transformed many aspects of our society. All the cities analysed in this paper planned cycling projects before Covid-19 and established actions to implement cycling infrastructure during the first lockdown.
The cities analysed have made significant upgrades in cycle lanes, traffic reduction, car-free sections, none of the cities has invested in wider sidewalks. Moreover, most of the interventions consist of new cycle lanes implementing planning already. Nowadays, there is a difference, among the level of implementation of the various types of intervention. Significant is Barcelona in terms of cycle lanes, and traffic reduction has completed the announced goals.
The cases analysed show that structural mobility planning is necessary and is an integral part of the metropolises' overall design. Covid-19's transformation has increased the recognition among politicians and citizens that cycling could be active transportation. In antifragile terms, all cities have responded to Covid-19's related problems by taking advantage of the crisis. These experiences reinforce the concept that cycling

strategies should be developed at a national, regional or city level with a medium to a long-term vision for cycling (EU, 2021). Transport studies and policies involving bicycles are not just 'about cycling', but about sustainable, productive, and prosperous cities (Fishman, 2016).
The lockdown allowed the bicycle to prove itself as the safest and most efficient urban mode of transport.
The action carried out during CODVID 19 acted not only on the hard aspects reshaping the cities with permanent and temporary solutions but also on soft aspects acting on people's perception and use allowing them to choose how to move.

City	car-free sections announced (Km)	car-free sections implemented (Km)	cycle lanes announced (Km)	cycle lanes implemented (Km)	Traffic reduction announced (km)	Traffic reduction announced (km)
Brussels	7,1	5,15	51,05	34,09	40,4	23,4
Paris	10	0	71,3	29,23	4,31	4,31
Milan	-	-	35	5,5	0.23	
Bogotá	n.a.	n.a.	n.a.	n.a	n.a.	n.a
Barcelona	-	-	21	21	12	12

Tab.2 Covid-19 measures track. SOURCE: https://ecf.com/dashboard

Even though googling: "future of mobility"[24] the first result is the website page of the car company BMW proposing 5 trends for urban mobility: (1) Electric vehicles: improve urban mobility with a slight hum. (2) Mobility on Demand: Car sharing instead of exclusive ownership (3) Autonomous driving: let the car drive (4) Car-to-X communication: when machines communicate with each other and with their environment (5) Urban mobility and local public transport, autonomous electric shuttle buses.
The use of bicycles even electric ones is not contemplated. The Covid-19 policies impose a sixth trend: the bicycle.
In recent years, activists' bottom-up actions have been central and have led the political debate on the right to mobility issues. The problem is not cars against bikes, but as the Paris municipality spokesman said: "The idea is not to kick cars out, but to share our public space in a better way". The city where bicycles play a central role in mobility policies should not be understood as a victory for bikes against cars, but rather a move towards improving the quality of our cities' spaces, creating more livable and human-friendly places.
Focusing on the importance of mobility in the contemporary city, understood as a tool to "create cities", as a phenomenon that not only regulates flows (transport practice), practice time-space but that is a space generator, and the bicycle is one of the main features (Pucci & Colleoni, 2016).
Furthermore, the use of the bicycles helps the development of the citizens' abilities to move, motility as defined by Kauffman. The use of the car has entirely cancelled the possibility to think of an alternative at on an urban scale. La Cecla commenting di Illich's book argues: "I do not think the bicycle won" It is an excellent idea that's still marginal." "it does not destroy the model of society if this model is not questioned in-depth".
Covid-19 does not lead to a total change of society, but it opens up opportunities to rethink our cities from a mobility perspective where cycling plays a central role, and the strategies put in place by the various cities are evidence that we are moving towards an irreversible path.
David Harvey in conclusion of an article about Covid-19 argued: *…we need a collective response to the Collective Dilemma of Coronavirus isn't this an interesting moment to really think about the dynamism and possibilities for constructing an alternative, socialist society? But in order to get onto such an emancipatory*

[24] Research was done in the google.it by including the word "futuro della mobilità"

path, we first have to emancipate ourselves to see that a new imaginary is possible alongside a new reality. We could answer citing José Antonio Viera Gallo "Socialism can only arrive by bicycle.

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Fig.1 Who Covid-19 guidelines. SOURCE: WHO

Fig.2 circulation plan Pentagon Brussel. SOURCE: https://www.brussels.be/sites/default/files/bxl/CEN20_004_v02.pdf

Fig.3 Brussels: mobility data during Covid-19. SOURCE: APPLE**.** https://covid19.apple.com/mobility

Fig.4 bike lanes Brussel Covid SOURCE: https://www.politico.eu/wp-content/uploads/2020/04/Elke-Van-den-Brandt_Pistes-cyclables-carte.pdf

Fig.5 bike lanes Covid-19 Bogota source:https://www.movilidadbogota.gov.co/web/sites/default/files/Paginas/27-04-2020/80km-v2.pdf

Fig.6 bike lanes plan Milan https://geoportale.comune.milano.it/MapViewerApplication/Map/AppShort/393

Fig.7 Milan: mobility data during Covid. SOURCE: https://covid19.apple.com/mobility

Fig.8 bike lanes plan Covid-19 Milan SOURCE: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=11&cad=rja&uact=8&ved=2ahUKEwiP1uTJwa7pAhUDNOwKHcH-C9AQFjAKegQIAhAB&url=https%3A%2F%2Fmedia2-col.corriereobjects.it%2Fpdf%2F2020%2Finterni%2FProgetto-ciclabilita-2020.pdf&usg=AOvVaw1Gwjelq36U5ThdcGJ_TDgV

Fig.9 New emergency cycle route in Corso Buenos Aires. source: https://www.comune.milano.it/documents/20126/992518/Strade+Aperte_IT_200430_rev.pdf/a100d04c-6b55-ae74-e0f8-b52563e07822?t=1589460655416

Fig.10 bike lanes plan Barcelona SOURCE: https://ajuntament.barcelona.cat/bicicleta/sites/default/files/Mapa_Carrils_Bici.pdf dic 2019

Fig.11 Barcelona: mobility data during Covid-19. SOURCE: https://covid19.apple.com/mobility

Fig.12 Plan Vélo Paris 2015 souce: https://cdn.paris.fr/paris/2019/12/04/6fe1c386b1be1cccf12a6620e13c7f4c.pdf

Fig.13 Plan Vélo state of realization 2019 https://cdn.paris.fr/paris/2019/12/04/6fe1c386b1be1cccf12a6620e13c7f4c.pdf

Fig.14 Plan Velo state of realization 2019

Fig.15 Paris: mobility data during Covid-19. SOURCE: https://covid19.apple.com/mobility

Fig.16 Plan Velo state of realization 2019 (plan observatoire) https://rerv.fr/

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REVIEW NOTES

The quality of the offer that the magazine has set as a priority since its foundation has given increasingly encouraging results, first with the recognition by readers and, subsequently, by the institutional bodies responsible for the quality of research in Italy. The recent inclusion of TeMA in the list of reviews of A class represents a milestone to start from. The Review Pages section, since the first issue of TeMA in 2007, has played a substantial role in the general balance of the review, both as an expression of constant updating and as a permanent observatory on emerging issues relating to the relationships between urban planning, mobility and the environment. Starting from the issue of August 2020, the Review Pages will have the new form of Review Notes. They will become short scientific articles, which, while maintaining the function of a reasoned review, will deepen relevant issues in the context of the scientific debate on the recent challenges of the cities, territories and environment. The Review Notes will contain critical thoughts congruent with the topic of the review. The guidelines for these considerations will be: centrality and interest in the scientific debate; advancements and innovativeness of topics; significant gaps resulting from the analysis of the state of the art; recent evidence stemming from the scientific debate; perspectives and potential developments. The Review Notes will consist of four sections, edited by the following researchers:

- Carmen Guida for the section Urban Planning Literature Review;
- Federica Gaglione for the section Town Planning International Rules and Legislation Overview;
- Gennaro Angiello for the section Projects and Innovative Approach;
- Stefano Franco for the section Economy, Business and Land Use.

Researchers can identify a specific and personal topic to deepen in more than one issue, becoming self-contained scientific articles. Articles are subjected to the usual submission process required by the statement of TeMA journal. The Editorial Staff provides a specific quality control of the articles.

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REVIEW NOTES – Urban planning literature review

Ecological transition: which transactions?

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Abstract
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always remaining in the groove of rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of a continuous updating of emerging topics concerning relationships between urban planning, mobility and environment, through a collection of short scientific papers written by young researchers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal.
In particular, the Urban planning literature review section aims at presenting recent books and journals, within global scientific panorama, on selected topics and issues.
This contribution aims at defining the definition and intervention domain of ecological transition. The outbreak of a novel coronavirus and consequent health, economic and social crisis is leading to a new era: significant financial resources, plenty room for economic manoeuvres may turn the ongoing pandemic into an opportunity, for the next years, to build more sustainable societies and environments. Within this scenario, urban areas play an essential role, as proved in the second paragraph with the support of interesting scientific publications, which are reviewed in the contribution.

Keywords
Ecological Transition; Urban planning; Strategies.

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1. Introduction

Climate and economy are the bases of desired sustainable development for near future, mingling with one another and with social politics, new technologies and cooperation. The promises of ecological transition find their place within these issues, which are the main challenges for our Planet, still struggling for the wounds due to the ongoing Covid-19 pandemic. In fact, the outbreak of a novel coronavirus, and consequent health, social and economic crises, opened a new season for the world economy: national and international indebtedness plans, wide scope for state actions and planning, massive investments and – partially – balance of health and job rights. These purposes can be met in the two-fold European recovery program, funded by the resourses of Next Generation EU and multi-annual financial framework, thanks to a generalized common debt. Climate change, pollution, energy depletion, soil destruction, erosion and impoverishment are presented as sources of increasing uncertainty concerning the future, to which Covid-19 consequences need to be added. In order to face such heterogeneous challenges, a broad and comprehensive approach is needed. Governments are struggling to design wide-ranging financial maneuvers which, in short period, may limit and hopefully prevent irreversible socioeconomic crises. At the same time, these complex financial operations would provide opportunities for digital, ecological and sustainable transformations (Bennett, 2017), in the medium and long run.

Repair and Prepare, Recovery and Resilience and Next Generation EU are the proposals made by the European Commission on 27th May 2020 to resolve the current crisis. More specifically, these are only some of the proposals, as over 28 texts have been presented. This capacity to respond to the challenge at hand is as impressive as the amounts put on the table: hundreds of billions of euros. Equally impressive is the fact that a number of dogmas, including the one on public debt, have crumbled.

The purpose at the basis of these movements has been recently proven by the creation, in Italy, of a new Ministry of Ecological Transition by the newly designed premier Mario Draghi and his government, to ensure a transition to green energy which will potentially drive recovery and make full use of European Union funds. Climate policies have been central to the Brussels agenda for years (Gargiulo, & Russo, 2017), as it wants to reach net zero emissions by 2050. Hence, some countries have already set up separate ministries, including France, Spain, Portugal and Austria to help deliver the goal. Although the establishment of ad hoc ministry may be understood as marketing promotion of more sustainable economic systems, its aim is not only to provide multidisciplinary solutions to promote ecological, social and economic transition. It aims at raising awareness and, consequently, responsibility. What we need is a shift in public opinion, a movement that empowers individuals to make better choices, with more options, and a more equitable world, where resources (and money) are shared (not wasted) among the people that produce goods and services.

An ecological transition is one (to borrow from sustainability lexicon) in which society progresses toward a structure that enables us to live in a way that does not impact the ability of our future generations to meet their own needs. This definition is not new: it has its roots in Brundtland report (1987). Since then, the planet and societies from all over the world experienced several crises, of different nature. Now, thanks to a drastic shakeup of economies, severely injured by Covid-19 outbreak and its infection, policymakers, citizens and stakeholders have the opportunity of a new and promising era to work hard and implement European strategies with ambitious energy and climate targets. These goals represent the keystones to transform Covid-19 crises into more resilient and responsible societies.

In this scenario, cities play an essential role: given that urban area exhaust a substantial share of the world's resources and correspondingly contribute to an equal amount of carbon emissions, urban regeneration (Bianconi et al., 2018), physical, functional and infrastructural, will be essential in the "ecological transition" process (Bottero et al., 2017).

This contribution aims at investigating about the sectors and disciplines involved in this wide project: circular economy, mobility, renewable resources but also agriculture and biodiversity (Levin, 2004). The following

paragraph wants to prove that urban areas will be beating hearts of the ecological transition process, defining the domain range for its development and implementation.

2. Cities as key actors in ecological transitions

The Covid-19 pandemic is forcing cities worldwide to re-shape their model and re-think their priorities if they want to make cities and human settlements inclusive, safe, resilient and sustainable. Moreover, climate change is arguably challenging urban settlements, with Covid-19 further highlighting the need for a sustainable future (Guida, 2020). Despite the pandemic, urbanization is not slowing globally. To fight climate change effectively, we ought to design more environmentally sustainable urban systems. 2021 may be a crucial year, and Italy plays a fundamental role as Chair of the G20 and Co-Chair of COP26, while the EU is trying hard to do its part with the economic and financial operations mentioned above.

Twenty years ago, the United Nations (UN) approved the so-called "Millennium Development Goals" (MDGs) initiative, which set eight ambitious targets to improve the world and make it healthier, and more ecological and equal. Thus, the word "city" was not included in the Agenda: urban systems were neither considered as important actors within that global challenge, nor as crucial elements for the success of the plan.

In 2015 a New Agenda was defined: 17 "Sustainable Development Goals" (SDGs) to build a more peaceful and prosperous planet by 2030. This time cities gained a relevant position, since 11th Goal states: "Make cities and human settlements inclusive, safe, resilient and sustainable". One year later, in Quito, Ecuador, a "New Urban Agenda" was established, involving 167 States, 40 UN's Agencies and more than 1,100 NGOs and social actors in the preceding public negotiate. This plan was based on a simple observation: it is impossible to achieve any of these global Goals without the contribution of cities. Covering just 3% of the Earth's surface, metropolitan systems are currently home to 55% of human beings and are expected to increase dramatically over the next 20 years. Cities are also responsible for about 60% of greenhouse gas emissions and 70% of solid waste, while absorbing around 70% of global energy.

In the same year (2016), European nations managed to approve the "European Urban Agenda", a comprehensive program that ranges from poverty reduction to mobility, from housing to circular economies, from climate change to the integration of immigrants. It is worth underlining that – mostly because of their long history and gradual dimensional growth – European cities are in general more sustainable, green and just than those in other continents which urbanized more recently. At the beginning of 2020, Europe has been strongly hit by the novel coronavirus and the subsequent social and economic crises. The debate on the future of cities is useful in order to analyze the necessary changes of perspective and to set the priorities in next years (Coppola, & De Fabiis, 2020; Gargiulo et al., 2020). Now that cities are fully and formally engaged in decision making processes and represent the final link from national and international financial plans to citizens and city-users, they will lead ecological transition practices, potentially turning the ongoing crisis into an opportunity to live in a more sustainable society. The following schemes describe interesting scientific products which provide a preliminary framework for the multidisciplinary interventions planned for the development and implementation of ecological transition.

Bioeconomy for Beginners

Author/Editor: Joachim Pietzsch
Publisher: Springer
Publication year: 2020
ISBN code: 978-3-662-60390-1

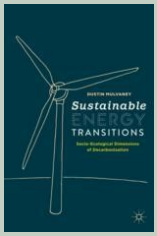
Bioeconomy is not a new concept: "for thousands of years, mankind covered its needs for food, materials, consumer goods and energy through renewable raw materials and renewable sources". The muscle power of humans and farm

animals, eventually reinforced by mechanical aids, formed the basis of their economic activity, the primary fuel of which was wood. In addition, there was wind and water for the mills, wind for the sailing ships and, above all, the rays of the sun. Almost all of the energy available on earth comes from these. Even if plants absorb only a part of it and less than 1% is used in the process of photosynthesis, solar energy generates many billions of tons of biomass in the sea and on land every year. Less than a tenth of these plants are eaten by animals, which, in turn, provide a small part of the food for carnivores and people who draw their energy from them. This energy and the heat generated by burning wood, peat and other biomass drove the economies of pre-industrial times: Until about 1780, all societies on this earth were bio-economies. But even then, humankind changed the landscape and adapted it to its needs. It created a cultural landscape that, to the furthest extent possible, no longer resembled the natural landscape as it would have developed without human intervention. Even then, humankind "overused" natural resources – with relevant consequences, such as permanent erosion and overgrazing and disasters such as famines. Even then, the use of natural resources alone did not guarantee sustainability.

This book provides an interdisciplinary and comprehensible introduction to bioeconomy. It also provides basic knowledge for understanding a transformation process that will shape the 21st century and requires the integration of many disciplines and industries that have had little to do with each other up to now. We are talking about the gradual and necessary transition from the age of fossil fuels, which began around 200 years ago, to a global economy based on renewable raw materials (and renewable energies). The success of this transition is key to coping with the challenge of climate change. This book conceives the realization of bioeconomy as a threefold task – a scientific, an economic and an ecological one. The first question that it seeks to answer is:where does the biomass come from that we need primarily for feeding the growing world population but also for future energy and material use? How can it be processed in biorefineries and what role does biotechnology play in this regard? Which aspects of innovation economics need to be considered, which economic aspects of value creation, competitiveness and customer acceptance are important? What conditions must a bioeconomy fulfil in order to enable a sustainable development of life on earth? May it be regarded as a key to further economic growth, or shouldn't it rather orient itself towards the ideal of sufficiency?

By dealing with these questions from the not necessarily consistent perspectives of proven experts, this book provides an interdisciplinary overview of a dynamic field of research and practice that raises more questions than answers and thus may nurture the motivation of many more people to seriously engage for the realization of a bioeconomy.

Sustainable Energy Transitions. Socio-Ecological Dimensions of Decarbonization



Authors/Editors: Dustin Mulvaney
Publisher: Springer
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Systems that produce, deliver, and consume energy all around us are undergoing a transition. This is a textbook that reaches people interested in learning about the socio-ecological dimensions of energy system transitions from multiple disciplinary perspectives, including ideas and concepts from engineering, economics, and lifecycle assessment to sociology, political science, anthropology, policy studies, the humanities, arts, and some interdisciplinary thinkers that defy categories. One prominent voice in current debates about energy transitions are argued to act on decarbonizing energy systems to mitigate climate impacts from carbon pollution from energy supplies. But other socio-ecological systems will be transformed and may benefit from shifts in energy use and production patterns. In 2020, 80% of global energy is still supplied from fossil fuels. Many places have taken great strides toward decarbonizing some aspects of life in 2020, but there are many miles to go to make a sustainable future. The adjective "socio-ecological" refers to the set of human and non- human systems interweaving the biophysical world and its ecologies with the metabolism of human civilization. Socio-ecological systems tied to our energy use are complex and often across great geographical distances, so the book aims to draw case studies from around the world to bring into perspective the various ways that human ingenuity is working to provide renewable and clean energy and tackling its side effects.

The multiple disciplines presented in this textbook aim to build bridges across the social and natural sciences and humanities to introduce readers to the development of energy and efforts and prospects of an energy transition. The author integrated case studies, figures and tables, exercise problem sets, pictures and diagrams of different energy systems, and links to further resources for further exploration of energy questions. This textbook introduces the key concepts that underpin sustainable energy transitions. Starting with the basic biophysical principles, current sources and environmental consequences of existing energy resource use, the book takes readers through the key questions and topics needed to understand, prescribe, and advocate just and sustainable energy solutions. The interdisciplinary nature of the book aims to build bridges across the social and natural sciences and humanities, bringing together perspectives, ideas and concepts from engineering, economics, and life cycle assessment to sociology, political science, anthropology, policy studies, the humanities, arts, and some interdisciplinary thinkers that defy categories. This accessible approach

fills the gap for a textbook that integrates sustainability science and engineering studies with strong empirical social science and it will be a useful tool to anyone interested in the socio-ecological dimensions of energy system transitions.

What Next for Sustainable Development? Our Common Future at Thirty

Authors/Editors: James Meadowcroft, David Banister, Erling Holden, Oluf Langhelle, Kristin Linnerud, Geoffrey Gilpin
Publisher: Edward Elgard
Publication year: 2019
ISBN code: 978-1-78897-519-3

Sustainable development brings together a series of normative themes related to negotiating environmental limits, to addressing equity, needs and development, and to the process of transformation and transition. To mark the thirtieth anniversary of Our Common Future (1987), that first placed sustainable development on the global agenda, the editors have brought together a group of international scholars from a range of social science backgrounds. They have discussed these same themes – looking backwards in terms of what has been achieved, assessing the current situation with respect to sustainable development, and looking forwards to identify the key elements of the future agenda. This book presents a series of critical reflections on these enduring themes. The overriding concern is with the present and with the future as the editors seek to explore the question: What next for sustainable development? This book examines the international experience with sustainable development since the concept was brought to world-wide attention in Our Common Future, the 1987 report of the World Commission on Environment and Development. Scholars from a variety of disciplinary backgrounds engage with three critical themes: negotiating environmental limits; equity, environment and development; and transitions and transformations. In light of the 2030 Sustainable Development Goals recently adopted by the United Nations General Assembly, they ask what lies ahead for sustainable development.

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REVIEW NOTE – Town Planning International Rules and Legislation

Strategies and guidelines for urban sustainability: The impacts of the Covid-19 on energy systems

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Abstract
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always following a rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is a continuous update about emerging topics concerning relationships among urban planning, mobility and environment thanks to a collection of short scientific papers written by young researchers. The Review Notes are made up of five parts. Each section examines a specific aspect of the broader information storage within the main interests of the TeMA Journal. In particular: The Town Planning International Rules and Legislation Overview section aims at presenting the latest updates in the territorial and urban legislative sphere.
The Covid-19 pandemic is causing a major impact on energy systems. Improving the energy efficiency of urban areas is now the cornerstone of scientific community and the European Commission discussions. Thus, the content of this review note aims at carrying out an analysis of the latest documents of the European Commission before and during the slow recovery from Covid-19 with the aim of identifying the priorities and areas on which to intervene to reduce energy consumption in different territorial contexts.

Keywords
Urban sustainability; Energy Consumption; CO_2 Emissions; Covid-19.

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1. Introduction

The Covid-19 pandemic, which has involved the entire world, has had a great impact on energy systems, holding back investment and threatening to slow the expansion of essential clean energy technologies. The major travel, trade, and economic activity disruptions caused by Covid-19 will lead to a significant decrease in carbon emissions. Emission reduction arises simultaneously to the wake of an international health crisis and widespread economic trauma. This situation will inspire governments to pursue structural reductions in emissions by organizing smart, sustained and ambitious policies to accelerate the development and deployment of a full range of clean energy solutions for different urban systems. Bearing this in mind, the International Energy Agency (IEA) has made it clear that tackling the global climate challenge and accelerating transitions to clean energy requires a grand coalition. This coalition requires the coordination of governments, industries, investors, and civil societies by sharing innovative ideas and best practices to increase the energy efficiency of cities. The IEA's annual Tracking Clean Energy Progress report shows that only 6 out of 46 technologies and sectors were "on track" to meet sustainability goals even before the pandemic. The pandemic has imposed unprecedented constraints, having extensive impacts on all components of the urban system (Gargiulo et al., 2020). For example, the urban mobility system is influencing the use of energy in a severe way. Perhaps, transportation is the only sector where the demand for energy and the effects of the Covid-19 response are more evident. The road use and rail transport along with the number of passengers have decreased, with consumptions reduced from 50-90%. The restrictive measures imposed by governments have completely changed the daily demand for mobility. The need to reach services in the proximity of their homes has indirectly encouraged forms of "soft" mobility, such as the use of bicycles. According to this trend, many cities, such as Milan, Paris, Rome, Brussels, Berlin, Budapest, have developed interventions intended at improving roads, public spaces and the circulation of pedestrians and cyclists. These changes may have long-term impacts on the transition towards clean energy in urban areas if the positive aspects associated with user behavior can be sustained after the end of the pandemic crisis. In cities, particularly in Europe, some policies have shown that they can help encourage the transition to more sustainable transport modes and technologies. These policies include direct investments in cycling and public transport infrastructure and traffic regulation changes to increase the user safety and usability in reaching their activities. On the other hand, the pandemic has favored the possibility of working from home, leading to an increase in domestic energy consumption. For example, residential energy consumption in the United States has increased approximately 6-8% over the last year (IEA, 2020). Responding to the users' new needs and requirements will lead to a rethinking of how to remodel the built environment. It will be necessary to implement policies and practices aimed at the redevelopment of buildings by improving their energy retrofit and limiting the consumption of energy from domestic heating and cooling. The policies needed after the pandemic crisis will have to stimulate demand for highly efficient and low-carbon products at the same time, which could help keep urban areas on track to meet climate goals while reducing energy consumption. The installations of renewable energy sources on-site such as solar thermal, solar photovoltaic, geothermal energy are opportunities that could also be supported by economic recovery plans. For example, through Eco-bonus, Italy provides tax deductions of 110% for energy efficiency and seismic safety renovations. The current pandemic crisis raised new research questions for scholars, in particular research about energy. The scientific community had been questioning for years all the different types of energy consumption (e.g. total energy, transport, or residential), overlooking urban characteristics such as population density, family size, income, etc. The studies have examined the urban features affecting urban energy consumption at two different micro and macro scales. Studies by Martin et al. (2017), Mazzeo (2013), Gobakis and Kolokotsa (2017), Gargiulo and Russo (2017), Pincetl et al. (2020) highlighted how the design of the built environment, the relationship between buildings and open spaces, the materials used for the external surfaces, the socio-economic context, population characteristics combined with climatic and microclimatic conditions affect energy consumption in urban areas. Since the relationship between

urban fabric and buildings influences energy performance, it is possible to obtain a lower energy requirement by improving the built environment. For example, building shape and height can influence their solar exposure with consequences on solar heat gains and the energy produced by photovoltaics integrated into the building envelope and by solar collectors. In particular, the characteristics of the built environment depend on three parameters relating to energy: the "surface-volume" ratio (S / V) of the buildings, the "height-width" ratio (H / W) of the canyon, and the main road orientation (Leconte et al., 2015; Memon et al., 2010). These variables are helpful to describe the compactness of the built environment and the surrounding open space characteristics. Compact urban configurations lead to the reduction of heat exchange between buildings and the external environment but also the decrease of solar heat gains. These parameters express the compactness of the built environment and the typology of the surrounding open spaces (Xu et al., 2019). Compact urban configurations reduce heat exchanges between buildings and the external environment but also reduce solar heat gains. Other studies have focused on the functional mix of urban areas combined with the percentage of jobs and how these variables affect the energy consumption of transport. Other Studies such as Enter Zhang and Zhou (2020) and Hong et al. (2016) have placed more attention on the use of methods, tools and techniques to measure energy performance, aiming to provide maps of the different territorial contexts to identify the prioritized areas. All these studies aim to provide simultaneously a panel of strategies, actions and interventions with a view to adaptation and mitigation. Some research pieces have highlighted the importance of the incorporation of energy efficiency measures in current projects to minimize the future effects of climate change, which constitutes one of the main threats that cities must face today. Whereas, other studies have focused on the efficient use of energy by contributing to lower energy consumption and the reduction of greenhouse gases released in nature, thus improving environmental sustainability. Therefore, the energy issue and the sudden improvements in energy efficiency in urban areas is a topic that has become the focus of discussions of the scientific community and the European Commission even in this pandemic scenario that cities are facing. Especially in recent years, the European Commission has been setting highly ambitious national targets. In this direction, the present review aims to carry out an excursus of the latest European Commission documents regarding the improvement and reduction of energy consumption before and after the Covid-19 crisis to identify the priorities in terms of energy efficiency issued by the European Commission and which can be applicable in different territorial contexts and which at the same time can counteract the occurrence of climate change.

Strategic vision with zero climate impact, COM/2018/773

In recent years, the European Commission has been placing a strong interest in the energy issue beginning from the need to tackle one of the phenomena that has been threatening cities that is climate change. The European Commission in 2018 adopted a long-term strategic vision for a prosperous, modern, competitive and climate-neutral economy by 2050 - A clean planet for all". The Commission's vision aims for a climate-neutral future reachable by covering nearly all EU policies. It is in line with the Paris Agreement goal of keeping the temperature rise well below 2° C, also pursuing efforts to maintain this value at 1.5° C. this goal must be achieved by 2050 so that the EU can maintain a leading role in terms of zero climate impact. Furthermore, the strategy highlights how Europe can play a leading role in achieving zero climate impact, by investing in realistic technological solutions, involving citizens, and harmonizing interventions in pivotal sectors like industrial policy, finance, or research - guaranteeing at the same time social equity for a fair transition. The strategy explains how to achieve this by considering all key economic sectors energy, transport, industry, and agriculture. In the vision of the European Union there are seven strategic elements: (i) optimizing the benefits of energy efficiency; (ii) optimizing the use of renewable energy and the use of electricity; (iii) adopting clean, safe and connected mobility; (iv) recognizing the competitiveness of European industry (v) developing adequate and smart grid infrastructure and interconnections (vi) harnessing the benefits of the bioeconomy and create carbon sinks (vii) tackling the rest of CO_2 emissions through the carbon capture and storage process. In particular, the strategies of the first three points and the fifth listed above are examined, which are the components that directly affect urban systems. As far as the building efficiency is concerned, the outlined scenario shows

that the energy efficiency of European countries depends on energy demand in both the residential and service sectors whose current energy consumption amounts to 40%.
In order to decrease energy consumption, the strategy is to increase the renovation rate, change heating fuel so that the vast majority of homes get heat by plants powered by renewable sources (electricity, district heating, renewable gas, or solar thermal), disseminate the most efficient products and equipment, use intelligent building and equipment management systems and improve insulation materials. Europe also stresses that the modernization of the built environment and the mobilization of all actors will require an integrated and coherent approach in all relevant policies; the participation of consumers will be decisive in this process, including their associations. The second strategy concerning the diffusion of electricity from renewable sources aims at the diffusion, at more competitive conditions, of electricity from renewable sources, offering opportunities for the decarbonization of other sectors, such as heating, transport, and industry, through its direct use. The use of Power-to-X technologies, which can transform electricity into synthetic gases and synthetic liquids, and their ability to store synthetic fuels and use them in various ways in economic sectors that are difficult to decarbonize (for example, industry and transport). The third deals with clean, safe and connected mobility by encouraging all modes of transports of low-emission vehicles by equipping them with alternative systems and at the same time with other energy efficiencies. Secondly, to aim for clean mobility that allows for intelligent traffic management and ever greater automation of all mobility modes, reducing congestion and reducing vehicular pressure in cities. At this point, Europe highlights the significant and decisive role of spatial planning in the field of regional infrastructures to fully exploit the advantages offered by the greater use of public transport. Furthermore, the European Commission underlines that urban areas and smart cities will be the first nuclei of innovation so that short journeys predominate through the creation and construction of safe cycling and pedestrian paths as well as clean local public transport. The second part of the document aims to define the role of the various institutions. In particular, it outlines that the Union policies with those of the Member States and regional and local administrations facilitate a just and well-managed transition that leaves no region, community, worker, or citizen behind. Aligned policies are important for growth and what supports growth, such as competition, labor market, taxation, climate action and energy policy. Besides, accelerate research, innovation and short-term entrepreneurship for a wide range of zero-carbon solutions. Finally, recognizing and strengthening the central role of citizens and consumers in the energy transition, encourage and support consumer choices to improve the quality of life and of their cities.

European Green Deal

The long-term strategic vision for a prosperous, modern, competitive and climate-neutral economy by 2050 - A clean planet for all "enacted in 2018 was the prelude to the excitement of the European Green Deal. The European Green Deal constitutes a set of political initiatives, proposed by the European Commission, with the main objective of achieving climate neutrality in Europe by 2050. Ursula von der Leyen defines that the Green Deal will be like "the landing of man on the moon". It is a difficult mission with the aim to improve the environment and citizens' state of health by making their Member States climate-neutral or by reducing emissions and sources of pollution and, at the same time, developing a new economy capable of generating new jobs. The actions on which the green deal is based on consist of five areas. The first is addressed to the climate. In particular, the European Union aims to become climate-neutral, i.e. zero emissions, by 2050, through a climate community law that will not only translate the vision into obligations and prescriptions but will point the way to new investments for institutions and businesses; the second on energy. Today, the production and use of energy cover more than 75% of greenhouse gas emissions: liberation from oil and other fossil sources is the essential prerequisite to fight climate change. In this context, the goal is the total decarbonization of the European energy system by encouraging member states to present their national energy and climate plans following the regulation on governance of the energy union and action to the climate. The third is directed to buildings since 40% of energy consumption is in the building sector.
Renovating buildings with the most advanced technologies will allow citizens to drastically reduce energy consumption and, at the same time, improve the energy performance of urban areas. The Commission will rigorously apply the legislation on energy performance in the building sector, starting with an assessment of national strategies.
Long-term restructuring of the Member States which will be carried out in 2020. The Commission proposes to work with stakeholders on a new restructuring initiative in 2020 and to envisage innovative financing schemes under InvestEU. The fourth area regards the industry sector. Only 12% of European industrial activities use recycled materials in their production processes. For this reason, the European Green Deal will have to encourage innovations in all industrial sectors to carry out concrete circular economy projects; The fifth on mobility. Transport is the source of 25% of greenhouse gas emissions. A greener Europe cannot ignore more sustainable forms of public and private mobility. The areas considered by the Green Deal involve industrial sectors, civilians, research institutions. It underlines the need to adopt a holistic approach, ensuring that all EU actions and policies contribute to different objectives, improving urban quality and users' level of wellbeing. The areas which this document deepen were already partially defined in the strategic vision issued by the European Commission, providing us with more practical solutions and interventions to improve the energy efficiency of cities. The Green Deal, on the other hand, also outlines the financing plan. In detail, the financing plan envisages: (i)

allocating at least 1,000 billion euros to be disbursed over the next 10 years as loans to support sustainable investments; (ii) creating the conditions for both private individuals and the public sector to invest in sustainable initiatives such as to intercept these incentives; (iii) supporting public administrations and project promoters to identify, structure and implement these sustainable projects. In turn, two instruments implement the directives of this document: the sustainable investment plan and the Just Transition Mechanism. The investment plan is divided between funds from the European budget, estimated at at least 25% of the total or a figure that amounts to 485 billion euros up to 2030, private co-financing and loans from the European Investment Bank (EIB), which has already announced that 50% of investments by 2025 will be dedicated to green projects. The "Just Transition Mechanism" aims to support the most economically and socially disadvantaged areas during the transition period. Considering Poland, for example, whose energy systems are still too tied to the coal and lignite supply chain to be able to reach the target within the deadlines set by Europe: Warsaw has, in fact, already expressed its perplexities on the Green Deal.
The Fund aims to incentivize new technologies while preserving jobs, thus reducing the inevitable social impact of the transition as much as possible: 7.5 billion euros are expected to be disbursed through the InvestEU platform, to trigger further loans from the EIB and move private funds around 45 billion euros allocated to sustainable projects.

'Green Transition' in pandemic recovery plan

A year after the issuance of the Green Deal, attention has focused on the urgent health aspects of the Covid-19 epidemic, almost completely obscuring the objectives set by the Green Deal. In April 2020, the European Parliament called for the European Green Deal to be included in the Covid-19 pandemic recovery program. Ten countries have urged the European Union to launch a Green Recovery Plan to avert the weakening of climate change action due to the Covid-19 pandemic. In a pandemic scenario, in September 2020, the European Commission issued the plan, entitled "A more ambitious 2030 climate goal for Europe: investing in a climate-neutral future in the interest of citizens", is accompanied by an impact assessment confirming that this reduction is a realistic and feasible strategy. The new climate target set more in the short term i.e., by 2030 will help to set the direction for the post-pandemic EU economic recovery by stimulating investment in a resource-efficient economy, promoting innovation in clean technologies, strengthening competitiveness. Besides, the Member States can draw on the 750-billion-euro from Next Generation EU, Recovery Fund and the EU's next long-term budget for these investments towards the green transition, as well as the new renewable energy financing mechanism of the EU. And the EU facilitates collaboration between the Member States to finance and implement projects in this field.
Also, the European Commission has adopted the assessment of the Member States' national energy and climate plans for the period 2021-2030. The individual assessments of the 27 National Energy and Climate Plans (NECPs) analyze the progress and the ambitions of the Member States in achieving the 2030 climate and energy targets.
The report examines the five different dimensions of the Energy Union: decarbonization, including renewable energies, energy efficiency, energy security, the internal energy market, as well as research, innovation and competitiveness. However, there is soaring progress in the renewable energy field, but we need to improve performance in terms of energy efficiency. It will be necessary to give a positive boost to the restructuring plan and the revision of the energy efficiency directives. The communication provides for a series of actions that are necessary for all economic sectors to achieve this ambitious decarbonization process and defines which legislative acts will be subject to review, such as the Energy Efficiency Directive, the Renewable Energy Directive, a system for the trading of share emissions. Recently, Energy Commissioner Kadri Simson said: "National energy and climate plans are an essential tool of our collaboration with the Member States to plan policies and investments for a green and just transition. The time has come to implement these plans and use them to overcome the crisis caused by the Covid-19 pandemic with new jobs and a more competitive Energy Union".
The examination of these documents shows that in recent years the European Commission has been playing a leading role in combating the fight against climate change through the improvement and energy efficiency of cities. The funding allocated by the Green Deal must be the starting point for promoting material projects that aim to provide strategies, actions and interventions on the different territorial contexts through the coexistence of a multitude of actors such as industries, research bodies, universities, civil societies. Efforts should aim more at adapting our cities so that results are obtained more in the short term than mitigation actions whose effects on cities require longer waiting times. Finally, the practical fulfillment of the national energy and climate plans (PNEC) must constitute the essential tool both for the achievement of the climate and energy objectives by 2030 and for the monitoring to improve the energy performance of the different territorial contexts and to overcome the crisis caused by the Covid-19 pandemic. The virulence with which this virus, invisible but so omnipresent, manifests itself is changing our social behavior and, with it, many relationships that structure the urban and territorial system. From this pandemic scenario, as the documents examined also affirm, we must start to rethink the organizational form of our cities. A city that must change its face by favoring policies and practices increasingly with a view to sustainability and energy efficiency.

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REVIEW NOTES – Urban practices

Toward greener and pandemic-proof cities: North American cities policy responses to Covid-19 outbreak

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Abstract
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always following a rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of a continuous updating of emerging topics concerning relationships among urban planning, mobility and environment, through a collection of short scientific papers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. In particular, the Urban practices section aims at presenting recent advancements on relevant topics that underlie the challenges that the cities have to face. The present note provides an overview of the policies and initiatives undertaken in three North American cities in response to the Covid-19 outbreak: New York City (US), Mexico City (MX) and Montreal (CA). A cross-city analysis is used to derive a taxonomy of urban policy measures. The contribution discusses the effectiveness of each measures in providing answers to epidemic threats in urban areas while, at the same time, improving the sustainability and resilience of urban communities.

Keywords
Covid-19; Urban policies; New York, Mexico city; Montreal

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1. Introduction

In December 2019, in the Wuhan province of China, a new form of Coronavirus (Covid-19) emerged. Since then, the virus has been spreading globally and, as of 05 March 2020, more than 200 Countries around the world have reported 136.82 million confirmed cases and a death toll of 2.96 million deaths (Template: Covid-19 pandemic data). The Covid-19 pandemic triggered both third and first world economies, causing severe disruption to society and business, especially in urban areas (OECD, 2020a).

2. Toward greener and pandemic-proof urban areas?

Urban areas have been the ground zero of the Covid-19 pandemic, with 90 per cent of reported cases (UN, 2020). They are densely populated places where people live and gather, thus at high risk of spreading the virus due to the close proximity among residents and challenges to implement social distancing (Neiderud, 2015). These conditions have generated a large debate about the future role of cities in the post-Covid scenario. In this respect, some authors have argued that large urban areas are nearly defenseless in times of unprecedented disease outbreaks (Desai, 2020) and that dense urban settlements are not compatible with the needs of social distancing (Megahed and Ghoneim, 2020). These circumstances, coupled with increasing dematerialization of services and pandemic-pushed growing teleworking rates, have prompted some authors to questioning the ever-growing urban concentration model and envisioning a resurgence of rural areas as alternative and safer mode of urbanization in the post-Covid society (Cotella and Brovarone, 2020).

On the contrary, other authors have stressed the pivotal role played by cities in the Covid-19 response in terms of implementing nation-wide measures, but also in terms of providing laboratories for bottom-up and innovative recovery strategies (UN, 2020; OECD, 2020a; UCCN, 2020). Advocates of this second line of argument have seen in the Covid-19 crises an unpredictable opportunity to reshape our cities toward a greener and cleaner urban future (OECD 2020a; Lai et al., 2020; Pierantoni et al., 2020). These optimistic claims are supported by a growing body of interdisciplinary research. Synergies, indeed, has been identified between policies aimed at providing answers to epidemic threats in urban areas and policies aimed at improving the sustainability and resilience of urban settlements (Garcia, 2020; Barbarossa, 2020; Pinheiro et al., 2020). Decentralization of public facilities, prioritization of soft over car-centric mobility, hierarchization of the transport system and public services, and redundancy of public, green and open-space functions have been identified as integrated measures able to achieve both public health and city sustainability targets (Pisano, 2020; Sharifi et al., 2020).

Within this context, the present short paper provides an overview of policies and initiatives undertaken in three major North American cities in response to the Covid outbreak. This is followed, in paragraph 4, by a discussion on whether these measures are (or will) promote a sustainable urban recovery.

3.1 New York City

New York is the most populous city in the United States. With an estimated population of 8,336,817 distributed over about 302.6 square miles (784 km2), it is also the most densely populated major city in the United States. The city is considered as the cultural, financial, and media capital of the world, significantly influencing commerce, entertainment, research, technology, education, politics, tourism, art, fashion, and sports. The city has experience a sustained urban growth over the past few decades, characterized by the implementation of large-scale urban projects and the development of an efficient and modern public transportation network, coupled with a well-developed shared-mobility eco-system.

The pandemic has severely hit the city's dynamic economy and social life, reversing the long-standing growth trends that have characterized its economy, with leisure, hospitality, finance, administrative and support services being the most affected economic sectors. As a consequence - only in 2020 - the city lost 750,000 jobs, nearly one out of every six job. This lopsided impact have exacerbated previously existing income inequalities, since the devastating effects have had a concentrated impact on predominantly low-income workers of color, young adults, and women (Parrot, 2021). During the first year of the pandemic, the city has adopted a number of measures to facilitate social distancing and

containing the spread of the virus. For instance, the city expanded its pedestrian walkways and pedestrian-only streets, which has come in handy during social distancing, and has closed down numerous streets in the five boroughs to allow for more pedestrian walkway. As a result, 83 miles of additional car-free streets (also known as Open Streets) have been implemented in 2020. In addition to pedestrian walkways, bike lanes, which were once a hotly contested and controversial topic, have been incredibly expanded: the New York City Department of Transportation has indeed constructed a record 28.6 lane miles of new protected bike lanes since the beginning of the pandemic. In addition to pedestrian sidewalks and bike lanes, there has been also an emphasis on the recovery of the leisure activities: bars, restaurant and café have been allowed to expand their terraces onto sidewalks and even close roads in some areas, resulting in 10,800 so-called Open Restaurants. Other intervention for the 2020 year included the restoration and the expansion of several public green areas and blue spaces. In January 2021, the city Council adopted an integrated and more structured approach to urban recovery by delivering the *Recovery for all* plan, the Major strategy aimed at creating a stronger, fairer and safer city for all New Yorkers. The strategy is articulated around six main pillars and 33 lines of intervention. Most of them introduce transformations in the built environment as a tool to promote social and economic recovery. For instance, under the *Fight the Climate Crisis* pillar, the plan envisions to make the *Open Streets* developed during the previous year a permanent part of the city landscape, while also opens applications for new streets, with a focus on local partner management and support. In addition, New York City will begin construction on five new *Bike Boulevards*, streets that are designed to give bicycles travel priority and put cyclist safety first. Under the same pillar, the plan also envisions the development of new public spaces (particularly for neighborhoods hardest hit by Covid) that will help support local small businesses, foster community ties and provide space for arts and culture. The *Bend Government to Fight Inequality* pillar focuses on social and spatial inequalities that have been further exacerbated by the pandemic crisis. In this respect, the plan envisions, among other measures, the establishment of a permanent taskforce on racial inclusion and equity with the aim of identifying the communities hardest hit by Covid-19 and driving new investments and initiatives in these neighborhoods. An important part of the plan concerns with the recovery and diversification of the urban economy. Actions in this domain are grouped under the *Build a New Economy* pillar and include, among others, the revitalization of small businesses by introducing a small-business recovery tax credits and loans scheme. Finally, particular emphasis is also given to the participation of the population (and especially the marginalized groups) in the decision-making process, as reflected in the *Community Power in Neighborhood* pillar.

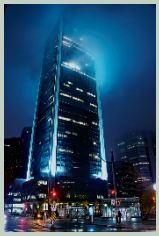
3.2 Mexico City

With an urban population of 9.2 million inhabitants, Mexico City is the capital and largest city of Mexico and the most populous city in North America. It is one of the most important cultural and financial centers of North America and one of the most productive urban areas in the world, generating – alone – approx. the 16% of total Mexico's GDP. Due to domestic migration, the city is expanding at an unprecedented rate. Rapid and unplanned urbanization however has caused several problems, including poor air and water quality, waste-disposal problems, high-energy consumption, and growing social and territorial inequalities. Despite this, the city is currently working toward radically reshaping its urban fabric, especially through the implementation of large-scale sustainable mobility initiatives.

The city economy has been severely hit by the pandemic. Furthermore, the pandemic has reinforced pre-existing social and spatial inequalities. Recent research findings (Jaramillo Molina, 2021) have underlined that, although the virus has spread throughout Mexico City, there are important spatial/geographical patterns associated with underlying inequalities: disadvantaged neighborhood have indeed reported a disproportional rates of infections and deaths. To recover its urban economy and alleviate pandemic-pushed social inequalities, Mexico City has announced on September 2020 an ambitious recovery plan. According to this plan, the city government will invest USD 1 billion to create around 1 million new jobs, mainly trought public investments in infrastructure and social housing. The plan is expected to contribute to the redevelopment of 13 urban corridors through housing projects, mostly housing improvement projects and new social housing in areas with good transport connection. For the city government the investment in infrastructure and social housing is essential in the recovery strategy due to the multiplier effect and the indirect jobs it may create. Although the projects will be carried out in large part by private companies, the plan poses particular emphasis on the consultations with the residents and the public at large in order to amplify the voices of those affected and allow for a more integrated and large-scale urban planning, compared to what would be possible with unguided private activities that have characterized part of the recent city development history. Beside intervention in the housing domain, the recovery plan also include measures aimed at improving public transport and soft mobility. In the respect, the plan envisions the creation of a new Bus Rapid Transit (BRT) line as well as two 'cablebuses' (cableways) lines connecting the historic center with recently developed, car-oriented neighborhoods. On the soft mobility side, the plan includes measures to expand the city bicycle path networks and promote the use of shared bicycles as a safe transportation mode, as well as the implementation of small-scale interventions aimed at increase the comfort and safety of cyclists on already-existent cycling routes. Interventions on the city's built environment will not only cover housing and transportation, but will also focuses on the recovery and expansion of Mexico City's industrial area (Vallejo neighborhood) with the aim of attracting new private investments, especially in the field of clean energy technologies.

Measures in the social welfare domain have been another important focus of the public administration recovery strategy. City unemployment rate is indeed relatively high, and there are large numbers of households living below the poverty line. Furthermore, almost half of the economically-active population works in the informal economy. To tackle these issue the City administration has created a dedicate budget, financed by both public funds as well as private donations. These resources have been devoted to provide aids to families in the form of direct economic support, rent relief support, food aids, municipal taxes relief programs and discounts on the purchase of public transport subscriptions. A further line of intervention concerns with the simplification, expansion and acceleration of digital services available to the citizens in order to reduce the needs to travel and contain physical contacts between public servants and city users.

3.3 Montreal



With 1.7 million inhabitants, Montreal is the second-most populous city in Canada and the most populous city in the province of Quebec. Historically the city has been the commercial capital of Canada. However, starting from the late 70s, Montreal was surpassed in population and in economic strength by Toronto. Despite this, Montreal remains an important center of commerce, finance, industry and technology.

Over the past few decades, the city has been home of important urban transformations. From one side, its historic district has been the focus of both public and private interventions finalized at consolidating the district's attractiveness as a living environment, in addition to a center of heritage and tourism. On the other side, the city has successfully promoted a model of urban development for its outskirt areas that supports the creation of dense, mixed-use communities around main public transportation nodes.

Since the beginning of the pandemic, Montreal has remained the worst affected health region in Canada, having both the highest total case count and the highest death rate (Ville de Montreal, 2020). Therefore, the city has experience significant economic loss that, in turn, have resulted in unprecedented rates of unemployment. In order to provide a response to the economic challenges posed by the pandemic, on June 2020, the city Council launched an ambitious recovery plan, aimed at supporting Montréal's economy in the short term, while taking concrete actions to stimulate city recovery in the long run in a more resilient, inclusive and sustainable way. The plan is geared towards three main objectives: i) stabilize and support the economy in the short-term, ii) reinvent the economic development of the city in the long term, and iii) mobilize all partners towards green and inclusive urban development. Based on these objectives, the plan defines three main axis of intervention. For the first axis *Businesses at the heart of our economic recovery*, $5.6 M will be injected in order to stimulate the vitality of the commercial thorough-fares and to support businesses resume their activities and develop major projects geared toward client experience and physical distancing. Beside direct economic support to commercial activities and business, measures under these pillar also cover: i) actions aimed at favoring the temporary or transitory occupancy of vacant city' spaces; ii) the creation of a permanent urban, carbon-free bicycle delivery service, as well as iii) the elaboration of a dedicated plan to regulate and boost the city's nocturnal economy. For the second axis *Helping entrepreneurs do business differently*, $4.8 M are invested to stimulate entrepreneurship, namely by providing support to small and medium-size businesses that are struggling with debt, or that wish to transform their business models. Measures under this axis, also aim to support start-ups and social economy organizations.

The third axis focuses on the redevelopment of the urban environment that is strategically seen as one of the main city asset, and a potent lever to stimulate economic recovery. This axis is called *Reinventing the economic development of our territory*, and envisions investments for $10.5 M to catalyze Montréal's transition towards a greener and more inclusive city. This axis focus on urban regeneration projects such as the decontamination of the Montréal's East End, an area of about 4 million square feet of land formerly devoted to industrial functions that will be mainly converted in research, innovation and entrepreneurial functions. Other example of interventions include: i) the extension of the orange metro line to the northwest, and the blue metro line to east; ii) the renovation of selected heritage buildings into mixed-use modern buildings, including low-cost housing; iii) the extension and upgrade of sidewalks in the historic city center. Finally, for the axis *Mobilizing the economic ecosystem to elicit collective and renewed commitment*, $1.1 M will help support and coordinate the most far-reaching initiatives of the city's economic development ecosystem in the current context, namely with respect to the city's global economic standing, to the creation and sharing of strategic data, as well as to the adaptation of the training provided in order to aid in the reintegration and reorientation of the workforce.

4. Discussion and conclusions

As Covid-19 spreads across the world, cities have become epicenters of the pandemic, amplifying the spread and transmission of infection, with their dense population and transport networks. At the same time, cities have become catalyst of sustainable recovery. Many examples of good practices taking place in cities across the word are captured by dedicated and constantly-updated reports of international organizations such as

WHO (2020), UN (2020) and OECD (2020a) and UCCN (2020). This contribution provided a focus on North America and examined policy response to the Covid-19 epidemic in three cities.
A cross-city analysis of measures implemented in the cities under investigation can be a useful exercise to derive a taxonomy of urban policy measures. This is reported below, together with some considerations on the effectiveness of such measures in providing answers to epidemic threats in urban areas while, at the same time, improving the sustainability and resilience of urban communities. Considering the social, the physical and the functional subsystems composing the city, measures could be addressed to:

PHYSICAL SUBSYSTEM

- *Expansion of cycling infrastructures*. Cycling is promoted by many cities as a recovery strategy since it can reduce pressure on crowded (and often depotentiated) public transport while allowing citizens to respect social distancing, thus lowering the risk of virus transmission. Especially in dense urban settlements, as those exanimated in this article, where commuting distances are compatible with the use of bike, cycling represents an alternatives solution to provide citizens with essential needs, go to work when necessary, and still perform some physical activity, even in times of pandemic outbreaks (Garcia, 2020). At the same time, the promotion of cycling in urban areas represents an essential ingredient to improve cities livability and reduce the externalities of car-oriented urban development (Ison and Shaw, 2012).
- *Improvement of walking paths/ expansion of pedestrian areas*. These measures can be considered effective tools to promote sustainable mobility while, at the same time adapting the city physical environment to the new challenges imposed by the virus outbreak. On the city sustainability side, these measures can contribute to sustainable mobility targets by shifting mobility demand from private cars to active transportation modes (Li et al., 2014). On the health side, ameliorate walkability has been demonstrated an effective tool to improve public health by promoting physical activity (Frank et al., 2006). Furthermore, extension of pedestrian areas and sidewalks can guarantee enough space for safe physical distancing while favoring business reopening by accommodating longer lines deriving for lower business accommodation capabilities (WHO, 2020).
- *Extension of green and open space functions*. Environmental benefit of public, green and open spaces are well-established: they contribute to the purification of water and air climate, to the regulation and mitigation of the urban climate, and support biodiversity conservation (Chiesura, 2004). Following the pandemic outbreak, researchers have found that the virus transmission spreads more easily indoors than outdoors (Morawskaa and Caob, 2020) and that urban green urban spaces have been crucial for exercise and mental wellbeing during the stringent lockdown (Razani et al., 2020). Extension of these areas represents thus a valuable contribution to foster city sustainability while, at the same, time providing concrete spatial planning answers to epidemic threats.

FUNCTIONAL SUBSYSTEM

- *Decentralization of public facilities*. Decentralization of public facilities is considered a fundamental property to contain the spread of the virus since it allows people to be able to get the goods and facilities they need within the minimum distance from their houses, thus limiting the interaction with the other sectors of the population (Pinheiro et al., 2020). Furthermore, the decentralization of healthcare services can reduce the response time, and saving operating costs (Pisani, 2020). A balanced juxtaposition of homes and services, is thus not only a well-known urban planning strategy to reduce long-distance trips and promote active transport, but represents also an emerging tool for containing epidemic spreading.
- *Improvement of IT infrastructures and digital services*. These measures can generate positive co-benefits: the digitalization of public services can indeed reduce the need to travel while at the same time

contain physical contacts between public servants and city users. Furthermore, IT technologies can also provide a fast and concrete response to citizen's needs. Investments in this domain should be thus certainly encouraged in the context of city's recovery plan.

SOCIAL SUBSYSTEM

- *Household / small business economic support.* The pandemic crises has exacerbated the existing social inequalities while severely affecting cities economy. Measure aimed at provide households economic, social or rental support as well as measures target at provide relief to most affected economic sectors have been implemented in all cities under investigation. While undoubtedly necessary, these measure, if not integrated in a wider urban economic recovery strategy, can be considered only effective in the short term. Their impacts on cities sustainability and resilience is hard to demonstrate.
- *Human capital development*. According to OECD (2020b), the global pandemic is triggering substantial changes in the labor market. Accordingly, it is essential for governments to help workers transition to the post-Covid 19 economy. These measures are highly recommended by international organizations as they provide the ground for fostering citizens' resilience to current and future disruptive events.

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REVIEW NOTES – Economy, business and land use

Citizen science: involving citizens in research projects and urban planning

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Abstract
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always following a rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of a continuous updating of emerging topics concerning relationships among urban planning, mobility and environment, through a collection of short scientific papers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. In particular, the Economy, business and land use section aims at presenting recent advancements on relevant topics that underlie socio-economic relationships between firms and territories. The present note tackles the issue of citizen science, a new data collection methodology for research project that generates sustainability benefits, and that is recently finding applications in urban context to solve social and environmental issues while providing useful information that can be also used to develop urban plans.

Keywords
Citizen science; Research projects; Urban planning; Urban areas; Citizen engagement.

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1. Introduction

The involvement of different stakeholders in a process of participatory urban planning guarantees a trustworthy relationship between public organizations and other relevant actors towards a process that fosters economic growth and social cohesion (United Nations, 2015). Forms of collaboration between public and private actors democratize decisions by empowering relevant stakeholders to contribute to the sustainable development of cities (Staricco et al., 2020) in a so-called participatory planning process (Innes & Booher, 2004). In particular, recent literature is focusing the attention towards the role of citizens that are recognized as a possible resource for data and insights (Åström, 2020). Among the techniques developed to involve citizens in participatory projects, Citizen science (CS) is emerging as an effective tool thanks to the development of technologies that favor technology-mediated interactions between citizens and public organizations (Cappa et al., 2020; Sauermann et al., 2020). CS aims at involving citizens, without any particular knowledge requirement, in research projects aimed at solving social and environmental problems (Conrad & Hilchey, 2011). In such a way CS allows the democratization of science favoring stakeholders engagement and public participation towards tackling Grand Challenges (European Commission, 2020). CS practically consists of involving citizens as volunteers in research projects with the aim of collecting or analyzing large quantities of data at lower costs (Kullenberg & Kasperowski, 2016). Indeed, to respond to the need of intense data collection or analysis by researchers, such as signaling bird species in the city or mapping polluted water spots in the river, citizen scientists may allow to achieve these objectives in a faster and cheaper way. At the same time for citizens is provided a pleasurable experience with a technology intensive projects, and the possibility to increase their literacy.

Due to its proved effectiveness, CS role is rapidly evolving, and it is now considered as a valuable instrument for engaging people in decision-making processes (Bottero et al., 2017), even if they don't have a background in collecting data or in the specific topic of the analysis (Wildschut, 2017). In other words, CS engages people, that is external to a given organization, as source of knowledge, and the ease to involve crowds through information technologies is spreading the phenomenon (Cappa et al., 2019; Mueller et al., 2018). This means that CS is a relevant instrument both for public managers and policy makers. In their paper, Kullenberg and Kasperowski (2016) report examples of some interesting CS applications: in the field of humanities the project "Ancient Lives" asks citizens to transcribe ancient Greek text from the Oxyrhynchus Papyri collection. In the health sector, MalariaSpot uses mobile technologies to ask citizens to provide information about malaria cases in order to have a bigger dataset that allows to study the phenomenon in a more finely grained manner. In fact, the digitalization, and in particular the spread of the internet and mobile devices, allows organizations to involve citizens overcoming geographical and socio-economic barriers, potentially connecting volunteers from all over the world if they are interested in the topic (Cappa et al., 2018). This opens new opportunities to organizations to collect large amount of data from different sources to tackle grand challenges towards a sustainable development also in urban contexts (Tira, 2020). In particular, through CS it is possible to collect and analyze data to a scale that would not otherwise be possible without the help of citizens. Such projects, that have socially and environmentally aim, allow to reach the scientific objective in a faster and cheaper way. In addition, CS projects also have an educational scope as they increase the scientific and technological literacy of volunteers contributing into these projects (Åström, 2020; Boudreau et al., 2011). By contributing to these different social, economic and environmental goals, CS represents a sustainable tool. European Commission, indeed, is promoting such projects as instruments to develop sustainability and social innovation (European Commission, 2020) and thanks to the possible benefits provided by CS, there is increasing scientific, managerial and policymaking interest towards this phenomenon. Among the different fields in which it is possible to apply CS, urban development is one of the most relevant and most suitable to the implementation of participatory activities involving citizens, as urban areas are characterized by high concentration of living people and of social, economic and environmental issues (Bai et al., 2018; Gargiulo & Russo, 2017). In other

words, the critical mass of individuals affected by such challenges that affect several people, makes the urban context a major setting for CS. The aim of this review note is to shed lights on recent advancements in literature about CS in the urban context. The next paragraph highlights research and practical example of CS applied to the relationship between cities and citizens. Finally, we provide discussions and concluding remarks.

2. The application of Citizen Science in urban contexts

With reference to urban development, previous research has analyzed the relationship between CS and urban contexts as cities are the contexts in which the highest share of social and environmental issues are concentrated (Lai et al., 2020; Sakshi et al., 2020). Most of the studies have devoted attention to the methodologies useful to motivate citizens to participate as much as possible to CS projects in order to collect the highest number of information possible from them (e.g., Tinati et al., 2017) as the higher the amount of data collected, the higher the quality of the outcomes both in terms of scientific results and decision-making quality and reliability (Mueller et al., 2018). CS is gaining increasing relevance in practice as well. According to a report developed by the European Commission, CS is a tool that helps cities in becoming smart, raising awareness in the population about relevant topics and strengthening the community (Craglia & Eds, 2014).

There are several reasons why citizens get involved in CS projects and they may change depending on their characteristics (Laut et al., 2017). Rotman and colleagues (2013) identify two citizens typologies, named professional scientists and volunteers. The first group is moved by scientific advancements and career development, while volunteers do that for *"curiosity and commitment to conservation and related educational efforts"* (Rotman et al., 2013, p. 225). Volunteers, instead, get involved in CS projects to contribute to the development of something they care about. This is evident in the case of urban development, where citizens can give their contribution to collect data and information that may drive the development of their city or, to narrow down, their neighborhood. The case of Brooklyn Atlantis in New York is emblematic in this perspective. It is a project where New York citizens are asked to tag waste into a canal in Brooklyn, in order to map the major spots of pollution. By collecting such information, it is possible to understand which the most polluted spots in the canal are. In turn, this information may serve to public administration to design future ecological plans and strategies differentiated from a neighborhood to one another.

On the other side, why should administrations trust citizens? First of all, it has been evidenced that having high quantity of data may assure a high level of quality of the outcomes. Moreover, citizens participation allow the engagement of all the relevant actors involved in the decision making rather than a top-down approach (Åström, 2020) that could make the city smarter (Aldegheishem, 2019). In addition, administrations that manage CS projects have the chance to collect information at relatively low costs (Nov et al., 2014).

Previous studies have highlighted that administrations can effectively implement CS practices to engage citizens in a virtuous stakeholder engagement process that helps in designing effective urban plans (Mueller et al., 2018). One of the first examples of CS applied in urban context regards the preservation of birds in cities. As discussed by McCaffrey (2005), the involvement of citizens in bird monitoring in several areas of Canada and United States helped administrations to design bird-related ecological projects. The research carried out by Cappa et al. (2020) showed instead that through the collection of citizens data about their appliance usage public organizations could use such information to nudge people towards a more effective usage of high consumption electronic devices aimed at energy efficiency. Other studies evidenced the benefits of CS for cleaning waters or monitoring air pollution (Cappa et al., 2018; Young et al., 2019). Thus, by solving social and environmental problems through research projects, CS also appear to provide useful tools to urban planners to solve such related issues. There are several examples of application of CS projects in urban contexts. With reference to European Union, for example, has been recently launched the MICS (Measuring Impact of Citizen Science), an initiative that coordinate some CS project and evaluate their impact for society. The following boxes provide interesting examples of CS projects mainly referred to urban contexts.

"Globe at Night" CS project

Globe at Night is an international citizen-science campaign to raise public awareness of the impact of light pollution by inviting citizen scientists to measure & submit their night sky brightness observations. Citizens can easily get involved simply by using a computer or a smart phone. Citizens have to take pictures of the sky at night and the relative constellations. After that they should upload the pictures on a web-platform or on a smart phone app that will automatically collect data about date, time and location. The project thus collects data provided by citizens that allow to analyze sky pollution and monitor it constantly. The information provided by this data help scientists in the analysis of air quality and could also benefit administrations by providing a cheap tool to monitor sky pollution. In its 14 years of life, Globe at Night, a pioneering project, has collected more than 200,000 data collected from 180 world countries.

Co-design at Marzenego river

Among other projects, the MICS coordinates an initiative aimed at monitoring the quality of the water of the Marzenego river.
As the website states: "the Marzenego river begins its course in the north-east of the Veneto Region, Italy. Along its 45 km, the river crosses an extremely heterogeneous territory - characterized by rural, industrial and urban areas – ultimately channelling into the artificial Osellino canal which reaches the Venice Lagoon. As a result, the Marzenego receives water from a dense network of drainage canals, which modify the morphology of the watercourse and put areas surrounding the Marzenego at risk of flooding.
Nature Based Solutions (NBSs) aim to manage both the sustainable use of natural resources to address socio-environmental challenges, and the risk of environmental disaster; providing an integrated approach to conserve, manage and preserve the functionality of natural ecosystems. Along the Marzenego river, NBSs may include the restoration of natural habitats through the widening and remodulation of the riverbed, and the creation of wetlands for nutrient and sediment reduction; promoting biodiversity, reducing flood risk, and providing recreational areas for neighbouring communities.
NBSs are particularly effective when they are developed in a co-participative context, in which volunteers can have the opportunity to express their expectations and needs and be involved in the decision-making processes. Citizen science can further involve citizens by including them in the environmental monitoring of the NBS.
The NBS implemented along the Marzenego river provides a suitable case-study for MICS to evaluate; elucidating the impact of citizen science initiatives in this specific environment. To co-design the citizen science activities, MICS adopts and applies the best practice generated by the Ground Truth 2.0 project. This process has already begun with the first of three workshops, designed to identify and define the project and the environmental monitoring activities to be carried out by citizen scientists.
In December 2019, 40 citizens – including scientists, teachers, environmental experts and public authorities – were introduced to the river restoration project; the concepts of citizen science and NBS; and the MICS project as a whole. Through a series of activities – intended to facilitate an effective co-design of the project - the volunteers contributed their views on the issues surrounding flooding and poor water quality, and their expectations for what the project might achieve. Expectations were summarised as an infographic, and demonstrate increased well-being, increased biodiversity, environmental risk mitigation and social development as key issues in need of addressing."

3. Discussion and conclusions

Sustainability is phenomenon that is increasingly central and important both in private and public organizations (Franco, 2021; Klein et al., 2020). In line with sustainability principles, CS is a tool that helps research in collecting data from volunteer citizens, thus allowing scholars to collect large amount of information at relatively low costs. The phenomenon is increasingly developing and is mainly related to environmental issues. Most of the CS projects indeed are aimed at preserving biodiversity, monitoring pollution or reducing energy consumptions. Recent applications show that CS is spreading more and more even in urban context and that from mere research tool, it could be also used to involve citizens in a form of participatory process in line with the principles of democratization of science, stakeholder engagement and public participation (European Commission, 2020). In this vein, this note aims at giving attention to CS as a phenomenon on which regional and urban administrations should increasingly look with great interest given its possible applications in a wide range of issues, and in line with the principles of sustainability as it is mainly oriented to solve environmental

problems through the engagement of a key stakeholder, i.e. citizens. This is in line with the stream of literature that discusses the potential benefit of the involvement of citizens in urban planning and decision-making (Åström, 2020; Mueller et al., 2018). Possible future development in CS may indeed regard the inclusion of mechanisms that involve citizens in the decision-making process. This consideration may provide useful insights to policy makers to develop future plans for the sustainable development of cities in a stakeholder engagement perspective. Future studies should look at possible applications of CS in cities using both qualitative (e.g. case studies, interviews) and quantitative (e.g. surveys) methodologies, underlining peculiarities with respect to mere scientific applications, the activities through which it can be implemented, and the mechanisms that underlie its positive outcomes.

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