TeMA

Journal of Land Use, Mobility and Environment

The climatic, social, economic and health phenomena that have increasingly affected our cities in recent years require the identification and implementation of adaptation actions to improve the resilience of urban systems. The three issues of the 15th volume will collect articles concerning the challenges that the complexity of the phenomena in progress imposes on cities through the adoption of mitigation measures and the commitment to transforming cities into resilient and competitive urban systems.

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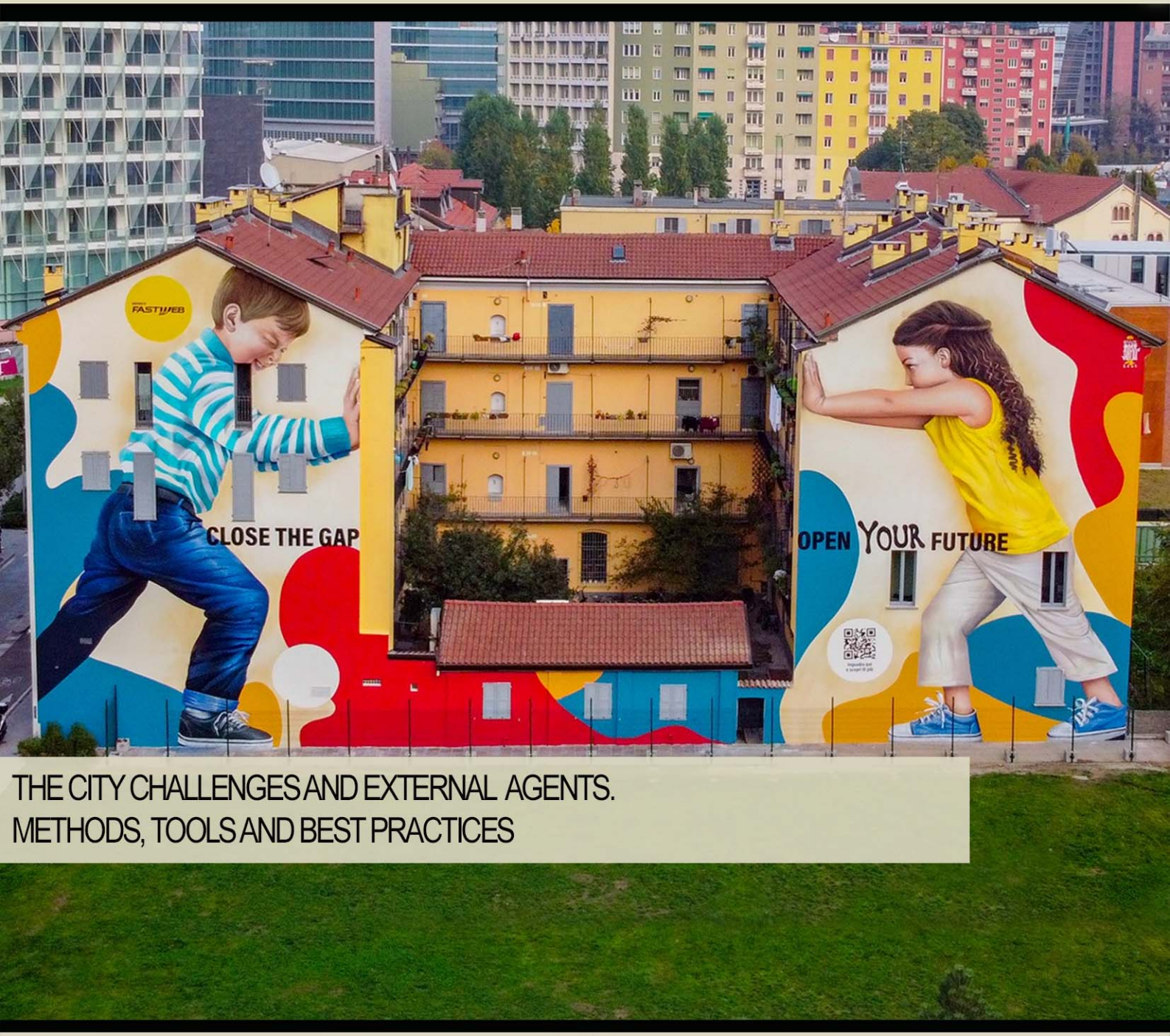

THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

Vol.15 n.1 April 2022

print ISSN 1970-9889 e-ISSN 1970-9870
University of Naples Federico II

TeMA Journal of
Land Use, Mobility and Environment

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

1 (2022)

Published by
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

TeMA is realized by CAB - Center for Libraries at “Federico II” University of Naples using Open Journal System

Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | on line ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

Editorial correspondence
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The cover image shows redeveloped building in the Garibaldi neighbourhood in the city of Milano (Picture by Fastweb, retrieved from: https://www.facebook.com/Fastweb/photos/10158794132149472).

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TeMA Journal of Land Use, Mobility and Environment

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Contents

EDITORIAL PREFACE: TEMA JOURNAL OF LAND USE MOBILITY AND ENVIRONMENT 1(2022)

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

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The challenge that the complexity of the ongoing phenomena imposes on cities involves not only adopting mitigation measures aimed at reducing the adverse effects of these phenomena; this challenge requires scholars, researchers, technicians, and decision makers to transform cities into resilient competitive urban systems rapidly.
The three issues of the 15th volume collect articles concerning the climatic, social, economic and health phenomena that have increasingly affected our cities in recent years and, hence, require the identification and implementation of adaptation actions to improve the resilience of urban systems.
For this Issue, the section "Focus" contains two contributions. The first article of the section is titled "Multiple components in GHG stock of transport sector: technical improvements for SECAP Baseline Emissions Inventory assessment", by Luigi Santopietro, Francesco Scorza, Beniamino Murgante (University of Basilicata, Italy) focus on the computational approach applied to the transport sector CO_2 emissions assessment in the SECAP Baseline Emissions Inventory (BEI) analysis. The case study of Castelsaraceno Municipality (Italy) highlights the robustness of the proposed approach compared with existing Municipal energy plan evidence and additional checks based on unconventional information sources.
The second article, titled "Mountain tourism facing climate change. Assessing risks and opportunities in the Italian Alps" by Elena Camilla Pede, Giuliana Barbato, Alessandra Buffa, Marta Ellena, Paola Mercogliano, Guglielmo Ricciardi, Luca Staricco (Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici and Politecnico di Torino, Italy), presents a risk methodology to assess the spatial distribution of the main challenges and opportunities for winter and summer tourism due to climate change at the sub-regional level on a 2021-2050 scenario. This methodology has been tested on an Italian Alpine area, which consists of very different landscapes from plain to high mountains.
The section "LUME" (Land Use, Mobility and Environment) contains five contributions. The first is titled "Municipal finance, density, and economic development. Empirical evidence from a global sample of cities" by Marco Kamiya (United Nations Industrial Development Organization, Austria), Raffaele Scuderi ("Kore" University of Enna, Italy), Giuseppe Tesoriere (World Resources Institute, Netherlands). This research focuses on how population density may influence municipal expenditure considering different budget categories, including sanitation, waste, water, affordable housing, and security.
The second article of the section, titled "Mobility infrastructures as public spaces. A reconnection project" by Giulio Giovannoni (University of Firenze, Italy), deals with reconnecting through urban planning public works design, the relationship between mobility infrastructure and spaces for social life.
The third contribution, titled "About non-knowledge in Knowledge management for planning: towards an applied ontological approach", by Maria Rosaria Rossella Stufano Melone, Domenico Camarda (Politecnico di Bari, Italy) highlights reflections on the awareness of how the lack of knowledge and the unknown are important elements to consider during any territorial and environmental planning process.
The fourth article, titled "Sustainable urban regeneration in port-cities. A participatory project for the Genoa waterfront" by Francesca Pirlone, Ilenia Spadaro, Martina Sabattini, Marco De Nicola (University of Genoa, Italy), takes its steps from an in-depth literature study of the definition of urban regeneration, from the analysis

of virtuous international case studies, to arrive to the identification of an approach and key issues to be able to develop a regeneration process that is sustainable and leads to an improvement in quality of life of its inhabitants.

The last paper of the section, titled "Investigation of extreme reflections of metal ceilings and salty soils using object oriented satellite image processing Sentinel-2 L1C using SVM classification method" by Bahram Imani, Jafar Jafarzadeh (University of Mohaghegh Ardabili, Iran), presents a novel remote sensing technique to derive land cover maps from satellite images. The proposed technique is particularly suited for identifying metal roofs since it can distinguish these objects from other high-reflection objects such as salines and dry soils.

The section "Covid-19 vs City-22" collects one papers, titled "A sustainable approach for planning of urban pedestrian routes and footpaths in a pandemic scenario" by Antonio Comi, Francis M. M. Cirianni, Angelo S. Luongo (University of Tor Vergata, Italy). The paper proposes methodology for the classification of pathways, by capacity and level of service, which can be used to verify pedestrian mobility demand for specific measures, strategies, and policies.

The Review Notes section proposes four insights on the themes of the TeMA Journal. The first section, "Climate adaptation in the Mediterranean: where are we?", by Carmen Guida, proposes an insight into the main threats of climate change to the network of Mediterranean cities and discusses why integrated solutions for the whole region are necessary to adapt the Mediterranean region to such phenomena better. The second contribution, "Accelerating sustainable urban transition: European Climate Action", by Federica Gaglione, examines how the transition to urban sustainability requires fundamental and structural changes in urban systems through which challenges such as climate change or the organization of energy systems that are defined on renewable sources are addressed. In this direction, the paper examines the European regulatory excursus starting from the climate law up to the EU Adaptation Strategy to increase the resilience of cities. The third section, "European cities embracing digital nomads", by Gennaro Angiello, provides an overview of the policies and initiatives undertaken by two European cities to attract and retain digital nomads and remote workers: Venice (IT) and Madeira (PT). The fourth contribution, "Sustainable development in cities: a review of frameworks and indexes", by Stefano Franco, clarifies the concept of a sustainable city from a practical point of view by describing some of the most general frameworks in defining urban sustainability. Finally, "The interventions of the Italian Recovery and Resilience Plan: Urban regeneration of the Italian cities", by Sabrina Sgambati, investigates the topic of urban regeneration within the framework of the Italian NRRP, deepening the main strategies, reforms and interventions activated in Italian cities.

The number and extent of the papers published in this Issue did not allow us to propose a scientific article for the Evergreen section, which will certainly find space in future journal issues.

TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 5-24
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/8391
Received 23rd September 2021, Accepted 2nd February 2022, Available online 30th April 2022

www.tema.unina.it

Multiple components in GHG stock of transport sector: Technical improvements for SECAP Baseline Emissions Inventory assessment

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Abstract
The issue of the greenhouse gas emission is one of the main targets for the Covenant of Mayors initiative within the structure of the Sustainable Energy and Action Plans (SECAP).
The computation of CO_2 emissions for SECAP transport sector was tackled in practice through several methods producing not comparable results and even not reliable scenarios. Considering SECAP as a voluntary planning tool suitable for the management of ecological transition in small municipalities, in this work a computational proposal for transport sector emissions is proposed. The methodological proposal represents an operative guideline, providing accurate results based on easy-accessible data customized for the small Municipalities (i.e. with a resident population under 10.000 inhabitants). Such approach is characterized by the analysis of two components of emissions stock: a fixed one connected with the vehicles' fleet of resident population; a variable one depending on the tourism flows generated by specific environmental/cultural attractors. The case study of Castelsaraceno Municipality (Italy) is discussed highlighting the robustness of the proposed approach compared with existing Municipal energy plan evidences and additional checks based on unconventional information sources.

Keywords
CO_2 emissions reduction; SECAP; Transport energy consumption; Territorial planning.

How to cite item in APA format
Santopietro, L., Scorza, F. & Murgante, B. (2022). Multiple components in GHG stock of transport sector: Technical improvements for SECAP Baseline Emissions Inventory assessment. Tema. Journal of Land Use, *Mobility and Environment*, *15* (1), 5-24. http://dx.doi.org/10.6092/1970-9870/8391

1. Introduction

On 12th December 2019 the European Council endorsed the objective of making the EU climate-neutral by 2050 (European Commission, 2019), in line with the objectives of the Paris Agreement (United Nations, 2015). In this scenario the efforts to improve the reduction of Greenhouses Gas (GHG) are supported by several European initiatives such as the Covenant of Mayors (CoM). The CoM supports the volunteer Municipalities that submit a common CO_2 emission target (actually the 40%), developing a Sustainable Energy and Climate Action Plan (SECAP). These plans represent operative tools promoting extensive modifications of urban environment following climate change adaptation issues and, as discussed in previous works by the authors, represent an informal alternative to traditional urban regulations strictly constrained by the current urban national and regional laws (Corrado et al., 2020; Santopietro et al., 2020; Santopietro & Scorza, 2020; Scorza et al., 2017). The extensive participation of Italian Municipalities to the CoM initiatives is representative of the level of commitment that local authorities gained towards climate/green goals. On the other hand, the heterogenous attitude in SECAP planning, implementation and monitoring expresses the absence of a clear technical framework allowing comparability among experiences and an extensive transferability of methodological approaches and tools. However, SECAP is an effective support for Municipalities decision-making process oriented to implement environmental and climate responsive interventions on urban components. In the perspective of the planning process, SECAPs engage Municipalities to develop planning actions with specific road-map of the interventions defining: actors involved, timeframe and responsibilities of the processes and a subsequent monitoring campaign of them.

The design of specific actions is a strength of the SECAP process; however, these actions are more linked to the implementation of interventions on selected urban areas than to an integrated urban vision.

Investigating the structure of the SECAP, the knowledge of the Municipal context is organized in different sectors, each one with a specific CO_2 contribution (Paolo Bertoldi & Rivas, 2020; D'Orso et al., 2020; Rivas et al., 2021). SECAP sectors are: buildings, transport, energy, water, waste (related to the energy saving issues), territorial planning, agriculture & forestry, environment & biodiversity, health, civil protection & rescue and tourism (related to the climate adaptation and mitigation issues).

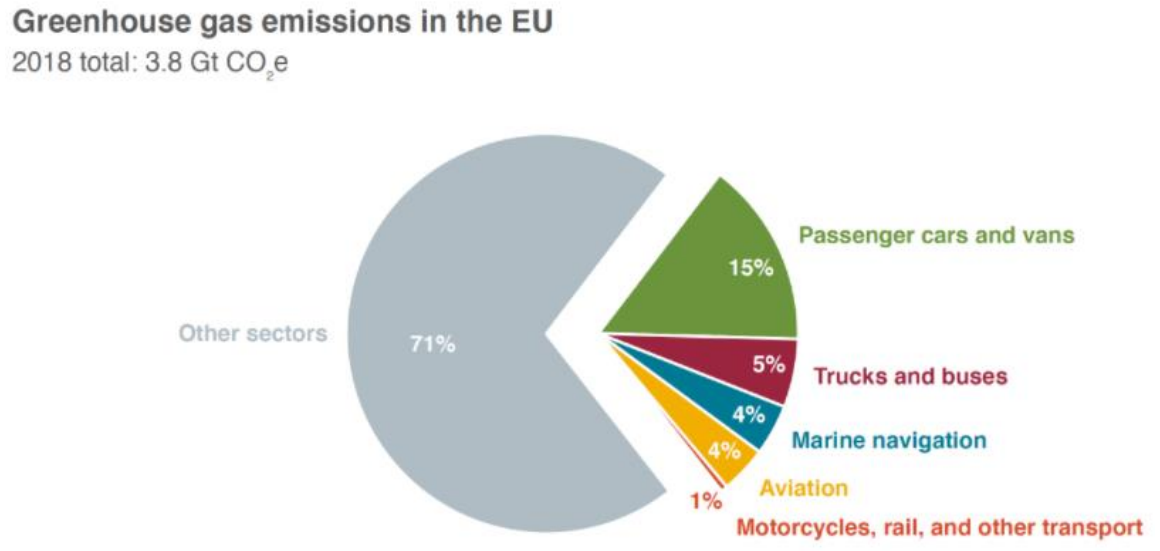

Fig.1 Share of EU-27 economy-wide greenhouse gas emissions in 2018 by transport subsector, including domestic and international components. Land use, land-use change, and forestry are included in the other sectors category

In this paper we focus on the computational approach applied to the transport sector CO_2 emissions assessment in the SECAP Baseline Emissions Inventory (BEI) analysis. Among the CoM sectors, the transport one is considered one of the main target sector (Croci et al., 2017; Kona et al., 2017). Furthermore, according to The International Council of Clean Transportation (see Fig.1) in 2018, domestic and international transport

were responsible for 29% (on a total of 3.8 Gt CO_2eq) of total economy-wide greenhouse gas emissions in the EU, while for European Environment Agency (EEA) the average carbon dioxide emissions from new passenger cars for the period 2000-2019 has decreased from 172.2 gCO_2/Km to 122.3 gCO_2/Km considering that in 2019, as in 2018, petrol cars were the most sold passenger vehicles.

Current technical practices concerning the assessment of the baseline emission for this sector include an heterogenous set of approaches and also CoM guidelines or other EU handbooks do not provide a unique way to compute different components of CO_2 emission connected with public and private transports means.

Additionally, no distinctions are made between systematic transport movements and other typologies connected for instance with tourism flows, seasonal events etc.

For the accuracy of CO_2 emissions due to transport sector, methodologies should take into account the size of the cities for which they are designed. The CoM identifies the small size Municipality with the XS acronym and such group includes CoM Signatories with a population under 10,000 inhabitants. This group represents a remarkable share of the whole CoM Signatories by September 2021: 4,334 Signatories, in percentage 63%.

The research suggests a method to estimate the CO_2 emissions from the "transport" sector specifically oriented to the XS CoM Signatories group. For this group of Municipalities, the components of systematic transport movements are not a considerable share of the whole emissions. In facts, the presence of cultural/environmental attractors or other specific destinations for daily or seasonal flows of people and goods in a Municipality, can generate extraordinary traffic flows that generally are not included in the computational approach for CO_2 emissions adopted in the SECAP.

The transport sector is divided into three subsectors, according to the CoM classification in order to compare the results: Municipal fleet, Public Transport and Private and commercial transport. The computation of the CO_2 emissions is very different among those categories and not always easy to do.

Indeed, the availability of transport data is generally not enough for small Municipalities and the computational model has to consider medium values derived from regional datasets. In facts no specific studies on the transport topics are available for that Municipalities size, allowing to estimate the data on CO_2 emissions with a high resolution. Thus, data for the Municipal fleet and Public Transport could be retrieved by Municipal Offices or Public Transport Plans developed at national or local level, while data from private and commercial transports are always estimated using benchmarks or top-down approaches related to regional or national level properly sized to Municipal level.

A specific focus of this the subsector private and commercial transport. We describe method providing affordable accuracy results based on easy-accessible data.

The paper is organized as follows: in the next section are explained some interesting statistics for the XS Municipalities and in the section 3 are presented the official CoM European Guidelines proposed by the Joint Research Centre to compute the CO_2 emissions of the transport sector. Section 4 explains some selected experiences on the estimation of private transport sector CO_2 emissions deriving from the EU XS SECAP Signatories framework.

In section 5 is explained the methodological proposal related to the computation of transport consumption while in section 6 is presented the application of the methodological proposal to the case study of the "small" XS Italian Municipality of Castelsaraceno.

The conclusions regard the main outcomes obtained by the application of the methodology on the case study of Castelsaraceno, limitations of the approach and future research perspectives.

2. CoM Signatories comprehensive figures

Before starting to explore some interesting European experiences of EU XS CoM Signatories, it could be useful look at the structure of this class of CoM Signatories.

The XS CoM Signatories are a relevant percentage (63%) on the whole of the CoM Signatories. Investigating data from the CoM database on its website, some interesting figures come out:

1. Population Size

The XS class counts the Signatories under 10,000 inhabitants, that by September 2021 are 4,334. Dividing them into two subclasses (under or over 5000 inhabitants see Tab.1) the Municipalities with higher percentage (75%) are under 5,000 inhabitants. Among them, Municipalities under 1,000 inhabitants are no. 1,052 (corresponding to 24% on the total XS signatories).

Population Size of XS Signatories	No.	Percentage on total XS Signatories
>= 5,000	1,121	26%
< 5,000	3,213	74%
<1,000	1,052	24%

Tab.1 XS CoM Signatories divided per population size

2. Commitment classes of the XS Signatories

The commitment chosen by XS Signatories are divided in 4 classes: 2020, 2020 & ADAPTATION, 2030 & ADAPTATION and 2020,2030 & ADAPTATION. First, 2020: towns, cities and regions voluntarily committed to reducing their CO_2 emissions beyond 20%, below 1990 levels, by 2020, describing mitigation actions in the SECAP template. Second, 2020 & ADAPTATION or 2030 & ADAPTATION: the initial greenhouse gas emission reduction commitment and integrating adaptation to climate change were strengthened by three pillars: mitigation (an at least 40% emission reduction target by 2030); adaptation to climate change; and secure, sustainable and affordable energy. The label ADAPTATION is related to the Mayors Adapt initiative, which supports local authorities to develop and implement local adaptation strategies. Third, 2020, 2030 & ADAPTATION: this class includes the signatories that signed up to CoM and strengthened their commitments to decreasing CO_2 emissions from 20% by 2020 to 40% by 2030 with the development and implementation of local adaptation strategies.

Among the 4,334 XS CoM Signatories, in September 2021 the 36% have a SECAP that couple the reduction of CO_2 emission reduction with the adaptation to climate change (see Tab.2). The remaining part (64%) is still stuck in CO_2 reduction of 20% by 2020, waiting an upgrade of the SECAP's strategies that improve the reduction of CO_2 and include the adaptation of climate-change.

Commitment	No.	Percentage on total XS Signatories
2020	2,763	64%
2020 & ADAPT	74	2%
2030 & ADAPT	949	22%
2020, 2030 & ADAPT	548	13%

Tab.2 XS CoM Signatories divided per commitment

3. Country of origin of the XS CoM Signatories

It is useful understand what the geographical distribution of the XS CoM Signatories is, counting for each population size and for each Country the number of XS CoM Signatories. The results coming out from the CoM database show that XS Municipalities are mostly concentrated in Italy (58%) and Spain (33%), and the two Countries together reach almost the whole of XS Signatories. This is representative of the high widespread to opt for European tools in planning - such as SECAP - in these Countries, opposite to institutional urban planning tools. In Tab.3 are reported for each CoM Country the number of Signatories divided per Population Size and the corresponding percentages related to XS CoM Signatories for each Country and the total XS CoM Signatories

Country	XS Signatories	Percentage of XS CoM Signatories per each Country	Percentage on the total XS CoM Signatories
Albania	0	0%	0.0%
Armenia	3	27%	0.1%
Austria	6	46%	0.1%
Azerbaijan	1	50%	0.0%
Belarus	1	5%	0.0%
Belgium	101	31%	2.3%
Bosnia-Herzegovina	4	13%	0.1%
Bulgaria	6	24%	0.1%
Croatia	30	45%	0.7%
Cyprus	9	38%	0.2%
Czechia	2	22%	0.0%
Denmark	2	6%	0.0%
Estonia	2	40%	0.0%
Finland	0	0%	0.0%
France	18	21%	0.4%
Georgia	0	0%	0.0%
Germany	2	3%	0.0%
Greece	20	14%	0.5%
Hungary	16	25%	0.4%
Iceland	0	0%	0.0%
Ireland	0	0%	0.0%
Italy	2,507	75%	57.8%
Kazakhstan	0	0%	0.0%
Latvia	5	24%	0.1%
Lithuania	0	0%	0.0%
Luxembourg	1	100%	0.0%
Macedonia	0	0%	0.0%
Malta	23	96%	0.5%
Mexico	1	33%	0.0%
Moldova	15	58%	0.3%
Montenegro	2	67%	0.0%
Netherlands	0	0%	0.0%
Norway	0	0%	0.0%
Poland	10	24%	0.2%
Portugal	34	29%	0.8%
Romania	19	28%	0.4%
Serbia	0	0%	0.0%
Slovakia	1	17%	0.0%
Slovenia	17	57%	0.4%
Spain	1,445	77%	33.3%
Sweden	9	16%	0.2%
Switzerland	1	11%	0.0%
Tajikistan	0	0%	0.0%
Turkey	0	0%	0.0%
Ukraine	21	13%	0.5%
United Kingdom	0	0%	0.0%

Tab. 3 XS Signatories classified by Country with related percentages on each Country and whole XS CoM Signatories

3. Estimation of road transportation emissions by main CoM official guidelines

The official CoM guidelines (P. Bertoldi, 2018; European Comission, 2010) propose a specific characterization of the road transportation emissions for BEI into two parts:

Urban road transportation, which includes road transportation on the local street network that is usually under the competence of the local authority;

Other road transportation, which includes road transportation in the territory of the local authority on the roads that are not under its specific competence. An example are highways that go through the municipal territory and are managed by specific national authorities; railways infrastructures.

These last one emission category can be included in the BEI if the local authority intends to include measures to reduce these emissions in the SECAP. Anyway, for the road transportation sector the data to be gathered is the amount of fuel consumed in the territory. Usually, the amount of fuel used is not equal to the amount of fuel sold. Indeed, for small Municipalities there are various reasons that support the previous quote such as the lack of the filling stations in that Municipality, different prices of fuels or modifications on fuel sales due to others factors. Also if Kennedy et al. (2009) have shown that use of fuel sales data is appropriate for cities for which the number of vehicle trips over the border of the city is small relative to the number of trips within the city, for small Municipalities this path may not reflect the effective CO_2 road emission to be address to local authority. Therefore, according to CoM official guidelines the estimation of the fuel used has to be based on:

- mileage driven in the territory of the local authority [km]
  The mileage driven (total amount of kms) on the street network of the local authority can be estimated on information of traffic flows and length of the municipal street network. Other common data sources are the transport department of the local authority, national or local street administration, household transport surveys (origin and destination surveys), private database on mobility in cities;
- vehicle fleet registered in the territory of the signatory local authority (cars, buses, two-wheelers, heavy and light-duty vehicles);
- average fuel consumption of each vehicle type [l fuel/km]
  Average fuel consumption of each vehicle category is related to several factors such as engine supply, age or driving cycle. A source of these data could be local or national auto clubs to perform data on the local level. Use of national level average fuel consumption for each vehicle category may produce not detailed estimates, in particular for urban areas.

Data for each fuel type and vehicle category can be estimated by the following equation (1):

$$\text{Fuel used in road transportation [KWh]} = \text{mileage [Km]} * \text{average consumption } \left[\frac{\text{l}}{\text{Km}}\right] * \text{conversion factor } [\frac{\text{KWh}}{\text{l}}] \quad (1)$$

The most typical conversion factors used come from European Environmental Agency or Intergovernmental Panel on Climate Change(European Enviromental Agency, 2019; Intergovernmental Panel on Climate Change, 2006). Usually, on the basis of the estimation of "Fuel used in road transportation" the CO_2 emissions are computed according to the emission factors described as follows.

There are two different approaches to compute CO_2 emissions using "standard" emission factors in line with the Intergovernmental Panel on Climate Change (IPCC) principles; or using LCA (Life Cycle Assessment) emission factors.

Standard emission factors cover all the CO_2 emissions that occur due to energy consumption within the territory of the local authority, either directly due to fuel combustion within the local authority or indirectly via fuel

combustion associated with electricity and heat/cold usage within their area. This approach takes into account that CO_2 is the most important greenhouse gas, and the emissions of CH_4 and N_2O do not need to be calculated. The standard emission factors according to CoM guidelines (P. (editor) Bertoldi, 2018; European Comission, 2010) are based on the IPCC 2006 Guidelines (Intergovernmental Panel on Climate Change, 2006). The tons of CO_2 emitted are computed using the following equation (2):

$$\begin{aligned} &\mathrm{CO_2\ \ emissions\ [ton]} \\ &= \mathrm{IPCC\ standard\ emission\ factor}\left[\frac{\mathrm{CO_2}}{\mathrm{ton}}\right] * \mathrm{\ fuel\ consumption\ [ton]} \end{aligned} \tag{2}$$

LCA (Life Cycle Assessment) emission factors, take into consideration the overall life cycle of the energy carrier. This approach includes not only the emissions of the final combustion, but also all emissions of the supply chain. It includes emissions from exploitation, transport and processing (e.g. refinery) steps in addition to the final combustion. This hence includes also emissions that take place outside the location where the fuel is used. In this approach, other greenhouse gases than CO_2 may play an important role. LCA emission factors are based on a European Reference Life Cycle Database (ELCD) developed by the Joint Research Centre and are available online. Therefore, the local authority that decides to apply the LCA approach can report emissions as CO_2 equivalent. Equivalent tons of CO_2 emitted are computed using the following equation (3):

$$\begin{aligned} &\mathrm{CO_2\ Equivalent\ \ emissions\ [ton-eq]} \\ &= \mathrm{LCA\ emission\ factor}\left[\frac{\mathrm{tCO_2-eq}}{\mathrm{MWh}}\right] * \mathrm{\ fuel\ consumption\ [MWh]} \end{aligned} \tag{3}$$

4. An outlook on CO_2 estimation approaches for "Transport" sector in XS CoM Municipalities

The computation of the CO_2 emissions from the transport sector derives from multiple components: public, private, commercial and other. The authors focus on the different approaches adopted to estimate the consumption from the private component of transport, considering that this component is not easily evaluable as public one and it represents a considerable weight among the overall CO_2 emissions from transport sector. The methods to estimate the CO_2 emissions selected from the XS CoM Municipalities are heterogeneous, but some clusters could be recognized. On this track, the authors have gathered some experiences deriving from European XS CoM Municipalities. In tab.4 have been highlighted the main features, pros and cons, of each country, dealing with transport-based CO_2 emissions.

Belgium

Burdinne, Martelange and Rouvroy municipalities have used to compute transport consumption the data provided by FPS MT (the Belgian Society of Transport). So, in this case, a national company provided official data suitable for SEAP elaboration. In particular, consumption data have been computed taking into account the petroleum sales, the traffic share in 2000 and 2005 evaluated by the FPS MT and the different driving modes of motorists related to the different road typology. Petroleum sales have been derived from petroleum sales of gas stations since 1990. Data related to the distribution of traffic share has evaluated by FPS MT for each municipality as the vehicles*kilometers travelled on the roads, in 2000 and 2005 considering the distribution of traffic on the municipal road network and the motorway network at provincial and regional level. In order to be coherent with the context, data related to transport have been revised taking into account only the specific traffic amount of the single municipality. Traffic on national or provincial roads crossing the Municipality have been excluded from the computation of transport consumption.

Malta

Gharb Municipality is an enclosed town and has a single major entry and exit point (only one road allowed the accessibility to the whole municipal territory). The absolute majority of the internal transit is due to vehicles arriving and departing from the town and the intervillage transit is very low. The values for private transport consumption were estimated using figures provided by National Statistics Office for vehicle ownership in the town. An average mileage through the village was estimated and this provided the total mileage travelled through the town per annum. It was assumed that all commercial vehicles operated on diesel fuel while a mix of diesel and gasoline is used for other private vehicles.
Qala and Ta' Xbiex Municipalities have performed an analysis of the vehicle stock for the baseline. Thus, a fuel consumption weighting factor has been assigned to each type of vehicle based on the engine capacity and estimated activity. From this, the annual energy consumption and CO_2 emissions allocated to the locality have been calculated.

Macedonia

Kolasin and Zabljac Municipalities have assessed their energy consumption for the transport sector considering data coming from different local sources such as the traffic conditions of the Municipality were deducted from registered documents of European Agency for Reconstruction; the energy consumption at national level were collected from the 2006 National Energy
Strategy for Development; fuel sales at local fuel stations within the municipality were gathered through interviews; distances between locations were calculated during the surveys; other data were assumed based on interviews with the municipal staff, the team’s experience and reliable forecasts. The emission factors for the vehicles and the heating values of the fuels were taken from the World Resources Institute (WRI) guide of the GHG Protocol. In this case, in absence of a specific data source the estimation is based on the integration of different sources of information.

Italy

Roccaraso, Lucoli and Caprariva del Friuli Municipalities have chosen to start from the data on provincial sales of fuels (petrol, diesel, LPG) obtained from the Ministry of Economic Development. Dividing these values by the number of petrol, diesel and LPG vehicles registered in the province, they obtained the data relative to the "2005 vehicle fleet" - ACI sales of the three fuels per vehicle [litres/vehicle] in the provincial territory.
The distinction of passenger cars by fuel was obtained by assuming a constant percentage distribution by fuel type at provincial level for all municipalities.
Multiplying the value of provincial sales per car of the three fuels each by the respective number of cars in the municipality we obtain, for the three energy vectors considered, the quantity of fuel for private transport in the municipality. Only at this point is it possible to take into account the number of kilometers travelled on the roads for which the local authority is responsible, multiplying the value of consumption [liters], which has just been obtained, by the share relative to the number of kilometers travelled on the urban network, thus excluding the percentage of kilometers on the motorway network. Finally, the emission factors (in those cases the IPCC ones) were used to obtain the CO_2 tons emitted by private transport.
Brogliano Municipality choose a top-down approach starting from provincial and regional emission data. The public database chosen is "Inemar-Veneto" where are collected data for vehicle type (cars, light vehicles, heavy vehicles, mopeds and motorbikes), road type (urban and suburban) and fuel type (car, light vehicle, heavy vehicle, moped and motorbike).
Despite the fact that estimation of fuel consumption is affected by different level of uncertainty for the private component of transport sector, all selected approach from XS CoM Municipalities show a common baseline

based on the investigation of the vehicle fleet provided by the National Agencies. However, the approach chosen by Italian and Maltese XS Municipalities seems to be more reliable while Macedonian approach depends on multiple estimation hypothesis that could provide a final estimation amount far from the local reality; the Belgium case is characterized by the availability of a national structured database delivered by a qualified authority that simplify the estimation process producing comparable results in different application cases.

Country	Pros	Cons
Belgium	Transport consumption provided by a National Society of Transport and based on different driving modes of motorists related to the different road typology	Petroleum consumption derived from petroleum sales of gas stations and exclusion of the traffic on national or provincial roads crossing the Municipality
Malta	Consumption estimated using figures provided by National Statistics Office for vehicle ownership	Fuel consumption weighting factor assigned to each type of vehicle based on the engine capacity and estimated activity
Macedonia	Traffic conditions of the Municipality were deducted from registered documents of European Agency for Reconstruction while energy consumption at national level were collected from the 2006 National Energy	Fuel sales at local fuel stations within the municipality and other data were assumed based on interviews with the municipal staff, the team's experience and reliable forecasts
Italy	Data about fuel consumption and vehicle fleet retrieved from National Agencies	Uncertainty about the distinction of passenger cars by fuel and assumption of a constant percentage distribution by fuel type at provincial level for all municipalities

Tab. 4 Pros and cons, of each country, dealing with transport-based CO_2 emissions

5. A computational proposal for the estimation of the CO_2 emissions for the transport sector

The official CoM guidelines define how compute the fuel used in road transportation starting from detailed data, but for the small Municipalities often these data are not accessible or not easy to collect. Therefore, the authors have developed a computational proposal for the CO_2 emission of the transport sector, based on the fuel consumption using some specific databases available in Italy. The database examined are:

- sales related to the annual oil consumption and the major oil products of the internal market, provided by the Italian Ministry of Ecological Transition. These data are divided for each Italian Province, specifying also the monthly sales;
- vehicle fleet (cars, buses, two-wheelers, heavy and light-duty vehicles) in the territory of the Municipality and its Province searching on the Italian National Automotive Club (ACI) database;
- number of resident inhabitants in the Municipality and its Province searching on the Italian National Institute of Statistic (ISTAT).

The computational proposal is structured as follows:

1. the annual oil consumption per Province is divided for the number of vehicles per Province. The result is the fuel consumption expressed as the number of the fuel tons per Province vehicle;
2. ACI provides the vehicle fleet for each Italian Municipality but it does not classify the vehicles by type of power supply. Therefore, starting from the Province classification of the vehicle fleet has computed the percentage of the vehicles divided per class (cars, buses, two-wheelers, heavy and light-duty vehicles) and type of power supply (gasoline, gasoline & lpg, gasoline and natural gas, diesel, lpg, electric). This percentage has been considered constant for each Municipality inside the Province;
3. the percentages of the vehicles divided per class and type of power supply have been multiplied by the number of vehicles of the Municipality. The result is the number of the vehicles classified for each class and type of power supply;

4. the fuel consumption per Province vehicle is multiplied by the number of the vehicles classified for each class and type of power supply. The result is the fuel consumption for each Municipality classified per type of power supply;
5. the fuel consumption is multiplied by the CO_2 emission factors developed by Institute for Environmental Protection and Research (ISPRA) (Romano et al., 2018) in order to achieve the tons of CO_2 emitted for each type of power supply and for each class of vehicles.

The overall computational process is presented in Fig.2

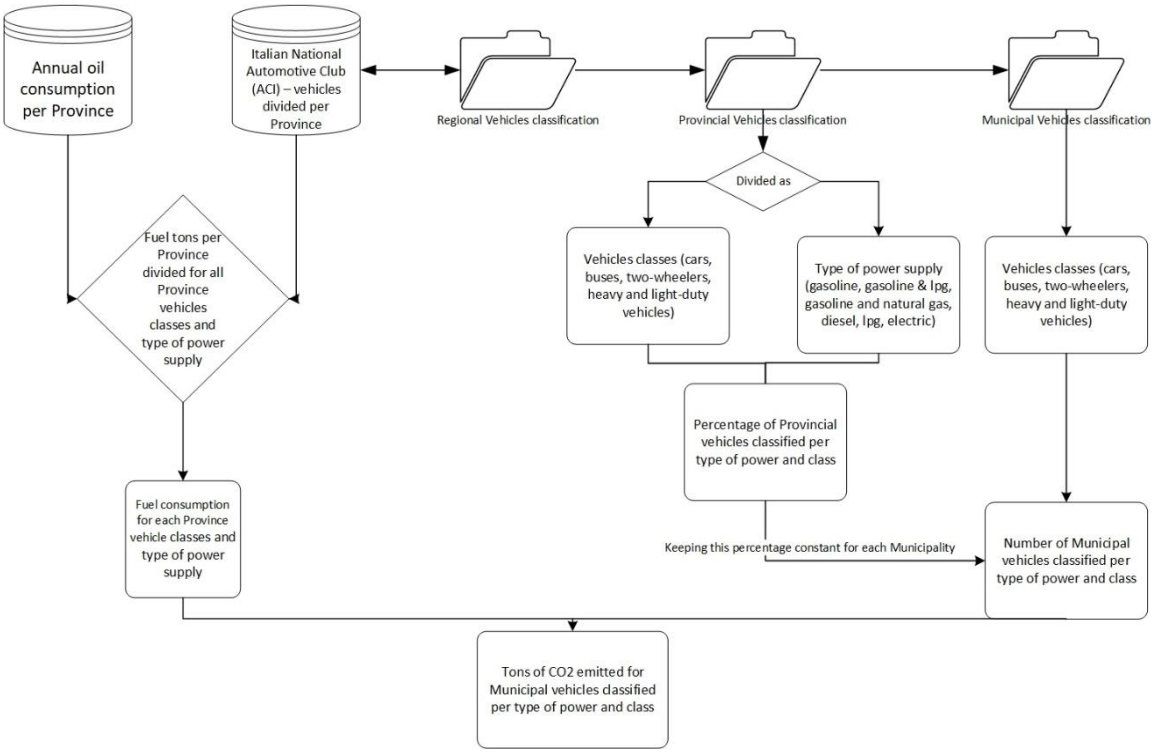

Fig.2 Computational process

Additionally, some private databases (db) can be used to add a meaningful check-step to the proposed methodology: UnipolSai and ACEA.

The first was developed in 2018 by the Italian insurance company UnipolSai, the second was developed in 2019 by European Automobile Manufacturers' Association (ACEA).

UnipolSai database is structured on the data coming from the black-box installed on the cars insured by the company so a small but relevant share of the total vehicles), and data are disaggregated per Italian Regions, Provinces and regional capital cities. Additional information regards some interesting features regarding the driving behavior such as days of car's usage, time spent driving or Km driven per year or per day. A technical report is available: "UnipolSai observatory on the driving habits of Italians" (UnipolSai, 2019).

It is possible to exploit this data to compute the CO_2 emissions per year in the case study region according to the equation (4):

$$\begin{aligned} &\mathrm{CO_2\ emissions\ [ton]} \\ &= \mathrm{CO_2\ average\ emission\ factor}\left[\frac{\mathrm{ton CO_2}}{\mathrm{Km}}\right] * \mathrm{Km\ driven\ (UnipolSai)} \\ &* \mathrm{no.\ of\ total\ \ cars(methodological\ proposal)} \end{aligned} \quad (4)$$

The CO_2 average emission factor comes from the Institute for Environmental Protection and Research (ISPRA) using the COPERT methodology. We compared this estimation with the results of previous approach.

The European Automobile Manufacturers' Association (ACEA) is the advocate for the automobile industry in Europe, representing the 16 major manufacturers of passenger cars, vans, trucks and buses with production sites in the EU. Each year, ACEA publishes its Automobile Industry Pocket Guide (ACEA 2020) in order to provide a complete overview of EU auto industry, as well as data on the production, sales, international trade and taxation of motor vehicles. Among the data published, ACEA provides the average CO_2 emissions of new passenger cars by each EU country. Thus, using ACEA CO_2 average factor and Km driven per year provided by UnipolSai it is possible compute CO_2 emissions according to equation 4 obtaining a second comparative estimation to check the results of the proposed methodology.
In the following paragraph the application of the proposed methodology on a specific case study area is described.

6. The case study of Castelsaraceno Municipality

Castelsaraceno Municipality, is a "small" Municipality with 1,274 inhabitants of the South of Italy, in Basilicata Region. This Municipality signed up to CoM in 2012, then has developed its SEAP (Sustainable Energy Action Plan) and the Monitoring Report, and now is engaged on the new CoM with the elaboration of the SECAP. Castelsaraceno Municipality represents a relevant case study because it is representative of XS CoM Municipality, it is located in an inland area of Basilicata Region and the only transport infrastructure of the territory is the road network (see Fig.3), thus the CO_2 emissions for the transport SECAP sector has to be related only to the vehicle transport.

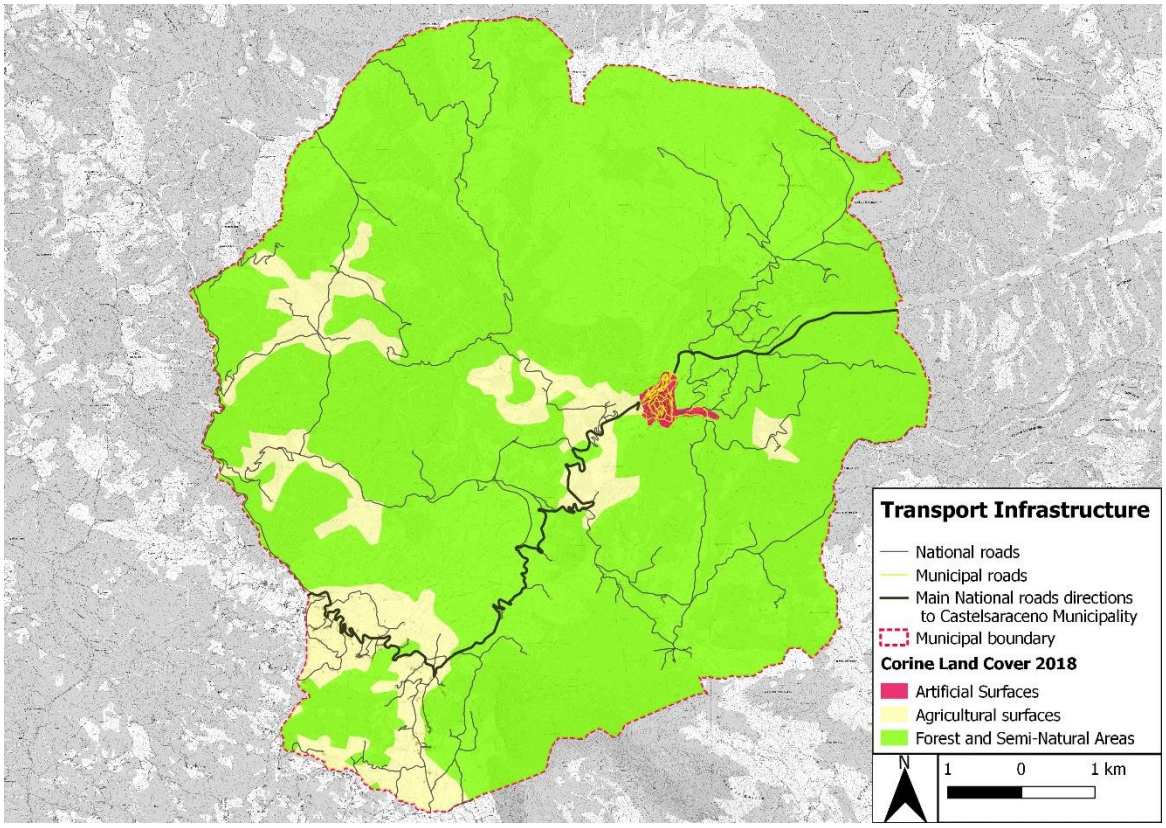

Fig.3 Transport infrastructure and Land Use data of Castelsaraceno Municipality

Furthermore, the Municipality recently realized a tourism attraction according to a tourism development strategy (Fistola et al., 2019; R. Papa & La Rocca, 2017): since in August 2021 "The world's longest Tibetan bridge" (see Fig.4) operates in Castelsaraceno. The bridge links two National parks (Pollino and Appennino Lucano Val d'Agri Lagonegrese National Parks) and, as a direct consequence the tourists flow exponentially

increased up to a number of the daily presences that only on the August 2021 rises up to 30,500 with a monthly number of tickets sold for the Tibetan bridge of 11,000.

Fig.4 The Tibetan bridge of Castelsaraceno Municipality, the world's longest with a length of 586 m

This huge amount of tourism presence represents a relevant source of CO_2 emission due to the vehicles transit connected to the tourism flow. Therefore, in the SECAP framework. We affirm that, according to this new scenario, it is necessary to design a tool to compute the transport sector CO_2 emissions related to two emission stocks (ESs):

1. a constant emission stock (ES) given by the vehicle fleet of the Castelsaraceno inhabitants;
2. a variable ES given by the tourist flow.

These issues may also be a recursive condition for many XS Municipalities where the presence of attractive natural and cultural heritage generates seasonal tourism accompanied with a relevant share of energy consumption that has to be appointed in the process of SECAP elaboration. According to this, specific actions have to be included in order to mitigate/reuse such CO_2 emission sources: an interesting domain for the elaboration of sustainable tourism development strategies.

The fuel consumption and the resulting CO_2 emissions related to the vehicle fleet of the Castelsaraceno inhabitants are obtained using the computational process explained in section 5. The vehicle fleet classified by power engine of Potenza Province have been imported by Italian National Automotive Club and referred to 2019 (see Tab.5).

Vehicle fleet of Potenza Province

	G	G & LPG	G & CNG	Electricity	D	Hybrid G	Hybrid D	Others	NC
Number of vehicles	121,249	12,766	5,575	68	175,966	358	92	2,181	8

Tab.5 Number of Potenza Province vehicles classified by power engine The abbreviation used for the power engine are the following: G=Gasoline, G & LPG =Gasoline and Liquefied Petroleum Gas, G & CNG = Gasoline and Compressed Natural Gas, D =Diesel, Hybrid G =Hybrid Gasoline, Hybrid D = Hybrid Diesel, NC Not Classified

In Tab.6 have been counted the vehicles for Castelsaraceno Municipality classified for power engine and Euro classification. From computation have been excluded the Electricity, Hybrid Gasoline and Hybrid Diesel cars

for Castelsaraceno Municipality due to their low percentages (under 1%) related to the whole vehicle fleet of Potenza Province.

Vehicle fleet of Castelsaraceno Municipality

	Cars [No.]				**Light-duty vehicles [No.]**				**Heavy vehicles [No.]**			
	G	D	G & LPG	G & CNG	G	D	G & LPG	G & CNG	G	D	G & LPG	G & CNG
Euro 0	99	24	6	1	13	0	0	0	16	1	0	0
Euro 1	27	11	2	0	3	0	0	0	13	1	0	0
Euro 2	70	43	4	1	3	0	0	0	12	1	0	0
Euro 3	59	102	2	1	3	0	0	0	14	0	0	0
Euro 4	48	120	11	3	1	0	0	0	4	0	0	0
Euro 5	19	78	5	4	1	0	0	0	4	0	0	0
Euro 6	24	53	8	5	0	0	0	0	1	0	0	0
Subtotal	345	431	39	15	23	0	0	0	63	4	0	1
Total		831				23				68		

Tab.6 Vehicle fleet of Castelsaraceno Municipality classified per power engine and EURO classification

The two-wheelers have been considered powered by gasoline and collected in Tab.7.

Two-wheelers of Castelsaraceno Municipality

Euro Classification	Euro 0	Euro 1	Euro 2	Euro 3	Euro 4
Number of two-wheelers	17	6	6	16	2

Tab.7 Two-wheelers of Castelsaraceno Municipality

According to computational process in Tab.8 have been collected the fuel consumption for each class of vehicles takes into account for Castelsaraceno Municipality.

Fuel consumption of Castelsaraceno Municipality [tons]

Vehicle class \ Engine power	Gasoline	Diesel	LPG
Cars	82	335	14
Light-duty vehicles	0	18	0
Heavy vehicles	1	49	0
Two-wheelers	11	-	-
Total		510	

Tab.8 Fuel consumption of Castelsaraceno Municipality

In order to compare the results with the tCO_2-eq suggested by the SEAP of Castelsaraceno Municipality, the CO_2 emissions have been computed according to LCA approach.
Final tCO_2-eq emissions have been computed according to Equation 3 and collected in Tab.9

CO_2 transport emissions of Castelsaraceno Municipality [tCO_2 eq]

Vehicle class \ Engine power	Gasoline	Diesel	LPG
Cars	301	1,130	71
Light-duty vehicles	0	60	0
Heavy vehicles	3	163	0
Two-wheelers	41	-	-
Total		1,769	

Tab.9 TCO_2 emissions for the transport sector of Castelsaraceno Municipality

In Tab.10 have been compared the CO_2 emissions of Private and commercial transport Sector collected for the 2013 SEAP to the results from author's proposal.

CO_2 transport emissions of Castelsaraceno Municipality [tCO_2 eq]

Private and commercial transport \ Engine power	Gasoline	Diesel	LPG	Total
2013 SEAP	1,176.03	1,793.57	65.19	3,035
Results from authors' proposal	345	1,353	71	1,769

Tab.10 Comparison among total CO_2 transport emissions of Castelsaraceno Municipality

The differences between the total CO_2 emissions are nowhere near to 50%, a remarkable amount compared to data available of the 2013 SEAP. This demonstrate how variable can be the results of the estimation depending on the adopted methods. In this case the previous SEAP adopted a simplified approach based on annual Kms estimated at municipal level on the basis of national medium data. The proposed approach is more related to specific municipal data and thus allow to have a more reliable picture of the vehicle emission according with the specific characteristics of the registered private fleet. Those relevant differences may generate huge overestimation of mitigation actions that in the case of public investments could also bring to an over expenditure of funds without achieve expected CO_2 reduction effects.
In order to check the results (see Tab. 11), it was applied the Equation 4 adopting the CO_2 average emission factors proposed by UnipolSai and ACEA and the number of the private cars of Castelsaraceno inhabitants. (see Tab.10)

CO_2 emissions by cars of Castelsaraceno Municipality

Database	CO_2 average emissions [gCO_2/Km]	Km driven	2019 tCO_2 emissions
UnipolSai	166	12,812	1,767
ACEA	119.4	12,812	1,271

Tab.11 CO_2 emissions by cars of Castelsaraceno Municipality according to UnipolSai and ACEA methodology

The CO_2 emissions from cars computed using the methodological proposal (1,769 tCO_2 eq.) are quite similar to the UnipolSai benchmark while for the ACEA, there is a difference of 28% from the methodological proposal. This represents good reliability of the methodological proposal, but it is limited only to a single class of vehicles in the Municipality. The evaluation of the variable emission stock given by the tourist flow becomes necessary considering that the number of arrivals to Castelsaraceno. The available data counts only for the month of August 2021 over 30,000 presences.
On the basis of this single information we developed a basic forecasts about the trend of annual arrivals (not only from Italy but also from several EU Countries) according to some specific hypothesis: to account for the

numbers of booked tickets provided by the Tibetan bridge website for the months September, October 2021; the prevision of 6 months of Tibetan brings yearly operation as it represents a form of open-air activity and it is conditioned by seasonal weather conditions; an increasing trend of arrivals due to the effectiveness of the tourism attractor.

This scenario suggests an increase of the CO_2 emissions amount from the transport sector of Castelsaraceno, and it requires monitoring reports about the CO_2 emissions from vehicles flows in order to pursuit sustainable goals and achieve the reduction of 40% of CO_2 emissions according to the CoM objectives.

Thus, we provided a first assessment of the CO_2 emissions on the data about arrivals provided by the Castelsaraceno Municipality through the database provided by UnipolSai and ACEA for cars and European Environmental Agency (EEA) for buses. In this first assessment, we consider only transports inside the Municipal territory with a hypothesis on vehicles and roads typology because of now more accurate information are not available.

Hypothesis of presences in Castelsaraceno Municipality			
Month	Presences	Car Arrivals	Bus Arrivals
May	5,338	1,201	12
June	10,675	2,402	25
July	21,350	4,804	50
August	30,500	6,863	71
September	4,000	900	9
October	1,000	225	2

Tab.12 Hypothesis of presences and arrivals by car and bus to Castelsaraceno Municipality

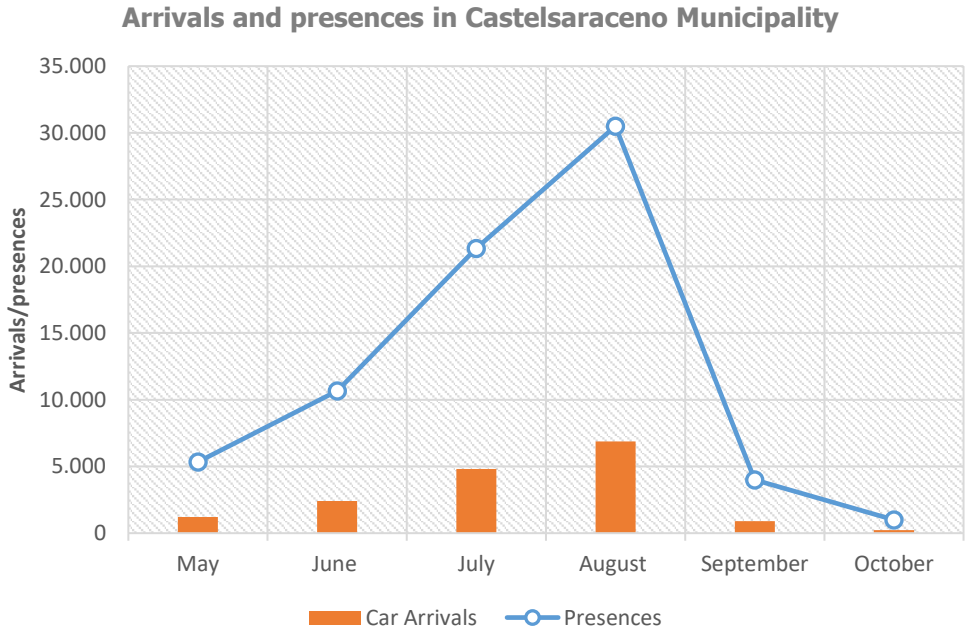

Fig.5 Graph of the Hypothesis of presences and arrivals by car to Castelsaraceno Municipality

Data used are as follows:

- The vehicles considered are cars and buses. The number of car seats considered are 4 while for the buses the seats are the 80% on a total of 54, according to the Italian Ministry of Transport measures against the Covid-19;

- Km driven on the roads are equals to the total measure of the length of National and Municipal roads inside the Municipality, according to the directions for arrival suggested to Castelsaraceno on Tibetan bridge website.

Number of arrivals to Castelsaraceno has divided into two groups, 90% of them has arrived to Castelsaraceno by car and 10% by bus. According to this hypothesis 71 buses and 6,863 cars arrived for the August 2021. The choice of the high percentage related to the arrivals by cars is based on the preference of Italian people to use car as main transport vehicle highlighted by the 2020 annual report by ISFORT acronym for High Institute for Transport Education and Research, that support the development of the technical knowledge and to the public debate about mobility and logistics in Italy. The complete trend for the months considered (from May to October) is presented in Tab.12 and in Fig.5.

In order to compute the variable ES of CO_2 by tourism flow and without the availability of detailed data the proposed methodology has been simplified. The car arriving to Castelsaraceno have been distinguished (see Tab.13) by power engine according to relative percentages suggested by the annual report of the Italian Automobile Club and relative CO_2 ES has been computed using data available on database of average emission factors for road transport in Italy elaborated by Italian National Institute for Environmental Protection and Research (ISPRA).

ES of CO_2 by tourism flow in Castelsaraceno Municipalities

Vehicle class \ Engine power and CO_2 emissions	Gasoline [No.]	Diesel [No.]	Total ES [tCO_2 eq]
Cars	9,181	7,214	109
Buses	-	170	5
Total	9,181	7,384	114

Tab.13 ES of CO_2 by tourism flow in Castelsaraceno Municipalities

In Tab.14 they have been collected the CO_2 emissions by tourist cars and buses computed using the benchmark provided by the EEA's annual Transport and Environment Reporting Mechanism (TERM) report (EEA, 2014).

Variable CO_2 ES by tourist flow of Castelsaraceno Municipality

Database	CO_2 average emissions [gCO_2/Km]	Total Km driven	Total CO_2 ES on tourism period (May-October)
UnipolSai (for cars)	166	40	109
ACEA (for cars)	119.4	40	78
EEA (for buses)	230	40	2

Tab.14 CO_2 emissions by touristflow of Castelsraceno Municipality

Combining the results UnipolSai & EEA and ACEA & EEA, promising evidences come out from the comparison between them and the total ES of Tab.13. The differences from the results of Tab.13in term of total ES CO_2, are only about 0.03% for the UnipolSai & EEA while for ACEA & EEA are about 30%; they are remarkable results considering that the proposed methodology has been simplified and the data used are based on national data without more specifications at local level.

Finally, the overall CO_2 ES of Castelsaraceno Municipality is equal to 1,883 tCO_2 (see Fig.6); in this amount the variable ES represents a relevant percentage considering the scenario of the CO_2 emissions growth from

the transport sector of Castelsaraceno related to tourism flow, and it requires the planning of measures in order to pursuit sustainable goals, according to the current EU2030 targets.

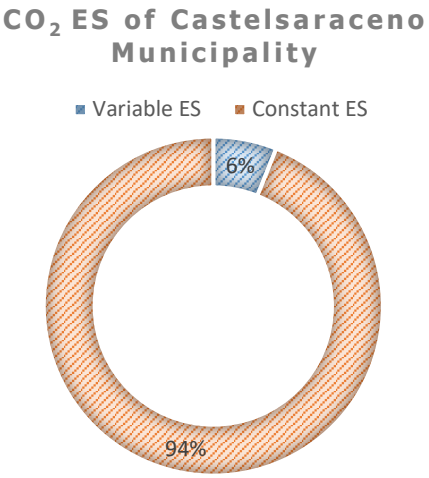

Fig.6 The overall CO_2 ES of Castelsaraceno Municipality

7. Conclusions

XS Signatories are representative of a wide share of EU Municipalities belonging to the EU lagging regions where urban development represents a challenge both in terms of demand for investments and new tools to boost effectively local development strategies(Casas et al., 2014; de Gregorio Hurtado et al., 2015). The EU 2030 strategies required the same commitments both to medium and large EU cities and small municipalities but the gap of capacities is evident (technical skills, funds availability, private in investments etc.). in terms of numbers it is possible to highlight a widespread success of the CoM policies for EU small Municipalities and both SEAP and SECAP had been intended as alternative planning instruments for the management of energy and climate investments and transformations in the urban areas (Santopietro & Scorza, 2021).

Previous researches (Campagna et al., 2018; Campagna & Deplano, 2004; Lai et al., 2019; Santopietro et al., 2020; Santopietro & Scorza, 2020; Scorza et al., 2017) remark the fruitful aspect of the sectorial approach, facing the climate-change, however the cities should not be considered by sectors but by set of systems (Rocco Papa et al., 2015)(such as green spaces, green infrastructures (Gargiulo et al., 2018; Lai et al., 2018, 2021) waterproofed soils, energy system (Scorza, 2016) , active mobility (Fortunato et al., 2020; Scorza et al., 2021; Scorza & Fortunato, 2021) etc..). Among these aspects, this paper focused specific issues connected to the procedure for the estimation of CO_2 emissions from transport sector in small Municipalities. The proposed approach organizes an analytical framework based on data available in main national databases (in Italy but also in other EU Countries), not asking specific additional technical specifications; providing reliable estimation base on Constant and Variable Emissions Stock (ES). The case study highlighted how the contribution of tourism arrivals has to be included in the SECAP BEI as private transport components of CO_2 emissions. This is a recurrent condition for XS Municipalities where are based tourism attractors (environmental, Historical, cultural, etc.). Traditionally, Small XS Municipalities do not include in the computation of CO_2 emissions those generated by tourist flows.

This is the case of the Castelsaraceno, a small XS Municipality where the construction of a tourist attraction produced a surplus in terms of CO_2 transport emissions. Considering the growth of the number of the vehicles travelling inside the Municipality, compensatory and mitigation measures should be taken into account for effective SECAP implementation: limitation of the automotive traffic inside the urban area, implementation or strengthening of the greenways, promoting sustainable mobility (Scorza et al., 2021; Scorza & Fortunato, 2021; Vinci & Cutaia, 2019), etc. Specific actions or measures can be implemented on the carbon-tax model

in order to provide funds for mitigation actions oriented to a local application of the sustainable territorial development principles (European Commission, 2016; Garau & Pavan, 2018; Las Casas et al., 2019; Las Casas & Scorza, 2016; Pilogallo & Scorza, 2022; Pontrandolfi & Scorza, 2016) and climate adaptation/mitigation(Zucaro & Morosini, 2018).

The computational proposal is oriented to give to Municipalities a concrete guideline to easy perform this assessment suggesting a way to upgrade and check the current SEAP/SECAP transport sector emission estimations adopting consequent measures both in policymaking and urban/territorial actions.

Limitations of the approach depends on the necessity to testing multiple cases the working hypothesis described in this research also selecting not Italian case studies in order to verify the availability of national and European data sources and eventual adjustments to reinforce the transferability of the approach.

Future developments are oriented to integrate these results with all emissions sectors required by SECAP in according with recent methodological framework (Scorza & Santopietro, 2021) oriented to include systemic approach in SECAP development promoting the principle of integration against sectorial disaggregation.

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Image Sources

Fig.1: Retrieved from the article published on International Council of Clean Transportation website, 9th April 2021:

https://theicct.org/blog/staff/eu-carbon-budget-apr2021

Fig.2,3,4,5,6: Authors

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 25-47
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/8841
Received 5th January 2022, Accepted 5th April 2022, Available online 30th April 2022

www.tema.unina.it

Mountain tourism facing climate change. Assessing risks and opportunities in the Italian Alps

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Abstract
The Alps are an interesting case for studying the relationship between tourism and climate change. Despite a growing number of studies, the impacts of climate change on the tourism sector remain uncertain, when the regional and local scale or seasonality are considered. This article presents a risk methodology to assess the spatial distribution of the main challenges and opportunities for winter and summer tourism due to climate change at the sub-regional level on a 2021-2050 scenario. This methodology has been tested on an Italian Alpine area, which consists of very different landscapes from plain to high mountains. The results show that high-altitude municipalities will face the stronger risks for winter touristic activities, due to reduced snow cover duration, but also opportunities to attract in summer tourists escaping from the hotter temperatures of the plain. At the same time, climate change could have secondary negative effects in these areas, as it will increase the frequency and the magnitude of extreme events. The results show that impacts of CC cannot be generalised, even in a limited area; same hazards due to changes in temperature and precipitation patterns can generate very different risk scores, because of local conditions related to exposure and vulnerability factors.

Keywords
Climate change; European Alps; Tourism; Risk; Seasonality; Vulnerability.

How to cite item in APA format
Pede, E.C., Barbato, G., Buffa, A., Ellena, M., Mercogliano, P., Ricciardi, G., Staricco, L. (2022). Mountain tourism facing climate change. Assessing risks and opportunities in the Italian Alps. *Tema. Journal of Land Use, Mobility and Environment*, *15* (1), 25-47. http://dx.doi.org/10.6092/1970-9870/8841

1. Introduction

The academic debate on the relationship between tourism and climate change has grown dramatically in the last twenty years and has become a distinct branch of knowledge (Ali, 2016; Becken, 2013). The carbon footprint of the tourism sector accounts for about 8% of global greenhouse gas emissions (Lenzen et al., 2018). At the same time, tourism is one of the human activities which have been and will be more threatened by climate change (Mora et al., 2018), either because of its direct effects such as variations in temperatures and precipitations (Wilkins et al., 2018), but also due to secondary effects such as the increase in frequency and extent of natural disasters (Rosselló et al., 2020).

The European Alps are an interesting case study within the relationship between tourism and climate change. In fact, the Alps have been identified as one of the most vulnerable areas to impacts of climate change in Europe (Hock et al., 2019). In recent decades, the impacts of observed climate change have been of different types and intensity (IPCC, 2022), and a significant further intensification of climate change is predicted by the major climate models for the coming decades in terms of increased temperatures, intensity and variation of seasonal precipitation, elevation of minimum snowfall and ice retreat (Ballarin-Denti et al., 2015). These trends are foreseen to have relevant impacts on tourism, which plays a crucial role in the economy of this region (Agrawala, et al., 2007).

Despite a growing number of studies in the field, the impacts of climate change to the Alpine tourism sector remain uncertain, especially when at the regional and at the local scale (Pütz et al., 2011; Steiger et al., 2020) when seasonality is taken into consideration (Serquet & Rebetez, 2011). In addition, the Alpine region includes areas that are extremely heterogeneous – even over a very short distance – in terms of elevation, landscape, socio-economic and environmental systems, etc. Therefore, the touristic attractivity of these areas can be affected by climate change to a very different extent, especially when distinguishing between winter and summer tourism (Pröbstl-Haider et al., 2015).

For these reasons, this article presents a spatial risk methodology to assess the main challenges for winter and summer tourism to climate change at the sub-regional level. This methodology used as a case study the so-called Homogeneous Zone of Pinerolo (HZP), which is characterized by very different landscapes, from flatland to high mountains. The results achieved as well as the methodology here implemented could be used as a spatial decision support system for public administration and local stakeholders to identify where winter and summer tourism is most threatened (or favoured), and which adaptation measures need to be implemented to face these expected risks.

Section 2 describes the literature state-of-the-art in relation to the impacts of climate change on the Alpine tourism. Section 3 introduced the case study, while Section 4 focuses on the analytical methods adopted to estimate the present and future climate, by explaining in depth which climate indicators have been used to determine not only the observed anomalies, but also the future trends (2021-2050). Section 5 presents and discusses the main results and, finally, a concluding session explores the implications and possible uses of the proposed research in terms of climate change adaptation policies for tourism.

2. Literature review

2.1 Climate trends and expected hazards in the Alps

The European Alps have experienced significant damages from climate change in the last decades, and further intensifying of these trends is foreseen by regional climate projections by the end of this century (Gobiet & Kotlarski, 2020). During the 20th century, the Alps registered increases in minimum temperatures of up to 2°C, and a more modest increase in maximum temperatures. This trend was particularly strong after the mid 1970s, and since mid 1980s warming observed in the Alps has been about three times higher than the global average, particularly in summer and spring seasons (Auer et al., 2007; Beniston, 2005; Ceppi et al., 2012). In

a comprehensive review of climate projections for the Alps, Gobiet et al. (2014) explained how a warming of 1.5°C is expected in the first half of the 21st century, compared to the reference period 1961–1990. This trend is supposed to increase up to 3.3°C in the second half. With regards to precipitations, changes have been subject to larger uncertainties and varied greatly from region to region. In relation to the future, the annual precipitation are expected to remain rather constant, while winter precipitations are expected to increase. The most negative consequences on precipitation pattern are expected within summer, but changes are possible due to the model uncertainty range. Nevertheless, extreme precipitation events are expected to intensify in all seasons (Gobiet et al., 2014). It is also important to highlight that long-time range projected changes considerably depend on the greenhouse-gas scenario under consideration. Specifically, the most prominent changes are associated to the worst Representative Concentration Pathway (IPCC, 2014a), the RCP8.5 scenario, by the end of the 21st century, while in relation to the mid-century these impacts are expected to vary slightly depending on the selected scenario (i.e., RCP4.5 or RCP8.5) (Gobiet & Kotlarski, 2020). Looking at the snowfall phenomenon, a reduction of 36% in winter it is expected, with a complete disappearance below 500 metres of altitude (EEA, 2009). On the contrary, extreme events are expected to intensify, particularly in the fall season (Rajczak et al., 2013).

These past and future climatic changes in temperatures and precipitations directly affected the comfort conditions for tourism, but they also have serious side effects. In fact, together with accelerated retreat in glacier cover and permafrost, these phenomena can lead to an increase of the frequency and the magnitude of natural hazards such as landslides, rock falls, debris flows, avalanches and floods (Keiler et al., 2010; Schindelegger & Kanonier, 2019). Table 1 summarises these hazards and their potential impacts on infrastructures, socio-economic and cultural activities related to the tourism in mountain regions.

Natural hazard	Description	Potential impact level	Sources
Desertification	Higher aridity of agricultural, forestry and pastoral areas with consequent rise in erosion and loss of organic matter in forest areas as a result of increased fire risk in connection with drought-related events.	Low	Corrado et al., eds., 2014 Matasci and Altamirano - Cabrera, 2010 Probst et al., 2013
Ecosystem changes (land and aquifer)	Changes in the phenological cycle and inland water and ecosystem transition (i.e. shift) due to habitat and soil mutations.	High	Beniston, 2012 Cannone et al. 2008 Cantonati et al., 2006 Ianni et al., 2015 Mourier et al., 2010 Revernmann et al., 2012 Wieser et al., 2008
Forest fires	Expected increase in the danger of forest fires throughout the year, mainly in the spring season.	Medium	Dupire et al., 2019 Moriondo et al., 2006 Moser et al., 2010 Schumacher and Bugmann, 2006 Wastl et al., 2012
Hydro-geological and hydraulic instability	Variation in seasonality and magnitude of phenomena associated with snow dynamics, instability of rock complexes, debris flows and surface landslides.	High	Ellena et al., 2020 Palladino et al., 2018 Probst et al., 2013 Prudent-Richard et al., 2008 Winkler and Reichl, 2014
Water scarcity	Decrease in the availability and quality of water resources related to the reduction of precipitation in winter and summer seasons.	Medium-high	Brunner et al., 2019 Hohenwallner et al., 2011 Klug, 2011 Mastrotheodoros et al., 2020 Zampieri et al., 2016

Tab.1 Predicted natural hazards due to climate change and their potential impact levels on tourism

2.2 Impacts of climate change on winter and summer tourism in the Alps

The Alpine regions are visited each year by 60-80 million people (four to six times the local population), accounting for 386 million commercial overnight stays (14.4% of the European total) of which 43.3% of the are concentrated in winter (from November 1st to April 30th) 126 million euros relates to the non-commercial stays. In the region, tourism generates an annual turnover close to 50 billion euros, and it provides 10-12% of employment (Agrawala et al., 2007; Future Mountain International, 2016).

As briefly explained before, tourism in the Alps is mainly dependent on natural resources and climate, therefore it is particularly vulnerable to climate change both in winter and in summer seasons, with impacts which diverge substantially (Balbi, 2012).

With regards to ski tourism, the Alps account for 37% of ski resorts worldwide and 80% of major resorts (i.e., 1 million skier visits per winter season). In fact, the region is the biggest ski destination in the world, capturing 43% of skier visits in the 2018/19 ski season (Vanat, 2020). Since snow is the key attraction in the Alps (Bausch & Gartner, 2020; Unbehaun et al., 2008), the evolution of natural snow conditions due to climate change is considered as a major threat (Elsasser & Bürki, 2002; Spandre et al., 2019). A recent review by Steiger et al. (2019) has comprehensively highlighted the main consequences resulting from these impacts. These were summarised as a decreased reliability of slopes dependent on natural snow, an increased snowmaking requirement, a shorter and more variable ski seasons, a contraction in the number of operational ski areas, altered competitiveness between and within regional ski markets, and related implications for ski tourism employment and holiday property values.

The first studies on the impact of climate change on winter tourism in the Alps appeared in the 1990s, mainly because of three consecutive snow-deficient winters at the end of the 1980s, which revealed the dependence of the Alpine tourism industry on snow cover (Koenig & Abegg, 1997).

In the early 2000s, a few studies tried to quantify the snow reliability of ski resorts based on the "100 days" rule, first suggested by Witmer (1986), which states that to successfully operate a ski area, natural snow cover should exceed 30 cm at least 100 days per season. The snow reliability line - i.e., the elevation above which these conditions are met - is supposed to rise by 150 m per each +1°C warming. Abegg et al. (2007) calculated that under present climate conditions, 91% of the current 666 Alpine ski areas can be considered as naturally snow-reliable. Under future climate change this percentage could drop to 75% with a +1°C warming, to 61% with a +2°C warming and to 30% with a +4°C warming. In other words, global warming could determine a process of concentration of ski and snow activities in areas at higher altitude with reliable snow cover (Elsasser & Messerli, 2001). Much less attention has been paid so far to the impacts of climate change on summer tourism in the Alps. In this case, the expected impacts seem less critical or might even be positive in some cases. According to Pröbstl-Haider et al. (2015), the Alps will attract more tourists in the summer, because this area is characterized by a more comfortable range of temperatures compared to lowlands during summer. On the other hand, the Alps will become more appealing for activities such as mountaineering, climbing, hiking and lake tourism thanks to additional days with sunshine.

Serquet & Rebetez (2011) analysed the relationship between temperature and overnight stays in 40 Alpine resorts, finding significant correlations between the number of nights spent in mountain resorts and hot temperatures at lower elevations (where most domestic tourists live). This correlation is stronger for Alpine resorts nearest to major cities. These results suggest that if climate change increases heat waves in frequency and intensity, domestic tourists will go to mountain resorts more frequently or for longer periods.

Conversely, negative effects could derive from natural hazards (e.g., landslides) related to the loss of permafrost, melting glaciers and heavy rain events, which could lead to dangerous situations for summer activities (such as mountaineering, etc.) and damage the infrastructures that ensure accessibility to Alpine areas (Pröbstl-Haider et al., 2015).

Overall, the positive economic effects of climate change on summer tourism will not necessarily offset the negative economic effects on winter tourism. For instance, Müller and Weber (2008) estimated the effects of climate change on tourism revenues in the Swiss region of Bernese Oberland in 2030.
Results showed that the increase of the revenues for the summer season (7%) would not be sufficient to avoid a comprehensive loss of about 7% (4% in case of implementation of adaptation measures) per year.

3. Aims and case study

3.1 Aims

Climate change impacts are related to changes of the average patterns of temperature and precipitation, but also to changes in frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events (IPCC, 2012).
Therefore, these impacts vary according to factors such as elevation, geomorphological features, socioeconomic structures, etc. As Elsasser and Messerli (2001) state, in relation to tourism these impacts can induce a spatial division into "winners" (positively affected) and "losers" areas (negatively affected). Notwithstanding, the literature reviewed in section 2.2 shows how the debate has mainly been focused on analysing climate change impacts on tourism at the level of the whole Alpine region, or at specific sub-levels such as supra-national (e.g., the Eastern Alps), national (e.g., the Swiss Alps), or regional (e.g., the Bernese Oberland). Much less attention was paid to examining how risks for tourism due to climate change are distributed at the intra-regional level, i.e., between the different municipalities included in a specific Alpine region. This is a key driver in the elaboration of strategies for climate change adaptation, which are usually defined at sub-regional level (Agrawala et al., 2007) and implemented at the local level (Bonzanigo et al., 2016).
This paper aims to propose a reproducible methodology for analysing how climate change risks for tourism can differ through locations within a regional case study, in order to identify where adaptation measures need to be prioritize (Oppenheimer et al., 2014; Schindelegger & Kanonier, 2019).

3.2 Selection of the case study

To test the proposed methodology (illustrated in section 4) a case study was selected in the Western Italian Alps. It is the Homogeneous Zone of Pinerolo (HZP) (Figure 1), which is one of the 11 so-called homogeneous areas in which the Metropolitan City of Turin is articulated.
The HZP can be considered an interesting case for several reasons. First, despite the adjective "homogenous", the HZP is quite heterogeneous both in terms of socioeconomic factors and geographical structure. It includes 45 municipalities: a medium-size city, Pinerolo, which has over 35,000 inhabitants; 4 municipalities which have between 5,000 and 10,000 inhabitants; 25 municipalities between 1,000 and 5,000 inhabitants, and 15 small villages that have less than 1,000 inhabitants.
From a geomorphological point of view, the HZP can be divided into three parts: (i) an agricultural plain (12 municipalities), (ii) a hilly area around Pinerolo (10 municipalities) and (iii) a mountainous area bordering France and comprising three valleys stretching from one end to the other (Val Pellice, Val Germanasca and Val Chisone) (23 municipalities).
Tourism is a key sector for the HZP. While the highest mountain areas of the HZP are mainly a winter tourist destination, the hilly belt and the lower mountain areas are especially attractive for summer tourists (thanks to the proximity to the City of Turin).
In 2018, the HZP recorded over 460,000 overnight stays (60% more than ten years earlier); 45% of these stays were concentrated in the summer season (June-September), and 33% in the winter season (December-March). Mountain municipalities accounted for about three quarters of the stays. Finally, the HZP matches one

of the 33 Integrated Territorial Areas (AIT), that Piedmont Region in its regional Strategy for adaptation to climate change has identified as the more suitable administrative dimension to elaborate ad hoc adaptation measures.

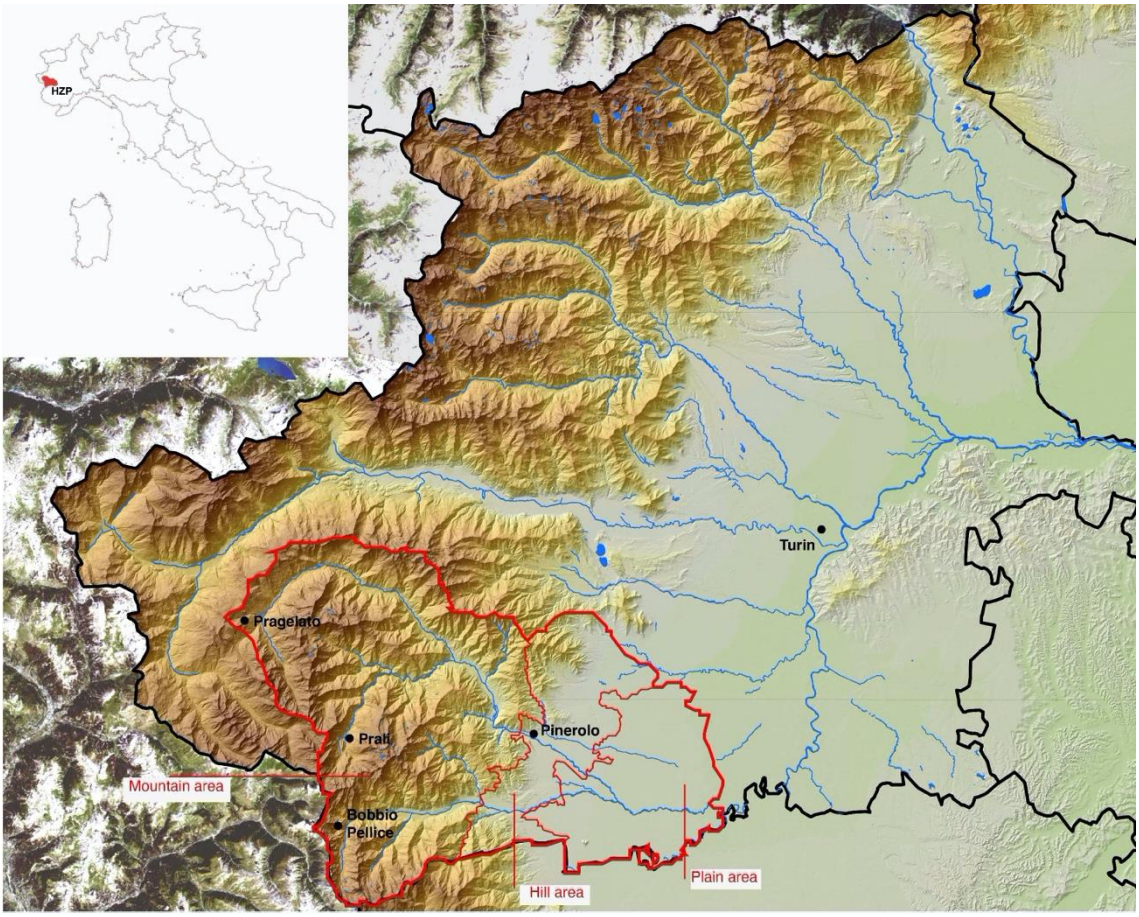

Fig.1 The Homogeneous Zone of Pinerolo

3.3 Climate, climate change and extreme events in the HZP

To analyse the climate changes, assessments and studies of its impacts are required for a length of at least 30 years (Bocchiola & Diolaiuti, 2010).

In the HZP, temperature and precipitation data have been regularly recorded from a local network of 13 meteorological stations, active since 1988.

The observed seasonal cycles of minimum and maximum temperatures from these records show that temperatures reach lower values in December and January, with a variable minimum temperature (Tmin) ranging between -5° and 0°C and a maximum temperature (Tmax) between 0 and 8°C. The maximum values are recorded between July and August, with the Tmax around 30°C and a Tmin of 18°C for the plain. Spring and autumn show intermediate and comparable values. Furthermore, the annual time series of maximum and minimum temperatures show an increasing trend with annual peaks of 1,5/2°C above the average level for the Tmax in some areas.

On the other hand, precipitation levels turn out to be very consistent in spring and autumn (with an average value over the area of about 300 mm), while winter is characterized by low rainfall of about 130 mm. Thus, while average values seem to follow the seasonal climatic trends, extreme values highlight critical issues in terms of magnitude and impacts on the territory.

For such reason, it is interesting to highlight some recent catastrophic events that affected the HZP. Since the 20th century, the area has been affected by seven major floods, listed in Table 2. These phenomena fell mainly in autumn and spring and have often resulted in landslides.

Date	Event
Oct - Nov 1945	Flood events combined with slope activities in the hilly area of the HZP. Impacts have affected the settlements, the infrastructures, the adjustments of defence to watercourses and roads, and have caused 2 deaths.
May 1949	A flood event due to an exceptional rainfall amount (it rained for over 5 days, with daily amounts up to 500 mm and a tip of 842 mm) mainly in the lower part of the HZP. The terminal sections of the Pellice and Chisone streams suffered the worst damage, in terms of arrangement and defence of waterways, agricultural land and roads.
May 1977	A violent flood event affected all the valleys of the HZP, destroying many city canal crossings and flooding many areas in the valleys. Several municipalities in the mountain zone recorded several damages on settlements, buildings, arrangements and defences of waterways, roads, and crossing-works. The event made 7 deaths, several injured and dozens of displaced persons.
Nov 1994	A flood event and the related slope activity affected all areas bathed by streams of the HZP, both in the plain and in the highest part of the territory. Damages on infrastructures, accommodations and water-defences, agricultural fields, roads, and public works were recorded.
Jun 1998	Several floods and landslides impacted on the hilly area of the HZP, with severe damages on the settlements, public spaces and infrastructures. The event made 9 deaths and several injured people.
Oct 2000	The flood event affected most of the HZP, with disastrous impacts on the infrastructures, accommodations, watercourse defences, agricultural fields, roads and yards.
May 2008	A stream flood with landslides provoked by intense rainfall hit part of the hilly and mountain areas of the HZP, with remarkable impacts on buildings, roads, infrastructures, sewer networks and sport facilities. The phenomenon made 12 deaths, 3 injured and more than 12 displaced persons.
Nov 2016	Flash flood events in the valley and part of hilly areas of the HZP affected the infrastructures, the watercourse-defences, agricultural land, roads and buildings, causing 1 death.

Tab.2 Main flood events in the last decades in the HZP, with associated local impacts

Regarding landslide and debris flow phenomena, some several active mass movements have been recorded in the HZP. These debris flows mainly affect mountain municipalities, but also the lower part of the valleys is threatened by conspicuous debris-masses. Moreover, the mountain portion of the HZP presents several areas at risk of avalanches. The database of Piedmont Region shows that the most numerous avalanche phenomena were recorded in 1969 (88 events), 1972 (73), 2008 (126) and 2009 (133), with an increasing trend in recent decades. Lastly, in relation to forest fires, the database of the Piedmont Region (which collects data from 1997 to 2016) recorded 211 events in this timespan, with an average annual value of 12.3 fires in the HZP, especially in the hilly zones. Despite a decreasing trend of events between 2007 and 2016, data highlight that January, February and November are the months with the highest average amount of burnt area due to fire events. This pattern is probably related to particularly dry autumns and winters.

4. Methodology

4.1 The risk assessment methodology

Based on the most reliable guidelines of institutions and organizations such as IPCC, United Nations, Covenant of Mayors for Climate & Energy EUROPE and the Alpine Convention (Bertoldi et al., 2018; Oppenheimer et al., 2014; Schindelegger & Kanonier, 2019; Zollner, 2018), the methodology here proposed identifies risks related to climate change as a function of hazard (H), exposure (E) and vulnerability (V) factors. The latter one is in turn divided into sensitivity (S) and adaptive capacity (AC). Each factor is here operationalised through specific indicators referred to tourism (Ellena et al., 2020; GIZ, 2017; Oppenheimer et al., 2014). In the case of winter tourism, the variation of the hazard related to climate change (H) is due to the increase in average temperatures as well as the decrease in snow precipitations (Croce et al., 2018). On the other hand, for the summer tourism exposed sample, the focus is on the increase of heatwaves, which will (indirectly) lead to longer stays in higher altitudes. The exposure samples (E) include indicators that consider the tourist offer as well as the main attraction capacities in relation to the analysed seasonal tourism. This to consider the link between tourism and economic flows together with the exploitation of existing natural resources in the area. Finally, Sensitivity (S) and adaptive capacity (CA), which refer to vulnerability (V), reflect respectively the

degree to which a system can be unfavourably (or beneficially) affected by climate change and the ability of this system to adapt or to cope with its consequences (Oppenheimer et al., 2014).

The following sections show in detail the indicators that have been measured at the municipal level for operationalizing each risk factor (Figures 2 and 3).

Fig.2 Hazard, Exposure and Vulnerability indicators for WINTER TOURISM

Fig.3 Hazard, Exposure and Vulnerability Indicators for SUMMER TOURISM

4.2 Hazard indicators

For climate hazards, reference climate periods and climate projections have been analysed using very high-resolution climate models. The evaluation of the historical period was carried out by using a subset of climate indicators based on temperature and precipitation, defined by the Expert Team on Climate Change Detection and Indices (ETCCDI) (Karl et al.,1999; Peterson et al., 2001).

Additionally, for the climate analyses, the observed daily gridded dataset NWIOI (resolution of 14 km) (Ronchi et al., 2008) over the 1981-2010 reference period was also considered to assess the observed values of these

indicators. Climate variations were evaluated comparing the values of the 2021-2050 period, with respect to the baseline period (1981-2010).

The analyses have been carried out using an ensemble of high resolution simulations (about 12 km) from climatic models available in the framework of the program EURO-CORDEX(Ellena et al., 2020; Jacob et al., 2014, Jacob et al., 2020 ; Kotlarski et al., 2014). The representative concentration pathway (RCP) scenarios considered here were the IPCC RCP4.5 and RCP8.5 scenarios (IPCC 2014a). Table 2 shows the indicators identified as a proxy to evaluate the climate hazards. For winter tourism, changes in average temperature (TG) and decrease in snow precipitation (PRCPTOT) have been considered.

Additionally, the snow cover duration (SCD) was included in the analyses to evaluates the total number of days with snow depth higher than 30 cm between November and March (Durand et al., 2009; Marcolini et al., 2017; Valt & Cianfarra, 2010).

As explained in section 2.2, this indicator has been largely used in literature to evaluate the impact of climate change on the winter tourism (Scott et al., 2006). SCD is a key factor to characterize the decrease of snow cover for cross-country skiing (Marty, 2008) and it is an interesting indicator (mainly) for the municipalities of Prali and Pragelato, where there are downhill and cross-country ski slopes. Nevertheless, due to the very high correlation reported between the SCD and the previous indicators for winter tourism (TG and PRCPTOT) (i.e., 0.88, figure 4), it was decided to use only SCD to characterize the hazard for the winter tourism.

For summer tourism, the indicators that have been considered corresponded to those related to heat waves events such as HUMIDEX, HW, and TR (see descriptions in Table 3 for further details).

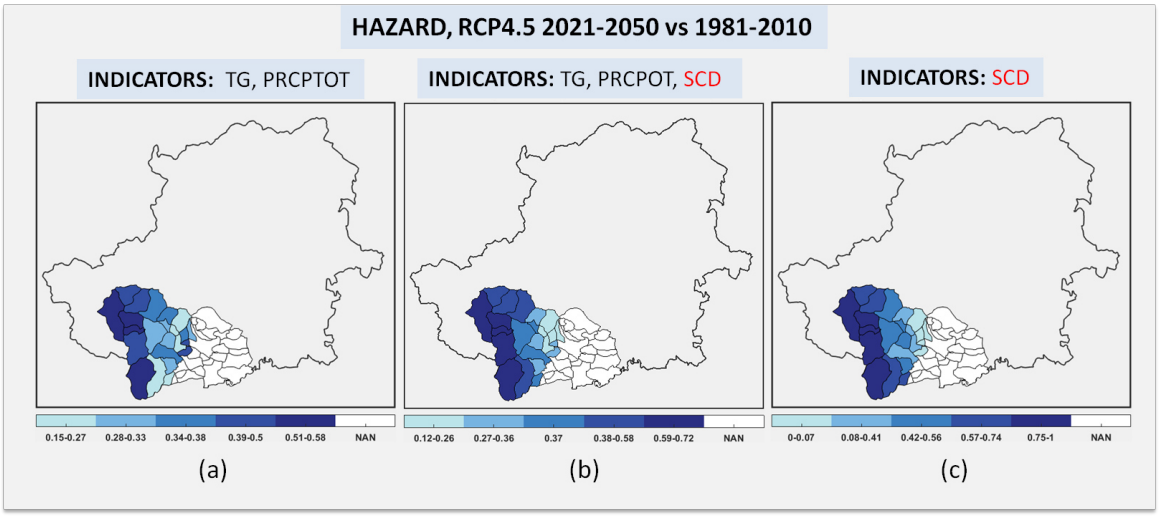

Fig.4 Hazard maps resulting from different sets of indicators: a) TG, PRCPTOT; b) TG, PRCPTOT, SCD; c) SCD

Season	Indicator	Description
Winter	Snow cover duration (SCD)	N° of days in a given snow season (from 1st Nov of a given year to the 31th Mar of the following year) with snow depth higher than 30 cm.
	[Annual total precipitation in wet days (PRCPTOT)]	Annual precipitation sum in wet days (days with precipitation greater than or equal to 1 mm).
	[Daily average temperature (TG)]	Average daily temperature per year (in °C).
Summer	Heat Waves (HW)	N° of days per year in which the daily maximum temperature is higher than 35 °C.
	Tropical nights (TR)	N° of days per year in which the daily minimum temperature is higher than 20 °C.
	HUMIDEX	N° of days per year in which the perceived temperature is greater than 45 °C.

Tab.3 - Hazards indicators for winter and summer tourism

4.3 Exposure indicators

For the exposure index, several tourist assets under climatic threats have been analysed (Emanuelsson et al., 2014; Oppenheimer et al., 2014). More specifically, the analysis considered the elements and the activities which could be directly or indirectly damaged by future hazard variations (Emanuelsson et al., 2014; Marzocchi et al., 2012). In the case of direct impacts for tourism, damages may affect tourism accommodations, winter-sports facilities, tourism activities and infrastructures. On the other hand, indirect impacts may refer also to interdependencies between assets (Ashley et al., 2005).

Table 4 shows the exposure indicators used as a proxy to evaluate the presence of touristic accommodation sites, services and sport structures and infrastructures.

Season	Indicator	Description
Winter and summer*	Accommodations	N° of accommodation sites for tourists
	Facilities	N° of infrastructures and facilities with a high landscape value
	Information	N° of information and reception offices for tourists
Winter	Sport activities	N° of winter sport centres
Summer	Hiking paths	Km of main and secondary routes, classified as cycling or hiking paths
	Cycling paths	Km of existing cycling infrastructures (paths and trails in green areas)

Tab. 4 Exposure indicators for winter and summer tourism

(*) This category belongs to indicators related to both winter and summer tourism

4.4 Vulnerability indicators

According to the IPCC (2014a, 2014b), in a risk-based conceptual framework, vulnerability can be assumed as a combination of sensitivity (S) and adapting capacity (AC). Consistently, within the current research context, both physical and non-material indicators (i.e., institutional adaptive capacity) have been considered, in coherence with local data availability (GIZ, 2017).

In the study, sensitivity indicators refer to the quantifiable physical touristic attributes of the selected area and correspond for the two seasonal scenarios (see Table 5).

Due to progressive data update, the latter refer to changes in tourist numbers from 2016 to 2017, since at the time of data processing the 2017 was the most updated year containing all data series for each HZP municipality. With regards to adaptative capacity, the indicators cover several aspects (Boyd & Juhola, 2015; GIZ, 2017; Master Adapt, 2018; Parry et al., 2007) such as: (i) knowledge, intended as general levels of education and awareness about climate issues; (ii) technology and engineering, meaning options that could ameliorate the adaptation process of a system; (iii) institutions, by looking at their role and capacity in guaranteeing sustainable resources-management and public participation; and, finally, (iv) socio-economic issues (e.e., GDP distribution, employment/unemployment rate, etc).

Accordingly, adaptive capacity indicators refer to these different aspects and are visible in Table 6.

Season	Indicator	Description
Winter and summer*	Arrivals	N° of clients hosted in the accommodation sites
	Presences	N° of nights spent by clients in the accommodation sites
	Duration of stay	Ratio between night stays and arrivals
	Tourist intensity	Ratio between number of arrivals and residents
	Receptive capacity	Maximum number of people that the accommodation sites can accommodate in one day or in the whole opening period
	Tourist flow variations	Changes in tourist visitors from 2016 to 2017

Tab. 5 Sensitivity indicators for winter and summer tourism

* This category belongs to indicators related to both winter and summer tourism

Season	Indicator	Description
Winter and summer*	Climate change initiatives	N° of local governments adherent to sustainability protocols
	Agriculture networks	N° of local agricultural networks where farmhouses, restaurants, bio-markets and urban gardens propose biological, traditional, good and equal products, food and social activities
	Eco museums	N° of eco museums with touristic proposals and guided tours
	Voluntarism	N° of institutions with volunteers
	Openness to sustainability	Sum of activities, bodies and initiatives related to sustainability. In particular, this indicator may include: institutions; municipal administrations; mountain communities or union of municipalities; national health service companies or bodies; public universities; non-economic public bodies; other legal forms.
Winter	Non-skiing activities	N° of tourist activities in the ZOP not related to skiing activities
	Artistic, social and cultural activities	N° of activities designed to satisfy various cultural and entertainment interests for the public, including live shows, museum management, games and betting, sports and leisure activities
Summer	Water scarcity measures	N° of provincial plans or strategies to tackle water scarcity in this season
	Fortification systems	N° of original fortification systems with touristic proposals and guided tours

Tab. 6 Adaptive capacity indicators for winter and summer tourism

* This category belongs to indicators related to both winter and summer tourism

4.5 Calculation of risk values

All the indicators described in previous sections were calculated for each of the 46 municipalities within the HZP. To be aggregated in Hazard, Exposure and Vulnerability indexes, all indicators were firstly normalised. Following the GIZ (2017) approach, there are three categories of scales that can be used to assess risk and vulnerability: metric, ordinal and nominal scale. Within this study, the metric scale was adopted.

The indicators were normalized by applying the Min-Max method (Ellena et al., 2020; GIZ, 2017; Master Adapt, 2018; OECD, 2007), so as to translate all values into a score between 0 and 1.

For some indicators, lower values reflect positive conditions (i.e., sensitivity), while in other cases lower values reflect negative conditions (i.e. adaptation).

In the latter case, an operation of "conversion" was made by reversing the direction of the value range in order to have all indicators in the same normalization ranking. Hazard, Exposure, Sensitivity and Adaptation Capacity indexes were calculated as a weighted average of their normalized indicators, while Vulnerability was calculated as the average of Sensitivity and Adaptation Capacity.

At the end, the final risk value for each municipality corresponded to the product of the values of Hazard, Exposure and Vulnerability.

5. Results

5.1 The 2050 scenarios

As mentioned in section 4.2, risk simulations were obtained according to the IPCC RCP4.5 and RCP8.5 scenarios, both for winter and summer tourism (IPCC, 2014a). The climate variations were assessed over the 2021-2050 period, compared to the 1981-2010 period.

For the winter tourism (Fig.5), the application of the methodology described in section 4 (limited to mountain and hilly municipalities, in which most touristic activities in winter are concentrated) highlighted two trends in the HZP.

In the 1981-2010 time-slot, the evolution of precipitation regimes and thermal increase (described in section 3.3) affected with more emphasis the municipalities in the lower valleys, which had to deeply reduce their ski touristic offer.

In addition, to provide more information on the current climate conditions, the calculation of the *snow cover duration* index (described in section 4.2) has been performed over the 1988-2018 period, based on observational data made available from ARPA Piemonte (2019) by in situ stations concerning daily snow depth. Only stations with information covering at least 75% of the reference period were retained, i.e., Pragelato-Traverses and Colle Barant.

The total number of days with snow depth higher than 30 cm between November and March is about 74 days for Pragelato – Traverses station, while the mean value is 38 days for Colle Barant station.

The future climate change in the 2021-2050 RCP4.5 scenario, conversely, will determine the major risks for the municipalities on the higher part of the valleys, with a further reduction in precipitations and an increase in temperatures.

These results are confirmed by the reduction of the snow cover duration index. In particular, the municipalities of Pragelato, Prali and Bobbio Pellice – which host the main ski activities of the HZP – will face the higher level of risks, due to both significant hazard and exposure.

It is interesting how, in the case of Prali and Bobbio Pellice, the risk is projected to be high despite a medium-low level of vulnerability (which is instead high in Pragelato). Moving down from these municipalities to the medium and lower portion of the valleys, the risk levels progressively decrease. However, in absolute terms, middle valley municipalities will be affected by growing climate hazards.

Results do not significantly change for the RCP8.5 scenario. These data therefore confirm a situation of increasing climatic risks for the upper valleys, mainly related to a decrease in snow cover duration (which in turn is due to an increase of average temperatures and reduction in precipitations). These trends pose the need for identifying diversified forms of alternative and sustainable tourism in winter, since to date the main activities focused on skiing.

With regard to summer tourism (see Fig.6), most of the relevant hazards related to temperature increases and heat-waves occurred in the hilly and flat part of the HZP during the 1981-2010 period. At the same time, mountain locations were significantly less affected.

Moving to the 2021-2050 period under the RCP4.5 scenario, climate projections show a progressive extension of the climatic risks to municipalities within the flat area, due to the temperature increase. On the contrary, for the mountainous zones, the levels of risk remain very low, despite the higher scores of exposure and vulnerability. This result is because hazard indicators are projected to stay unchanged for the mountain municipalities, while they will worsen substantially in the plain.

For example, the former will not record any increase in the number of days having a daily maximum temperature higher than 35°C, while this number will increase by 4-5 days in the latter. Even more evident is the trend related to tropical nights: their number will nearly remain unchanged in the mountain municipalities but will increase by 9-11 units in the municipalities within the plain.

In contrast, for mountain municipalities, the number of days having a daily maximum temperature higher than 35 °C is about 1 day/year, while the tropical nights are at most 2 days/year. Results for the scenario RCP8.5 do not significantly change by the previous estimates.

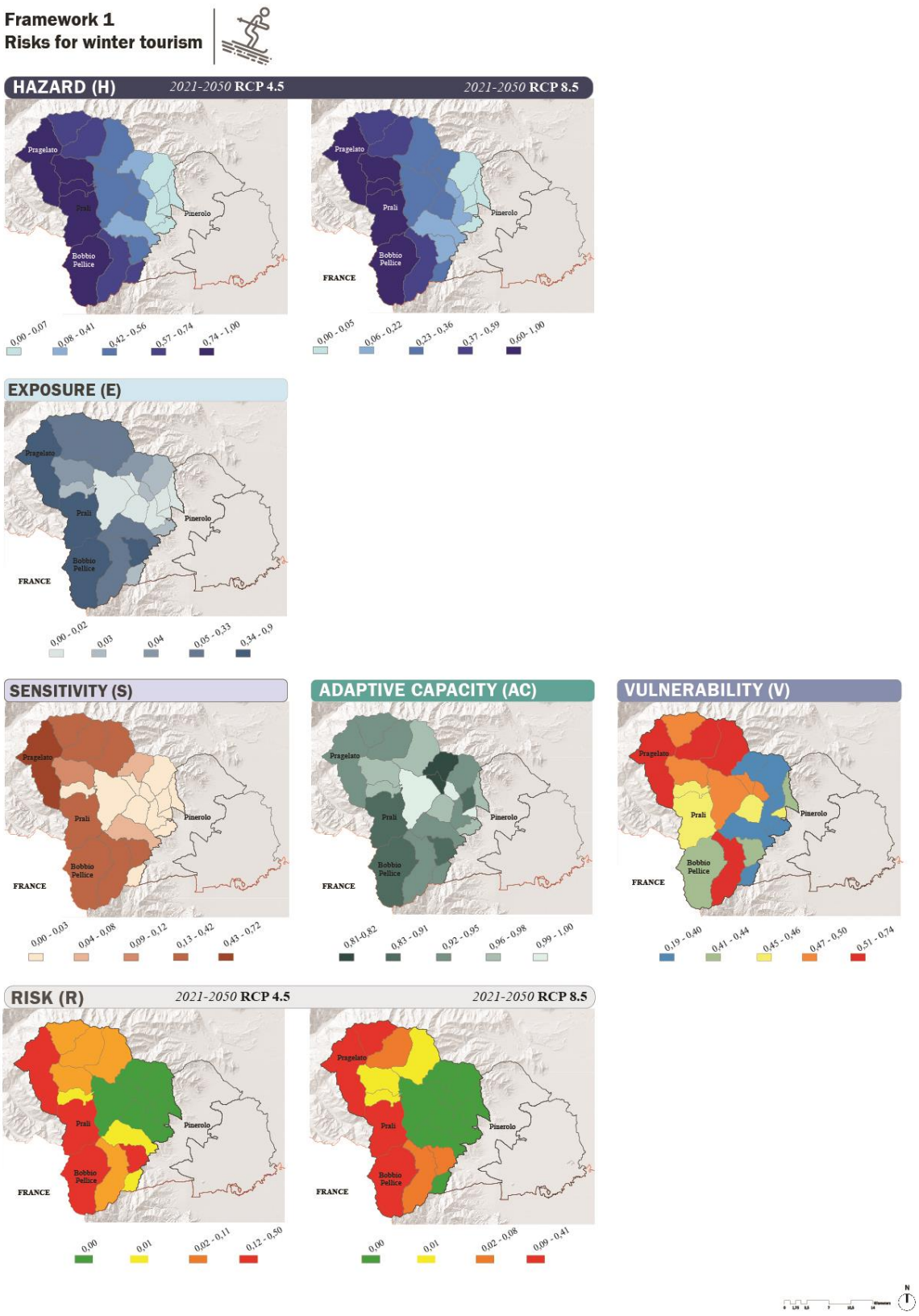

Fig. 5 Results for winter tourism

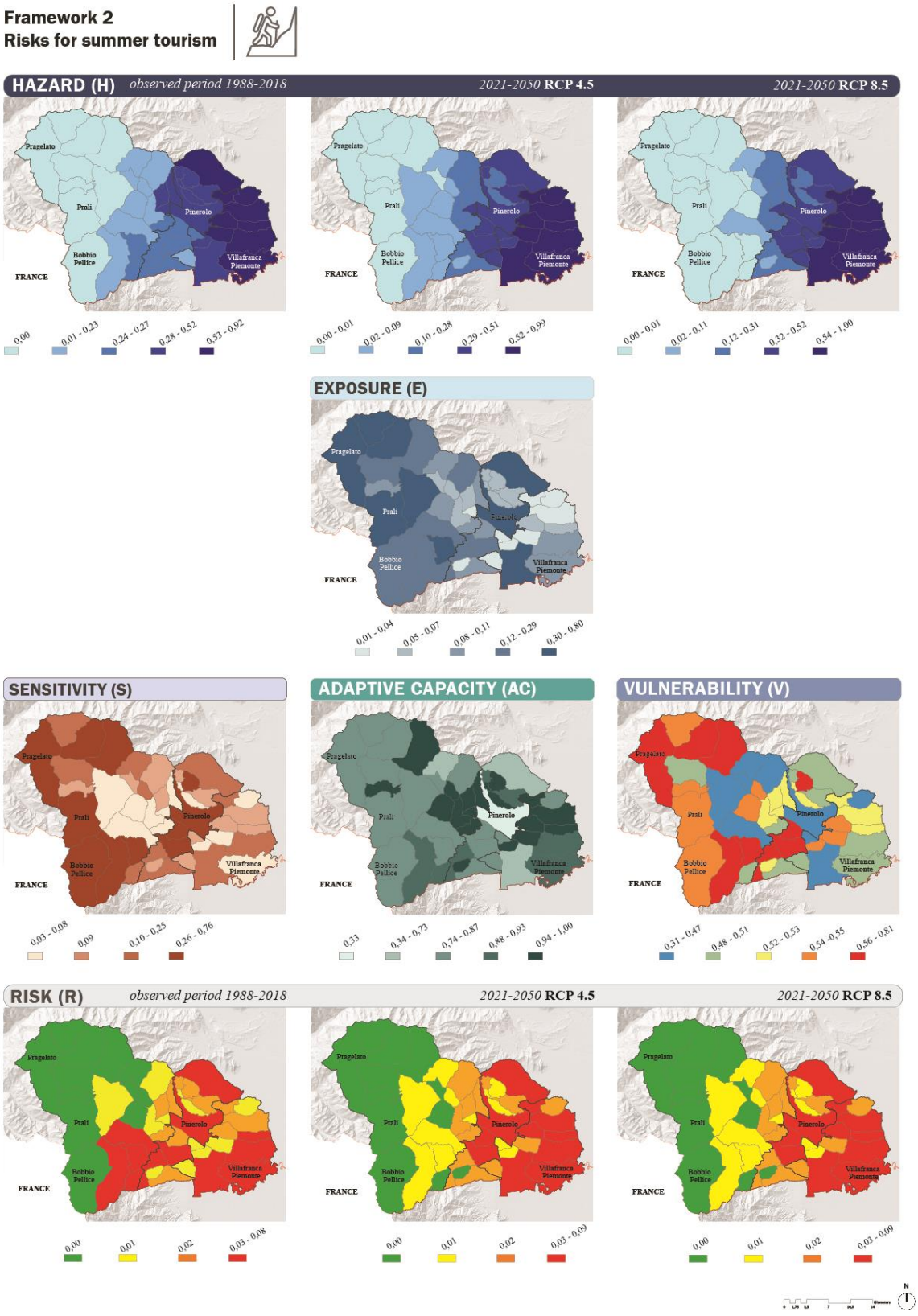

Fig.6 Results for summer tourism

These results indicate that an understandable increase in the duration of the stays in high altitude areas (less affected by heat waves) is expected for the summer season, at least partially compensating for the winter reduction. Therefore, these changes will increase the pressure on the to-date available resources (especially water and electricity).

5.2 Overlapping with extreme events related to climate change

A previous paper by Ellena et al. (2020) already analysed how hydrogeological hazards – such as flood, avalanches and landslides – are likely to change in the next decades in the HZP, leading to increased risks in the area for built settlements and infrastructural systems. In this section, implications of those risks for the tourism sector are examined. In general terms, hydrogeological instability will worsen due to two main trends: on the one hand, a general increase in maximum daily precipitation and maximum precipitation for 5 consecutive days, especially under RCP8.5 scenario; on the other hand, an increase in the number of days per year with a minimum temperature above 20°C, 25°C and 35°C. For what it may concern the risks for the built settlements due to flood, the higher risks are observed in the flat and hilly part of the HZP, while in the 2050 scenario the risk will change in particular in the mountain areas, following opposite trajectories. In fact, the risk will increase in Chisone valley (in particular in Pragelato), while it will decrease in Germanasca and Pellice valleys. These differences are mainly related to the exposure, which in these cases is very high in Chisone valley and much lower in the other two valleys. On the contrary, the risks related to flood for the infrastructural systems will increase mainly in the plain and on the hills of the HZP, which turned out to be more vulnerable to these hazards. In this case, the more touristic municipalities in the mountain part of the HZP are not significantly affected by risks. However, they could be indirectly affected, as their accessibility depends on the availability of transport infrastructures in the plain. Namely, if a flood makes these infrastructures unusable, tourists cannot reach the HZP valleys.

As pointed out in *section 3.3*, flood events tend to concentrate in spring and autumn, i.e. the seasons in which the presence of tourists in the area is lower. However, the damages that these events can cause are often relevant and cannot be repaired in a short amount of time. Therefore, floods can have significantly negative impacts on both winter and summer tourism.

Looking at landslides and avalanches, to date the maximum level of risk both for built settlements and infrastructures is concentrated in the medium part of the mountain valley, while in the 2021-2050 scenario this risk will move to the higher part of these valleys, where most touristic activities take place. Avalanches pose a serious danger for ski mountaineering and other outdoor sports in the winter, while an increased frequency of landslides could discourage activities in the summer, as well as interrupt roads and transport services that ensure accessibility in the HZP. Finally, also the hazard related to forest fires – until now stronger on the hilly part of the HZP – will progressively move in the next decades toward the mountain municipalities. In this case, however, risks for the built settlement will become very high in Pellice valleys, while they will remain low in Chisone and Germanasca valleys thanks to the reduced levels of exposure.

6. Discussion and conclusion

This paper develops and tests a risk assessment methodology to analyse how potential positive and negative impacts of climate change on winter and summer tourism will spatially distribute on a 2021-2050 scenario within the HZP. Since a singular case study was considered, any claim of exhaustiveness and systematicity must be excluded; however, some interesting issues emerged from the results of the application, both in substantial terms and regarding methodological aspects. Overall, the elaborated risk maps are consistent with the review of the literature carried out in section 2. The high-altitude municipalities are going to face the greatest impacts due to climate change, although in opposite directions when considering seasonality. This scenario has direct consequences for the mountain landscape, environment, and tourism. In winter, reduced snow cover duration will threaten ski activities, which are the main attraction for tourists in this season. After the ’80, this reduction already involved the dismantling of ski facilities in the medium part of the HZP valleys. In the next decades, also Pragelato and Prali will need to concentrate skiing activities at altitude over 1,500 meters. Moreover, the inter-annual and intra-annual variability of snow fall and cover will increase, intensifying the complexity in managing ski activities. Nowadays, snowmaking and its related investments are the most

widely implemented adaptation measures to face climate change for winter tourism sector. However, its environmental and economic sustainability is limited. Even if many snowmaking facilities are improving their resource consumption (in water and energy), the deterioration of landscapes and changes in natural ecosystems are inevitable side effects of this activity. Damages are caused by the creation of additional pressure on water reservoirs, water plumping, slope expansion, soil erosion and other issues. The climate projections and their direct and indirect impacts on risk assessment could help authorities and stakeholders to build new long-period visions of winter tourism for these territories. In this sense, it will be crucial to promote diversified winter attractions for tourists less focused on snow.

The negative risks for the winter season could be partially balanced for the high-elevation municipalities by increased opportunities related to the summer tourism. In fact, in the summer months the tourism is projected to become more appealing in the higher valleys due to the milder temperature. Moreover, these areas will be less hit by heat waves than the hills and the plain.

As a consequence, HZP mountains could become the destination of tourists from the near metropolitan area of Turin during weekends, especially during the hottest months (i.e. July and August). This sort of "renaissance" of the Alpine summer tourism (Abegg, 2011), which might be pushed further by the current COVD-19 pandemic (De Luca et al., 2020), could however also lead to an increased pressure on local water resources.

Therefore, there could not be sufficient water to fulfil the demand along the tourism seasonal peaks, although melting glaciers may compensate for short-term hydrological scarcity (Hohenwallner et al., 2011). These direct primary effects could be exacerbated by secondary effects of climate change, which will likely increase frequency and magnitude of extreme natural events just in those high-elevation parts of the HZP. A foreseen intensification of flood events in spring and autumn could cause damages to the built settlement of these areas, as well as to the infrastructures that ensure accessibility for tourist flows. These results should support local authorities in strengthening the traditional policies applied in terms of urban planning, building materials, architecture, distribution of green spaces, public services, etc. Avalanches and landslides will determine major risks not only for settlement and infrastructure systems, but also for winter and summer tourism activities like skiing, free-ride, hiking, climbing, mountain biking, and so on. Also, wildfires seem likely to be intensified due to extreme temperature and precipitation conditions. If it is true that these results are broadly in line with the main literature findings, it emerged from this study how they cannot be easily generalised, even within an area with limited extension, such as the HZP.

The same climatic hazard levels can lead to very different levels of risk even in neighbouring municipalities, if they show different conditions of exposure, sensitivity and adaptive capacity. This was found in many simulation results, particularly when comparing risks between the upper and middle parts of mountain valleys, but also among the upper municipalities themselves in relation to flooding and forest fires. In this sense, the proposed methodology can be a useful decision support system for identifying priorities in adaptation strategies and plans, especially in cases such as the HZP, which is in charge of the elaboration and implementation of these plans within its boundaries (Francini et al., 2021). A consideration of expected trends in climate hazards, combined with analyses of local exposure and vulnerability levels, can help to recognise how risks and opportunities are spatially distributed within a given Alpine area. A multi-level approach can indeed help to answer the following questions: i) which municipalities require urgent interventions? (ii) which ones, on the contrary, present low levels of risk, so that their tourist offer can be immediately promoted and valorised to support the overall attractiveness of the area? Alongside to these points, some limits of the proposed methodology have to be acknowledged. In the analysis, the collection of exposure indicators was affected by the lack of complete and reliable data-series on local tourism.

This deficiency somehow limited a broader collection of touristic elements/activities[1] which could be directly or indirectly affected by climate change hazards.

First, the inclusion of some indicators in the calculation of exposure, sensitivity and adaptation capacity indexes was not possible because of the lack of data availability. To exploit all its potential benefits, the proposed methodology requires rich bases of municipal or even sub-municipal data, which are often poorly available, especially for rural and mountain areas outside urban agglomerations. Second, the selected indicators have been aggregated in hazard, exposure, and vulnerability indexes, without being weighted according to their relative importance. The inclusion of different weights (possibly defined through participatory approaches that involve local stakeholders) would improve the significance of the indexes used in the calculation of the risk levels. Finally, in a view of determine which area to prioritize, the risk values are not expressed in absolute values, but in relatives, therefore the maps show how much a certain municipality is more/less "at risk" than another one. This imply difficulties to compare how risks increase or decrease based on different future time periods and RCP scenarios. Therefore, further research is welcome to overcome these limits and improve a methodology that can help to identify trans-sectorial adaptation measures to face challenges and seize opportunities for the Alpine tourism, according to that "policy integration" called for by Becken et al. (2020) just in relation to tourism and climate change.

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[1] In case of a broader availability of data on local tourism, other exposure indicators may include: the tourism climatic index (TCI) proposed by Mieczkowski (1985), the tourism contribution to local economy (% of GDP), the workforce (% of total employees in local tourism activities), the percentage of employees in the sector with low education, the trade balance in travel (to the HZP) (% of GDP), etc.

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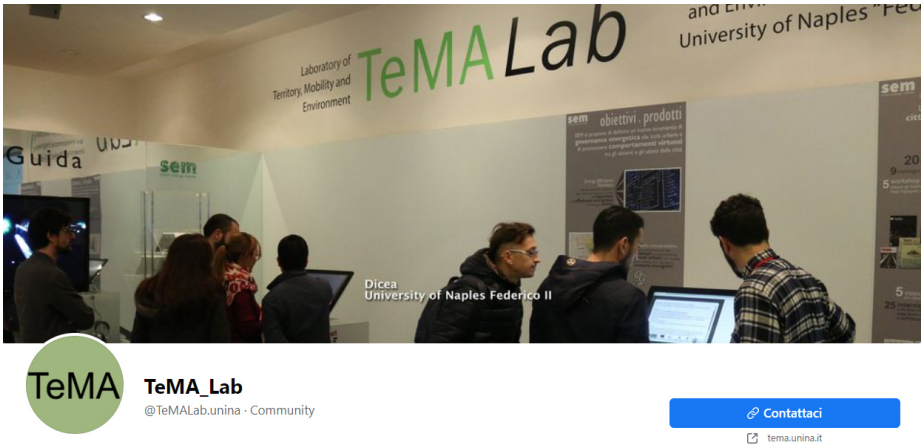

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 49-65
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/8298
Received 22nd September 2021, Accepted 3rd March 2022, Available online 30th April 2022

www.tema.unina.it

Municipal finance, density, and economic development. Empirical evidence from a global sample of cities

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Abstract
This research focuses on how population density may influence the municipal expenditure using a global dataset from UN-Habitat. Specifically, we test its role on different budget categories, including sanitation, waste, water, affordable housing, and security. We find that in general density is likely to be correlated with expenditure. This evidence is not robust across the considered expenditure categories. Rather, population density is likely to influence specific budget items and its explanatory power varies as we consider different measures of it. Among control variables, we point out the significance and magnitude of the regressors related to economic development, which in some cases matters more than density in explaining some expenditure categories. Findings suggest that making cities denser can be a valuable option of urban policy, if the target is expenditure optimization. Nonetheless, this works only when it is combined with a mix of other factors, and location is also considered.

Keywords
Urban density; Municipal expenditure; Economic development; Cities.

How to cite item in APA format
Kamiya, M., Scuderi, R. & Tesoriere, G. (2022). Municipal finance, density, and economic development. Empirical evidence from a global sample of cities *Tema. Journal of Land Use, Mobility and Environment, 15* (1), 49-65. http://dx.doi.org/10.6092/1970-9870/8298

1. Introduction

Density is an aspect of major interest for urban studies. It has been explored from different perspectives including spatial planning and socioeconomics, and ultimately associated with timely global issues like climate change and Covid-19 pandemic (Hernandez Palacio, 2012; Papa et al., 2015; Mert, 2021). Among these topics, in urban studies the association between density and municipal expenditure performance has been examined with particular attention (Gielen et al., 2019; Jain et al. 2021). Pioneering studies explored how population density may influence expenditure for local services and infrastructures (Ladd & Yinger, 1992; Carruthers, 2002; Burchell & Mukherji, 2003; Burchell et. al., 2005; Carruthers & Ulfarsson, 2008). This has been widely discussed in countries like the United States (Carruthers & Ulfarsson, 2008; Burchell et al., 2005) and it has become part of the vibrant debate in both Europe and emerging economies like India and China (Bhatta et al., 2010; Fregolent & Tonin, 2016; Tian et al., 2017; Bergantino et al., 2019).

Overall, low-density is associated with higher cost, because of the considerable levels of financial resources that are required to extend basic infrastructure over greater distances to reach relatively smaller numbers of residents (Litman, 2015). Conversely, higher density may improve the operational efficiency of local authorities through cost savings from economies of scale (Tran et al., 2019).

Nonetheless, there is no consensus on the central role of urban density in influencing local finance when compared to other factors. Past studies claimed that factors like economic development, quality of institutions, and governance have greater importance (Beghelli et al. 2019; Castells-Quintana & Wenban-Smith, 2020). However, the results are not conclusive (Castells-Quintana & Wenban-Smith, 2020).

To contribute to this debate, our research explores the relationship between density and municipal expenditure. We focus on municipalities as defined by UN-Habitat (2018), as the level of local government with a certain degree of budget autonomy in terms of both revenues and expenditure.

The main contribution of this study is the test of hypotheses about urban density through a novel global dataset of municipalities, which therefore considers countries with different development levels. To the best of our knowledge, this is the first attempt to analyse this topic based on the information collected directly from a global sample of cities. Our analysis follows the broader interest of the literature in testing empirically whether density influences municipal expenditure to provide different services (Ewing, 2008), namely sanitation, waste, water, housing, and security (Carruthers & Ulfarsson, 2002; Gielen et al., 2019; Sass & Porsse, 2021). In parallel, we aim to give further evidence on the explanatory power of economic development. This is crucial because cities located in advanced countries could have more efficient governance, capabilities, and technology, and therefore reach scale economies (Andrews & Boyne, 2009; Hortas-Rico & Solé-Ollé, 2010; World Bank, 2015; Miyazaki, 2017).

Following a thorough check for a set of municipality-level indicators, we have found significant relationship between urban density and some types of budget items. Our estimates point out that it does not necessarily have a central role. We also find evidence that in more developed economies, local government may reach economies of scale for specific spending items.

The paper proceeds as follows. Section 2 presents the theoretical framework. Section 3 introduces the research method and the database. Sections 4 and 5 show results, and present discussion and conclusion.

2. Research Framework: theories and hypotheses

The modern term "sprawl" was used by Earle Draper in 1937 (Cinyabuguma & McConnell, 2013), and since then its meaning has been controversial. Some authors assert that it can be both defined as a consequence of land use practices (Bahl, 1968; Clawson, 1962; Downs, 1999; Glaeser & Khan, 2004; Frenkel & Ashkenazi, 2005), and associated to different urban development patterns (Nelson, 1992; Pendall, 1999). Others emphasize that sprawl reflects the massive consumption of land per person rather than either simple urban growth or population growth (Carruthers & Ulfarsson, 2003).

Among the causes of sprawl, at an early stage population growth was considered as the leading cause of spatial growth and low-density, as cities expanded to contain new dwellers. Other studies remark that three major forces – population growth, rising household income, transportation improvements – directly influence urban density as individual housing preferences combined with higher income levels have contributed to constantly expand the demand for land (Mieszkowski & Mills, 1993; Brueckner, 2000, 2001).

There are underlying factors such as lack of proper urban management as well, but in general, the growth of road networks may be considered a primary force for urban sprawling (Errigo & Tesoriere, 2018). Other contributors indicate that density is also linked to specific characteristics of the places in emerging economies, like land use policies and governance issues (Qadeer, 2004; Fregolent & Tonin, 2016). Research in India (Bhatta et al., 2010) and China (Tian et al., 2017) give evidence that sprawling is mostly led by local policy. This mainly due to incentives to maximize benefits from leasing and high-pressure from real estate developers to acquire land. To this end, local governments have "tended to oversupply land, leading to urban sprawl problems" in emerging cities (Tian et al., 2017).

Overall, two key lessons emerged from literature. First, the concept of sprawling is extended to inefficient land development pattern (Coppola, 2012; Tian et al., 2017). Second, and more importantly for the scope of this research, low density could not be associated with city sustainability, especially from a municipal finance perspective (Edwards & Xiao, 2009; Errigo & Tesoriere, 2018). This relationship has been widely treated in literature since the report entitled "Costs of Sprawl" (Real Estate Research Corporation, 1974).

The main assumption from pioneering research is that the cost per unit of development rises as density decreases. Ladd and Yinger (1991) and Ladd (1992, 1994, 1998) suggest that the relationship between the number of people per square mile and per capita spending has a U-shaped relationship. Accordingly, as density increases, at first cost decline but then increase sharply. This implies that municipal services can be subject to either economies or diseconomies of scale.

More recently, the results from similar studies have been quite controversial. On the one side, few studies remark that low-density leads to higher costs because of the significant investment required in extending roadways and other types of infrastructure like water, sanitation, roads, and other services covering long distances, in order to reach relatively fewer numbers of people (Carruthers, 2002; Carruthers & Ulfarsson, 2003, 2008). In line with this, Fregolent and Tonin (2016) found that if urban development is poorly planned, spread out, and disorganized, it may affect the spending capacity of municipalities . On the other side, other research in both developing and developed countries found that some spending items are more sensitive to urban density than others, and regulatory framework and decentralized settings may have a primary role (Gielen et al., 2019; Sass & Porsse, 2021).

Therefore, the results are not conclusive as it is not clear how urban development pattern can have a highly marked impact on municipal budget, or rather, budget performance depends on other factors, mostly related to economic development (Rico, 2014).

Accordingly, we explore the following two hypotheses regarding the correlation between density and municipal expenditure.

H1. Urban density influences municipal expenditure. The influence varies with the specific expenditure item.

A critical point beyond the land pattern effect is that the cost of services delivery varies from city to city, especially if they belong to more advanced regions (Cappelli et al., 2021). This may depend on the level of development of the region where the city is. Most of advanced economies may reach economies of scale. This is because they benefit from more efficient administrative processes, regulations and technologies, as it was suggested in recent research focussed on local institutions in developed countries (Miyazaki, 2017). The author stresses how administrative efficiency may be the result of either high service standards or responsiveness to local preferences. Better local expenditure performance may depend also on the fact that municipalities in developed countries are able to engage private sector to directly deliver public services,

thus reducing the financial burden for local budget. This mechanism is not adopted extensively in poor and developing countries, where fragile administration and low capacity and regulation affects the use of private capital for public services provision (World Bank, 2015). Overall, municipalities in advanced economies may also use alternative ways to finance local services as pointed out in Andrews and Boyne (2009).

All these issues may hinder correlation between development level and expenditure performance. Hence, our second hypothesis is formulated as follows.

H2 The level of development of cities may influence the municipal expenditure performance, reaching economies of scale.

It is worth noticing that the two hypotheses are related to the pending discussion on the role of urban density on public policy performance. We give empirical evidence on how different economic development stages may influence spending performances contributing to understand if consistencies significantly persist worldwide.

3. Research Method

3.1 Global Municipal Dataset: an overview

Our empirical analysis uses cross-sectional data at the municipal level from the Global Municipal Database (GMD) launched by UN-Habitat with the New York University's Marron Institute of Urban Management and the Lincoln Institute of Land Policy. The database contains budget data from a sample of 102 municipalities worldwide (UN-Habitat, 2018). This database is linked with the Atlas of Urban Expansion (AUE) by Marron Institute and the Lincoln Institute, which includes spatial and planning data from 200 cities.

The regional sample distribution is 30 percent in East Asia and Pacific Countries, 19 percent in Europe and Central Asia, 13 percent in Latin America and the Caribbean, 16 percent in Sub-Saharan Africa, and 11 percent in North America. The remainder belongs to the Middle East and North Africa and South Asia, sharing 5 and 6 percent respectively.

As to GMD limitations, there are issues related to budget responsibilities, which may be affected by several layers of governance and differences in prices of labour, especially for those categories more labour intensive such as security. Furthermore, differences in budget category definitions may emerge in such global sample. For the sake of reducing all biases, a team of city-based experts led the data collection process, gathering the data directly from public records where possible, and in many cases obtaining data directly from municipal government staff using a participatory approach (UN-Habitat, 2018).

Informal areas of cities in developing countries are not considered in official data. We refer to those areas where municipalities do not provide services and communities manage self-provisioning through informal mechanisms.

Despite limitations, the database used for this research is one of the first open-source data at the city level on municipal finance worldwide, including those located in developing regions, like Africa and Asia. GMD fills a geographical gap of the research in this field, which is mostly focussed on developed regions like the USA (Ladd, 1992; Holcombe & Williams, 2008; Carruthers & Ulfarsson, 2008), Europe (Hortas-Rico & Solé-Ollé, 2010; Fregolent & Tonin, 2016), Japan (Miyazaki, 2017), and Australia (Tran et al., 2019).

3.2 Empirical Model

The empirical model drew inspiration from well-consolidated literature on local public spending, especially those exploring cost and demand related factors (Carruthers & Ulfarsson, 2003; Hortas-Rico & Solé-Ollé, 2010; Gielen et al., 2019; Sass & Porsse, 2021). Accordingly, we see expenditure as depending on a group of local factors related to regional features and population size, on the one hand. On the other hand, spending is a function of demand factors like income, tax share, and transfers from higher government level

(Hortas-Rico & Solé-Ollé, 2010). Following this, our empirical approach can be synthesised by the equation:

$$exp = \alpha + \beta_1 density + \beta_2 deveopment + \beta_3 X \quad (1)$$

where *exp* is municipality expenditure (Hortas-Rico & Solé-Ollé, 2010; Sass & Porsse, 2021). As described below, we will test different expenditure items as dependent variables. With *density* we mean to include population density, our target endogenous regressor that, as such, will be handled appropriately. The variable *development* catches the level of economic development, whereas *X* includes a set of controls.
We adopt two different empirical approaches. We first perform an OLS model treating density as exogenous, and then we run an IV regression where the endogeneity of density is appropriately handled (Holcombe & Williams, 2008 and 2009; Drew & Dollery, 2014).

3.3 Dependent variables

As already mentioned, we test different municipal expenditure items (Rico, 2014). All items are expressed in million dollars. According to UN-Habitat (2018), capital expenditure (CEXP) is related to the general purchase and creation of "lasting assets, including land, infrastructure, buildings, or equipment". This does not include the spending for specific infrastructure and services, normal government operations and does not include debt service (Holcombe and Williams, 2008). SANI is the expenditure item for "infrastructure planning and engineering, sewer systems, wastewater treatment, septic tanks, public latrines and subsidies to private sanitation systems, asset replacement and major rehabilitation" (UN-Habitat, 2018). WASTE includes both services and infrastructure planning and engineering for waste treatment. WATER (water services) takes account for water treatment and distribution expenditure, including asset replacement or major rehabilitation. The HOUSING indicator is related to programmes that subsidize affordable housing for specific populations targets, such as low-income households. Among the capital costs this may include land acquisition, construction of housing, and programme assets and facilities. Finally, we consider SECURITY, which quantifies spending on public safety department or programming, and police, courts (UN-Habitat, 2018). As we observe for other categories, capital costs of this category are mostly referred to infrastructure vehicles, facilities, asset replacement and significant rehabilitation.

3.4 Regressors

Explanatory variables include the population density of the city, the economic development stage, and population size. Furthermore, we take into account municipal finance covariates. We list them as follows.

- To measure the variable *density* in equation (1) we will test two indicators, namely log of person per hectare (Logpersonhec), and log of the person - built up area ratio (Logbuiltpercapita) – see Libertun de Duren and Guerrero Copean (2016) and Ida and Ono (2019).
- The development variable is measured through the "Advanced" regressor, a dummy that catches if a city has reached an advanced economic level, following the classification of World Bank (2015).
- The set of municipality level controls X is taken from GMD and includes:
  - Pop, the city population size in tens of thousands (Tran et al., 2019);
  - Transfers is the amount of per capita transfers to municipal budget from higher government entities;
  - Ownsource is the amount of taxation collected by the municipality raised from local taxes and fees, and corresponds to per capita revenue (Carruthers & Ulfarsson, 2003; Miyazaki, 2017);
  - Dec is the amount of expenditure categories financed by each municipality as measure of devolution process (Carruthers & Ulfarsson, 2002; Rodríguez-Pose & Bwire, 2004). This is used

under the hypothesis that more decentralised administration may be more efficient (Hortas-Rico & Solé-Ollé, 2010).

Tab.1 reports descriptive statistics on these variables. Figure 1 shows geographical location of cities and density.

Variable	Source	Variable	Measurement	Mean	Std. Dev.	Min	Max
CEXP	GMD	Metric	USD	1180.352	2992.506	2.333405	15891.8
SANI	GMD	Metric	USD	202.3473	670.7522	0.06	4629.945
WASTE	GMD	Metric	USD	94.47893	338.5314	4.43	2706.406
WATER	GMD	Metric	USD	207.6478	790.5325	1	6490.191
HOUSING	GMD	Metric	USD	149.6497	439.8418	0.04	2303.915
SECURITY	GMD	Metric	USD	735.0063	2856.138	0.01	24966.8
Logpersonhec	AUE	Metric	Persons/hectare	66.56842	56.99658	7	352
Logbuiltpercapita	AUE	Metric	Person/built up area	131.0107	103.5525	20	577
Advanced	GMD	Categorical	1 if yes, 0 otherwise	.2631579	.4426835	0	1
Pop	GMD	Metric	Population	478.97	598.23	10.46	2465.72
Transfer	GMD	Metric	USD	2.26e+09	6.75e+09	3.97e+10	9.83e+09
Ownsource	GMD	Metric	USD per capita	1098	1647	1	8466
Dec	GMD	Metric	Number of services financed	8.78	2.86	1	13
Metro	UN-Habitat	Categorical	1 if yes, 0 otherwise	0.42	0.50	0	1
Openspace	AUE	Metric	Hectare	31957.62	47564.09	396.64	199731.6

Tab.1 Descriptive Statistics

Fig.1 Geographical location of the sample and density

3.5 Endogeneity: approach and robustness check

Endogeneity between public expenditure and density is a critical topic. For this reason, most of the recent research hints at using Instrumental Variables (IV) (Holcombe & Williams, 2008 and 2009; Drew & Dollery, 2014). Following this, we selected appropriate instruments to face endogeneity based on a literature review

as suggested in Libertun de Duren and Guerrero Copean (2016). Of course, our selection was targeted to relevant and valid instruments (Imbens, 2014).

Urban studies theorised a set of practices to act against growing city footprints and lower densities, which are associated with "loss of open space, urban decay, urban air and water pollution, traffic congestion, low-density housing developments, patchwork housing developments in the midst of agricultural land, increasing reliance on the automobile, and a general spreading of urbanized development across the landscape" (Brueckner, 2001). These points were found also in Brueckner (2000), who claims that three market failures contribute to a sub-optimal pattern of land use, namely the failure of development to internalize (1) the benefits of open space, (2) the social costs of traffic congestion, and (3) the cost of the services.

Land use may reduce the sprawling of cities, especially of those oriented towards mixed planning strategies (Alberti, 1999; Freeman, 2001). Most of the empirical research suggested adopting a land use policy. Particularly, literature posits how planning land within urban boundaries may increase the density and mitigate the sprawling of cities (Qadeer, 2004). With this regard, narrative on land use stresses the role of open space to influence directly living conditions, residential and employment densities, and intermixing a variety of land use (Frank & Pivo, 1994; Dehring & Dunse, 2006). As pointed out in Wu and Plantinga (2003), "residents prefer to live close to an open space". In line with this, Martinuzzi et al. (2007) assert that open space is the leverage to make more efficient use of the land. This is primary to revitalize urban centres, re-attracting people, and support more densely populated cities (Martinuzzi et al., 2007).

In parallel, mass transit accessible to residents is advocated as a possible policy prescription to increase the density surrounding the metro areas. In fact, in countries where government policy promotes high-density residential development, transit is an effective tool in shaping development, regardless of density. Transit and land use can be mutually supportive for increasing the urban density (Smith, 1984; Salvesen, 1996). This is also found in Ewing and Cervero (2017) who explain the benefits of denser cities focusing on urban transport and city planning. Ewing and Cervero (2017) stress how transit use is strictly connected with dense development, which is enabled to produce several benefits like reduced household transportation costs, increased social interaction, and social capital. This point is also remarked in recent studies on cities in both developing and developed countries, where transportation and land use change are influential to population density (Lin & Shin, 2008; Ratner & Goetz, 2013; Tian et al., 2017).

Following this literature, we select open space and metro system as instruments. Open space (openspace) is related to the hectare of city allocated to this land use. Instead, metro system (metro) is a dummy variable that equals 1 if city has such transportation system within its boundaries. Although open space and metro system might hide a direct effect on the value of properties and likely on public expenditures, this is not conclusive for all urban settings; rather, this is the effect of several local factors as stressed in Fausold and Lilieholm (1999). Another caveat is related to the type of open space and the metro system that may impact on property value and thus on public expenditure. This is not a standard rule, despite it depends on local features, like distance, land market size and real estate development (Rodriguez & Targa, 2007; Sander & Polasky, 2009; UN-Habitat, 2016). Our approach may be plausibly appropriate for our sample focused on cities belonging to differently developed contexts. The two instruments selected are exogenous and not correlated with the error term in the equation, as we will see afterwards in the robustness check. To test this assumption, we use Sargan test (1958) of overidentifying restrictions and Anderson test (1984) for instrument relevance. This likelihood ratio test is under the null that the equation of interest is under identified. Finally, we performed Pagan and Hall's (1983) tests of heteroskedasticity for instrumental variables. Under the null of no heteroskedasticity, the test statistic is distributed as chi-square with degrees of freedom equal to number of indicator variables. F-test on the instruments in the first-stage regression is included as suggested in Staiger and Stock (1997).

Furthermore, we used robust clustered estimates of standard errors at country level in order to account for potentially non-i.i.d. observations (Cameron & Miller, 2015). The clustered standard error estimates have been considered the most feasible solution to put into account all those country-level aspects the model does not catch, and support the evaluation of the parameters' significance. Finally, we make an IV Lasso to estimate structural parameters in the presence of many instruments and controls based on methods for estimating sparse high-dimensional models (Chernozhukov et al., 2015). This robustness check is included in Tables 4 and 5.

4. Results

We ran OLS first, where CEXP and the other expenditure categories (SANI, WASTE, WATER, HOUSING, and SECURITY) were the dependent variables. Findings gave evidence of misspecification and thus bias as emerged from the Ramsey test. For this reason, we do not include the results of the OLS regressions (see the appendix). We directly shifted to IV regression (Cameron & Trivedi, 2005) whose results are presented in Tab. 2 and 3. They include the two measures of density, person per hectare (Tab.2) and person per built up area (Tab.3), instrumented by openspace and metro. They include clustered standard error at country level.

	(1)	(2)	(3)	(4)	(5)	(6)
	CEXP	**SANI**	**WASTE**	**WATER**	**HOUSING**	**SECURITY**
Logpersonhec	-1440.8	-810.0*	175.4	-1424.3**	137.7	-4491.7**
	(1.58)	(2.24)	(0.86)	(3.04)	(0.63)	(2.89)
Advanced	-3434.7***	-533.8*	157.3	-598.7*	20.79	-1012
	(5.64)	(2.28)	(1.20)	(1.98)	(0.15)	(1.01)
Pop	0.950*	0.468**	0.258**	0.631***	0.232**	2.145***
	(2.37)	(3.16)	(3.09)	(3.29)	(2.58)	(3.37)
Transfer	0.156***	0.00542	0.0158*	0.00498	0.0205**	0.0086
	(4.20)	(0.43)	(2.22)	(0.31)	(2.68)	(0.16)
Ownsource	1.610***	0.205***	0.00292	0.0811	0.0539	0.593**
	(11.99)	(4.10)	(0.10)	(1.25)	(1.77)	(2.75)
Dec	-147.5*	-56.69**	-10.99	-45.08	-0.129	54.22
	(2.24)	(2.61)	(0.90)	(1.60)	(0.01)	(0.58)
Intercept	3564.9*	1774.3**	-235.6	2767.3**	-303	6436.7*
	(2.15)	(2.73)	(0.64)	(3.29)	(0.77)	(2.31)
Anderson	47.865	50.443	50.443	50.443	50.443	50.443
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Sargan	0.264	0.157	0.833	0.672	1.041	0.3
	(0.6071)	(0.6924)	(0.3614)	(0.4123)	(0.3076)	(0.5839)
Pagan-Hall	26.997	53.66	15.177	33.76	25.657	39.544
	(0.0003)	(0.0000)	(0.0338)	(0.0000)	(0.0006)	(0.0000)
F-Test	30.0124	30.7411	30.7411	30.7411	30.7411	30.7411
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Partial R^2	0.47	0.42	0.42	0.42	0.42	0.42
N=102						

Tab.2 IV Regression with Logpersonhec as instrumented variable – clustered SE in parenthesis (*p<0.05, **p<0.01, ***p<0.001)

	(7)	(8)	(9)	(10)	(11)	(12)
	CEXP	**SANI**	**WASTE**	**WATER**	**HOUSING**	**SECURITY**
Logbuiltpercapita	-1,827.4	-1,054.8**	198.9	-1,872.8*	206.5	-5,624.7
	(1905.7)	(344.9)	(258.8)	(763.5)	(359.0)	(3,002.5)
Advanced	-3649.4**	-675.3***	174.1	-856.1*	57.63	-1,691.5
	(1369.5)	(163.1)	(139.0)	(382.6)	(261.9)	(1,956.0)
Pop	0.900*	0.434***	0.269*	0.572**	0.235**	1.925*
	(0.43)	(0.12)	(0.11)	(0.22)	(0.08)	(0.84)
Transfers	0.149***	0.00627	0.0160*	0.00321	0.0210**	0.01
	(0.02)	(0.09)	(0.08)	(0.01)	(0.06)	(0.02)
Ownsource	1.627***	0.220***	0.000761	0.108	0.0504	0.668
	(0.26)	(0.03)	(0.04)	(0.08)	(0.05)	(0.45)
Dec	-138.5	-52.97	-11.67	-38.46	-0.877	73.91
	(114.8)	(31.3)	(19.6)	(47.9)	(19.7)	(58.1)
Intercept	4,762.4	2,516.1***	-336.8	4,108.0*	-483.8	10,098.5
	(3,861.4)	(578.5)	(451.1)	(1,873.9)	(827.4)	(5,683.6)
Anderson	28.068	27.813	27.813	27.813	27.813	27.813
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Sargan	0.114	0.057	1.995	0.328	0.661	1.303
	(0.7355)	(0.8107)	(0.1579)	(0.5669)	(0.4163)	(0.2536)
Pagan-Hall	26.803	48.481	14.214	30.067	25.454	37.658
	(0.0004)	(0.0000)	(0.0405)	(0.0001)	(0.0006)	(0.0000)
F-Test	20.3844	14.4563	14.4563	14.4563	14.4563	14.4563
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Partial R^2	0.32	0.26	0.26	0.26	0.26	0.26
N=102						

Tab.3 IV Regression with logbuiltpercapita as instrumented variable – clustered SE in parenthesis (*p<0.05, **p<0.01, ***p<0.001)

	(13)	(14)	(15)	(16)	(17)	(18)
	CEXP	**SANI**	**WASTE**	**WATER**	**HOUSING**	**SECURITY**
Logpersonhec	-237.259	-46.1747*	190.6005	-207.056*	419.2303	-864.2694
Advanced	-2,323.944***	-51.98684**	85.38065	-144.0906*	35.29072	-127.9016
Pop	0.3757139	0.2501354**	.5439717**	.6862311*	0.221882**	2.560276**
Transfer	0.2213293***	0.0134393	-0.0646811	0.0658619	0.454001***	-0.016063
Ownsource	1.362154***	0.1564087**	807161	0.0948892	0.0590645	1.117265
Dec	-65.20723	-42.27011	-49.34358	-55.79443	-81.44783	-15.58846
N=102						

Tab.4 IVLASSO with Logpersonhec (*p<0.05, **p<0.01, ***p<0.001)

	(19)	(20)	(21)	(22)	(23)	(24)
	CEXP	**SANI**	**WASTE**	**WATER**	**HOUSING**	**SECURITY**
Logbuiltpercapita	204.496	-114.4803*	135.0506	-167.7957*	323.2105	-774.5062
Advanced	-2335.252	-57.97395**	54.13303	116.7284*	2.314799	-34.63093
Pop	0.3931617	0.2642166*	.5630952*	0.7091641*	0.2514827*	2.471434***
Transfer	.2211168***	0.0127987	-0.0582572	0.0640858	.0434905***	-0.0099596
Ownsource	1.363541***	0.1559703***	0.0852757	0.1000074	0.0637038	1.103324
Dec	-66.49773	-40.72005	-44.61104	-55.1805	-75.68576	-6.375162
N=102						

Tab.5 IVLASSO with logbuiltpercapita (*p<0.05, **p<0.01, ***p<0.001)

4.1 Main findings

Looking at the Tab.2, Models 1 to 6 gives evidence that most of our regressors are significant. Our target regressor for density, Logpersonhec, is negatively and significantly correlated with SANI, WATER, and SECURITY. This finding implies that a percentage point increased may reduce the corresponding capital expenditures, which may indicate that denser cities are able to generate economies of scale. Nonetheless, this is not valid for all and intuitively depends on the type of infrastructure and public service.

Interestingly, the economic development variable (Advancedeco) may reach economies of scale for the general budget category CEXP, and for WATER, and SANI services, thus supporting Bergantino et al. (2019) who point out the efficiency of advanced economies to reduce the financial burden of municipalities. Indeed, this result is not surprising if we take into account that WATER and SANI services could be provided by private sector in the advanced economies. In the opposite direction, this mechanism is not adopted extensively in poor and developing countries (World Bank, 2015). In most cases the magnitude of the coefficient (Advancedeco) is lesser than those related to Logpersonhec.

Robustness check is provided through Sargan test of overidentifying restrictions, Anderson and Pagan and Hall's tests of instrument relevance, including F-test and partial R-squared values from the first stage regressions of the set of exogenous variables on the relevant endogenous variable. Our results show that the F-statistic is aligned with the indication of Staiger and Stock (1997), especially when Logpersonhec is significant. After these tests, we observe that the instruments are both robust and relevant for our research hypothesis.

Focussing on the results we obtain when using the second measure of urban density, that is person/built up area (Logbuiltpercapita), they are in line with our assumptions. The direction and significance of our target regressors in Models 7 to 12 (Table 3) change in terms of significance and magnitude if compared to Table 2. Particularly the coefficient of Logbuiltpercapita has a more explanatory power for water services (SANI and WATER) than those captured by the previous measure of population density (Logpersonhec). Furthermore, denser cities may have higher positive effect on specific expenditure than that shown in Advancedeco – Models 8 and 10. Overall, a city of Advancedeco may generate economies of scale for general expenditure (CEXP), Sanitation (SANI), and Water services (WATER) as verified in Models 7, 8, and 10.

Regarding the robustness check, Sargan test, Anderson and Pagan and Hall's test confirm the empirical approach, despite they are weaker than the models in Tab.3. F-test is slightly weaker (Staiger and Stock 1997). Nonetheless, all robustness checks are still valid.

Overall, our findings suggest that density is a significant factor for the expenditure patterns of cities. Our data seem to support both Hypotheses 1 and 2. Specifically, for what concerns Hypothesis 1, density is likely to influence the expenditure performance when we account for specific services, like water, sanitation, and security. This is also confirmed when using Logbuiltpercapita, which seems to have better explanatory power.

Hypothesis 2 is partially supported. Therefore, if a city belongs to more developed countries the performance of local expenditure could be influenced. If this emerges from the general budget category CEXP, the significance and magnitude of the coefficient for other categories (SANI and WATER) gives weaker support than those related to density, especially if we use person/built up area as dependent variable.

4.2 Other evidence

Exploring the results that emerge from control variables, we may stress the following main points. First, population size (Pop) influences most of the expenditure of municipalities, as remarked in the literature (Carruthers & Ulfarsson, 2008; Tran et al., 2019). We observe positive association, in line with the

pioneering research on city size and public expenditure (Alonso, 1964). Throughout the models, larger population influences the spending performance for all budget categories (Tables 2 and 3). This is consistent with urban studies stressing how the population size is a driven force of local finance. This finding may be indicative of the concerns that emerged in most populated cities (Castells-Quintana & Wenban-Smith, 2020).
Transfer from national government, taxation and decentralisation are primary to support municipal finance (Carruthers & Ulfarsson, 2008; Hortas-Rico & Solé-Ollé, 2010). In this sense, the significance of Transfer suggests that it could be crucial for general expenditure (CEXP) and other welfare expenditure such as HOUSING (Tab.2 and 3), remarking its role in financing specific needs of the population. The same direction is found in Models 3 and 9 related to the WASTE.
Regarding own-source revenue from taxes and fees, the variable reports significant correlation with capital expenditure. Interestingly, the positive significance of Ownsource is not for all expenditure categories, as shown in Models 1, 2, and 6. This may produce an increase of expenditure for CEXP and specific category, like SANI and SECURITY. Conversely, it seems that other form of compensation, like transfer from higher government level, may have a stronger role as financial sources of services like WASTE, and HOUSING.
Another remarkable feature emerges from decentralization (Dec), which does not have the expected significance. Looking at Tab. 2 and 3, Dec is negatively associated with CEXP and SANI expenditure (Models 1 and 2). Contrarily to the expectations, more decentralised power is not significantly associated with expenditure performance. However, this finding is aligned with Rodríguez-Pose and Bwire (2004) who discuss how devolution may create inefficiency among government levels.

5. Discussion and conclusion

Over the last two decades, cities have been experiencing a terrific horizontal growth. Connected with this, urban sprawl and low density have raised environmental, social, and economic concerns (Sass & Porsse, 2021; Mert, 2021).
This inefficient urban development model has significant effect on the unit cost of local public services, generating higher levels of local government expenditures, as suggested by the "antisprawl" literature (Carruthers & Ulfarsson, 2008). Nonetheless, the impact is not always verified and transferred homogeneously to all budget categories. There are spending items that are more sensitive to low density, like expenditure on security and public transportation, sanitation, water supply and distribution, road cleaning, and public lighting (Gielen et al., 2019).
In parallel, local context characteristics have become a matter of interest especially to investigate if efficient administration, capabilities and technologies may have a primary role. Thereby, the relationship between planning and municipal finance has been observed by geographical and institutional lens (Hortas-Rico & Solé-Ollé, 2010; Miyazaki, 2017). With this regard, the results on how urban density may impact municipal expenditure and how context may influence local finance are mixed.
Recalling our research question, the empirical results give an indication that this correlation is not a silver bullet. It may change following the type of services and infrastructures. Besides, other factors seem to have a primary role. For instance, it may be asserted that the economic development of city matters. Nevertheless, the significance and magnitude of coefficients give a flavour that this matters less than density in most of the models. On the other hand, population size, own-source revenue, and transfers from higher government levels are relevant, thus influencing the financial performance of local governments.
Based on these findings, three main policy implications emerged. First, urban density can be associated with economies of scale in municipalities' expenditure. Our results stress that making cities denser and thus achieving more desirable living conditions is a right option of urban policy. In particular, density may be influential to centralised facilities like sanitation, water, and security. However, in our view this has to be pursued with a "quality-of-life orientation", as stated by previous contributions (Gyourko & Tracy, 1991;

Carruthers & Ulfarsson, 2008).

Second, advanced economies may perform well in terms of municipal spending, taking advantage likely from rules and regulations, technology, and capabilities. This gives a flavour on the important role of strengthening efficient local government to provide local services in a more effective fashion.

Moreover, the results related to welfare categories remark the role of national government layers to finance local needs, then filling the gap of financial resources. This result seems to be insightful. For instance, social housing is interlinked with contributions from other government layers, giving evidence that specific budget items are dependent on higher government financial transfers.

To this end, spending performance seems to be associated with both planning and governance factors (UN-Habitat, 2014, 2018). In this sense, urban planning may create the right conditions for supporting efficient local expenditures. On the other hand, administrative efficiency may respond to local needs, reaching economies of scale. This latter may recall the idea of Glaeser (2011) who mentioned that laisser-faire is not a good option in urban policy. Rather, it needs a stronger institutional framework, in which cooperation at different government levels may make cities a better place to live for everyone.

In conclusion, our research remarks how urban planning associated with efficient administrative system is crucial to allocate efficiently public goods and services (World Bank, 2015). However, our results should be interpreted carefully, given the variety of global cities included in the sample, which belongs to both rich and developing countries. Analysis on a municipality-by-municipality basis may provide more accurate evidence, especially if data at the neighbourhood levels are provided. This is a challenge, especially in developing regions in Africa and Asia, where informality, lack of transparency and reliable data may have a key role. For this reason, the main contribution of the paper stands in testing some hypotheses about municipal finance, density and economic development using micro data, and therefore in finding if some regularities persist across a global sample, including developing countries' cities. To the best of our knowledge, our research is the first attempt to analyse this topic based on the information collected directly from cities across the world.

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Appendix

	CEXP	SANI	WASTE	WATER	HOUSING	SECURITY
Logpersonhec	83.06	-224.4	-110.3	-424.2	-56.49	-1859.6
	(634.3)	(237.1)	(134.6)	(298.6)	(147.5)	(1015.6)
Advanced	-2771.8***	-278	32.5	-161.9	-64	137.5
	(541.4)	(201.8)	(114.6)	(254.2)	(125.5)	(864.5)
Pop	0.632	0.347*	0.317***	0.423*	0.273**	1.598**
	(0.379)	(0.137)	(0.078)	(0.173)	(0.085)	(0.588)
Transfer	0.182***	0.00514	0.0209**	0.023	0.0170*	0.0389
	(0.035)	(0.011)	(0.006)	(0.0147)	(0.007)	(0.049)
Ownsource	1.557***	0.188***	0.0114	0.0515	0.0597	0.515*
	(0.133)	(0.049)	(0.028)	(0.062)	(0.030)	(0.213)
Dec	-149.4*	-57.22*	-10.73	-45.98	0.0446	51.86
	(66.37)	(21.84)	(12.40)	(27.52)	(13.59)	(93.57)
Constant	980.1	776.2	251.4	1062.7	27.92	1950.5
	(1238.7)	(453.4)	(257.5)	(571.2)	(282.0)	(1942.5)
Ramsey Test	7.38	29.58	4.55	5.24	3.33	47.26
	(0.0003)	(0.0000)	(0.0053)	(0.0023)	(0.0235)	(0.0000)
N=102						

Tab. 6 OLS check for misspecification (Ramsey Test) - clustered SE in parenthesis (*p<0.05, **p<0.01, ***p<0.001)

	CEXP	SANI	WASTE	WATER	HOUSING	SECURITY
logbuiltpercapita	308.7	-261.5	-174.7	-251.3	-137.9	-2648.7*
	(634.7)	(239.3)	(135.3)	(304.4)	(148.5)	(1006.6)
Advanced	-2665.8***	-302.8	-1.361	-94.71	-104.1	-294.1
	(549.3)	(206.2)	(116.6)	(262.3)	(127.9)	(867.4)
Pop	0.607	0.333*	0.316***	0.367*	0.278***	1.547**
	(0.365)	(0.131)	(0.074)	(0.167)	(0.081)	(0.553)
Transfers	0.186***	0.00536	0.0215**	0.027	0.0160*	0.0336
	(0.035)	(0.011)	(0.006)	(0.014)	(0.007)	(0.047)
Ownsource	1.548***	0.191***	0.0146	0.0482	0.0631*	0.558**
	(0.133)	(0.0499)	(0.0282)	(0.0634)	(0.0309)	(0.21)
Dec	-151.1*	-56.32*	-10.09	-45.3	0.575	61.36
	(66.36)	(21.83)	(12.34)	(27.76)	(13.54)	(91.81)
Constant	505.8	919.8	415	845.4	209.1	4110.4
	(1405.3)	(523.5)	(296.0)	(665.8)	(324.8)	(2201.9)
Ramsey Test	7.25	20.83	9.64	6.26	3.8	62.35
	(0.0003)	(0.0000)	(0.0000)	(0.0007)	(0.0133)	(0.0000)
N=102						

Tab. 7 OLS check for misspecification (Ramsey Test) - clustered SE in parenthesis (*p<0.05, **p<0.01, ***p<0.001)

Image Sources

Fig.1: Author Elaboration from UN-Habitat (2018).

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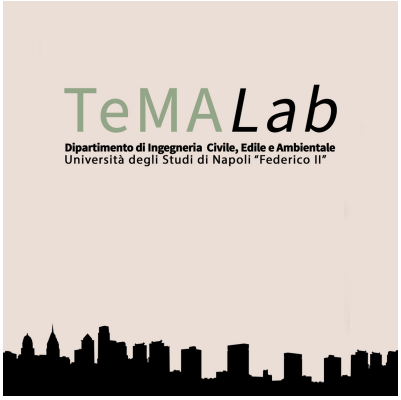

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 67-78
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/8295
Received 11th November 2021, Accepted 22nd February 2022, Available online 30th April 2022

www.tema.unina.it

Mobility infrastructures as public spaces. A reconnection project

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Abstract
The essay deals with the theme of reconnecting, through urban planning and public works design, the relationship between mobility infrastructure and spaces for social life. The first part contains a historical reflection on the integration between mobility infrastructures, commercial/directional facilities and public spaces. The second section analyzes the consequences determined by the advent of the car and the urban explosion on this relationship. The third part of the essay develops a critical reflection on the way we look at the relationship mobility/public space and proposes a change of perspective. The concluding section of the essay contains some specific proposals, of a planning and normative kind, to recover the integration between mobility facilities and public/private spaces for social life in contemporary cities.

Keywords
Mobility infrastructures; Public places; Urban explosion.

How to cite item in APA format
Giovannoni, G. (2021). Mobility infrastructures as public spaces. A reconnection project. *Tema. Journal of Land Use, Mobility and Environment*, *15* (1), 67-78. http://dx.doi.org/10.6092/1970-9870/8295

1. Mobility infrastructure and public space in the historic city

Mobility infrastructures are unquestionably among the spatial elements that most characterize, for better or for worse, contemporary urbanization and the daily lives of its inhabitants. Their environmental, aesthetic and social harmonization is essential in order to raise the quality of life of cities and of suburban areas. In order to correctly design and rehabilitate mobility infrastructures, however, it is necessary to grasp, among other things, how their role of facilities for social life has evolved over time. In fact, I argue that this aspect has not been sufficiently developed in historical research and in theoretical reflection on mobility and on contemporary public spaces.

In pre-modern cities, public space and mobility infrastructures were largely overlapping and often coincided. Territorial routes connecting different cities inexorably converged at the heart of cities, often intersecting at their center, which was also their main public space. When they crossed urban centers, these great arteries of communication had an intrinsically urban connotation and constituted the main spines on which the most important public facilities were linked. Several years ago, as I was still a student, I became aware of this. I was driving along the Via Cassia, one of the consular roads originally built by the ancient Romans, from the Val d'Orcia towards Florence. Once I got close to the city of Siena, mistakenly ignoring a sign restricting private traffic, I continued straight on. After a while I found myself in a street with a very narrow section, in the midst of astonished pedestrians who barely had enough space, in the narrowest part of the street, to pass between my small car and the walls of the houses facing each other. I was on the famous Via de' Banchi in Siena, the urban stretch of the Via Cassia, in fact a medieval highway that pointed straight to the heart of the city. As an enthusiast of urban history, I was perfectly aware of the fact that the territorial routes crossed urban centers while connecting them. However, I had never appreciated in such a direct manner the perfect coincidence – in a restricted space such as the spine constituted by the ancient Via dei Banchi and the Via di Città – between large mobility infrastructures, commercial nodes and large directional poles. Indeed, the Via de' Banchi took its name from the ancient presence of numerous 'banchi di cambio' (exchange banks) and was, in fact, the heart of one of the most important medieval financial centers. All flows – financial, commercial and mobility – were intercepted by the city and channeled into streets that, although they were often very narrow, were able to simultaneously accommodate multiple functions.

The case of the Via Cassia was once again emblematic as this road crossed Florence. It entered the city center through Porta Romana, one of the medieval urban gates, and reached the urban center after having crossed the Arno River. The overcoming of this barrier was made possible by the Ponte Vecchio, today an exclusively touristic and pedestrian space, but at the time a real mobility node, whose function was comparable, on a strict transportation level, to that of the Ponte Morandi in Genoa: it allowed mobility flows to cross the city and it overcome physical and natural barriers. However, with its double row of stores and its panoramic views over the river, this infrastructure – used at the same for transport, commerce, and social life – interpreted at best the concept of multifunctional hybridization. To go on with the Florentine case, it is also illustrative of the centripetal force exerted by the urban center the fact that the Dogana (customs house) was located inside Palazzo Vecchio, that is at the very center of the city. Today Piazza della Signoria is exclusively touristic and completely pedestrian. However, in the past we can imagine it filled with carts waiting their merchandise to be inspected for taxation.

Although the facts described above are in themselves well known, I believe that the question of the coincidence in the historical city between mobility infrastructures, directional/commercial spaces and public/social spaces, has not so far been made explicit in such terms. And yet a reflection on these specific aspects that characterized the historical city is, in my opinion, fundamental in order to fully grasp the implications that the transformations brought about by the advent of the automobile have had on our way of conceiving, on the one hand, the mobility infrastructures, and, on the other, the main public, commercial and directional spaces that in the historical city were an integral part of them.

2. The urban explosion and its effects on mobility systems

The urban growth caused by industrialization and urbanization and therefore the subsequent crisis of the historical mobility networks has led to the inevitable abandonment of the traditional way of conceiving and designing transport infrastructures and the public spaces integrated with them. Much literature has been written on the functional separation brought about by the emergence of the principles promoted by the Modern Movement and urban planning based on zoning and on functional separation. This literature, with its often nostalgic accents, has not been followed by a similar discussion of the implications that the transformations described above have had on the relationship between public space and transport infrastructure. These, on the one hand, have led to the separation of large traffic flows from urban centers and, on the other hand, have entailed the almost complete decoupling of transport infrastructures and urban public spaces. The urban crisis took place at staggered times based on the level of industrialization and motorization of different countries and cities. In large American cities, such as Boston, Chicago and New York, it manifested itself as early as the turn of the 19th and 20th centuries.

The solutions adopted in the different countries were diverse. In the United States the removal of large traffic flows from the Central Business Districts was going to damage huge economic interests, so it was tried to safeguard the accessibility of these through the creation of true urban highways. These entailed huge public works and massive demolitions inside city centers. The case of the Central Artery, built in Boston in the 1950s as the John F. Fitzgerald Expressway, is one of the most emblematic. Funded with $100 million worth of bonds, it involved the destruction of large parts of the city's most central neighborhoods and was met with enormous opposition by residents and businesses that were being harmed (Fig. 1)[1]. In the mid-1970s, due to its devastating effects on urban livability, plans were already being made for its undergrounding. At the beginning of the 1980s the first projects were drafted and after seventeen years of work, in 2007, the new underground freeway was inaugurated. This further titanic work of engineering had cost, at current values, the gigantic sum of 24 billion dollars[2]. Despite these huge investments, however, the attempt to safeguard the economic and financial interests of the Central Business Districts was doomed to failure. Demographic, financial, commodity and mobility flows would have shifted inexorably to suburban areas, triggering ruinous trajectories of decline and of social and material degradation in the downtown areas. In some cases, these central spaces, once thriving business districts, would never again experience a real recovery process.

In Italy, these phenomena began much later. The rate of motorization began to grow exponentially in the late 1950s. This, in turn, determined a real crisis in the now obsolete historical mobility network. Already in the mid-1960s, the first experiments in pedestrianizing some parts of the historic centers began. At the same time, large-scale programs for the construction of new infrastructures and for functional decentralization were conceived. These projects adopted different planning models. To remain in the Florentine area, the Detti Plan, adopted in 1962, proposed a model of decentralization organized along a major axis connecting Florence to Prato and hosting the main commercial and directional facilities. However, compared to the rapidity with which the 'suburban flight' reconfigured the economic and social geography of large American

[1] "Property takings and evictions had begun in 1950, and a cloud of impending disaster wafted gradually over the city's oldest and most cohesive residential neighborhood. […]. A swath of destruction slowly worked its way south through the commercial heart of the North End and then into the downtown core. Progress was slowed by holdouts: Hay market meat merchants delayed their eviction until new quarters had been furnished; one tenant of the small commercial row building at 200 Milk Street held up demolition in that area for a month before vacating; work halted for a week near Fulton Street in the North End after a boy who had been playing amid the wrecked buildings was injured. By the fall of 1953, however, the demolition had progressed as far south as Oliver Street, near Fort Hill Square". Tsipis, Y., "Boston's Central Artery", Charleston, Arcadia, 2001, p. 8.

[2] Moskowitz E., "True cost of Big Dig exceeds $24 billion with interest, officials determine", Boston, Boston.com, July 10, 2012, available at https://www.boston.com/uncategorized/noprimarytagmatch/2012/07/10/true-cost-of-big-dig-exceeds-24-billion-with-interest-officials-determine/ [accessed 09/10/2021].

cities, in Italy the decentralization process took place in a much slower and incomplete manner, reaching a degree of completion only in the last thirty years.

Fig.1 Boston Central Artery, 1958

In fact, until a few decades ago the regional system was still urban-centric. Each portion of the urbanized countryside gravitated towards a historic center where all services (commercial, directional, etc.) were located. Today, such a hierarchy has definitely collapsed and historic centers are just nodes, often peripheral, of wider regional systems whose barycenter is in the periphery. The main commercial, service, and directional functions, both public and private, have moved towards the edge of urban areas, close to major arterial routes. New social spaces have arisen in peripheries as well: from outlets to sports facilities, from multi-theaters to gas stations, from entertainment centers to parking lots. These same historic centers are used in very similar ways to shopping malls: you get the car, find parking in a multi-story garage, and plunge into a crowd of consumers. In terms of regional hierarchies we have shifted from a polycentric system to a centrality that is dispersed throughout the entire urbanized territory.

These structural changes are not recognized and accepted by most scholars and politicians. They go on conceiving the city and the country as two totally distinct worlds. Metaphors alluding to urban walls (urban boundaries, green walls, etc.) are largely used to symbolically or physically mark boundaries that only exist in our minds. In the 'urbanized countryside' as well as in most suburban peripheries such boundaries are simply impossible even to imagine. Aside from the fact that a sharp distinction between city and country never existed in the past[3], the problem with this way of conceptualizing the territory is that it obstructs our capacity to solve real problems and to seize the many opportunities that contemporary suburban landscapes

[3] Bruegmann R., "Sprawl: a Compact History", Chicago, The University of Chicago Press, 2005, pp. 21-32.

offer[4]. New social spaces are assimilated into the non-places of an alienated existence. The corollary of such an absurd postulate is that nobody takes up the task of controlling and guiding the production of these spaces in order to maximize the benefits to society[5]. A paradigm shift is a prerequisite for better-balanced development: the shift consists of recognizing that the periphery has become the center.

3. The rhetoric of 'non-places': a way of looking that obstructs our view

The concept of non-places, introduced by Marc Augé in his 1994 book of the same name, is often used to describe most of the spaces that characterize the contemporary city. This use is widespread among architects and urban planners, who often qualify as 'non-places' spaces ranging from shopping centers to airports, car parks, service stations, public housing districts, and the suburbs in general. I believe that the concept of the non-place is an ideological device that is both useless and harmful. Its uselessness derives from its inadequacy to describe any social-spatial system. In fact, by qualifying a space as a non-place, a generic negative connotation is attributed to it and, in fact, its deeper understanding is precluded. The harmfulness of this concept is a direct consequence of its futility. By preventing us from understanding the complexity of the social dynamics that take place in space, the concept of non-place ends up by greatly limiting the design capacity of architects, urban planners, and politicians. This is particularly regrettable, since the spaces considered non-places by dominant urban thinking correspond to much of the contemporary city and its suburbs. Therefore, it stands to reason that the frequent use of this concept would manifest a widespread attitude that is unscientific, ideological and nostalgic to the study and planning of the contemporary city and suburban areas.

What Augé defines as non-places constitute the main social structure of the contemporary city. This social framework has been little studied by academics, and neglected by architects, urban planners and politicians, who have only in a handful of cases been able to plan and design it in a way that is appropriate to its economic and social function. I argue that by challenging Augé's concept of non-places and proffering a theory that instead elevates and promotes these important spaces, it would be possible to manage and organize them appropriately as well as explore their full potential through architectural and urban design.

For Augé, non-places are the product of what he defines with the neologism 'supermodernity' (surmodernité), that is, the current condition characterized by three main figures of excess: overabundance of events, spatial overabundance, and the individualization of points of reference. For Augé, supermodernity, that is to say the present era characterized by excesses, essentially produces non-places, i.e. spaces without history, identity and social relations[6]. The concept of non-place is defined by Augé in opposition to that of anthropological place. Of variable size, the anthropological place is such insofar as it is an entity invested with meaning. It is also concerned with identity, as a place of birth and of self-identification; relational, as the object of a shared identity as well as support of social relations; and historical, as it is stable over time and it is possible to find in it points of reference that are considered as fixed and immutable. On the contrary "a space which cannot be defined as relational, or historical, or concerned with identity will be a non-place"[7].

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4 Sieverts T., "Cities Without Cities. An Interpretation of the Zwischenstadt", New York, Spon Press, 2003, pp. 12-43; Ingersoll R., "Sprawltown. Looking for the City on its Edges", New York, Princeton Architectural Press, 2006, pp. 1-22.

5 This is paradoxical even in historical terms: the shopping mall was invented in 1940s by a socialist utopian, Victor Gruen, in order to create a place for public life in the suburbs; in his visionary Broadacre City, Frank Lloyd Wright conceived gas stations as community centers.

6 "[N]on-places are the real measure of our time; one that could be quantified – with the aid of a few conversions between area, volume and distance – by totalling all the air, rail and motorway routes, the mobile cabins called 'means of transport' (aircraft, trains and road vehicles), the airports and railway stations, hotel chains, leisure parks, large retail outlets, and finally the complex skein of cable and wireless networks that mobilize extraterrestrial space for the purposes of a communication so peculiar that it often puts the individual in contact only with another image of himself". Augé M., "Non-Places: Introduction to an Anthropology of Supermodernity", London, Verso, 1995, pp. 51-52.

7 Ibid., pp. 77-78.

Although the title of Augé's book speaks of the 'anthropology of supermodernity', his definition of non-places – and his repeated classification of their features – is not presented as a research hypothesis to be verified through accurate anthropological work but is a kind of 'ideal type'[8]. It is interesting, therefore, to consider the concept of non-place in light of Max Weber's definition of ideal type: "It is a conceptual construct (*Gedankenbild*) which is neither historical reality nor even the "true" reality. It is even less fitted to serve as a schema under which a real situation or action is to be subsumed as one instance. It has the significance of a purely ideal limiting concept with which the real situation or action is compared and surveyed for the explication of certain of its significant components"[9].

If we assume that Augé's non-place falls into the category of the ideal type described by Weber, what is missing from the work of the French anthropologist is the comparison of this concept with the empirical reality of which Weber speaks in the above definition. Spaces that are identified as non-places are never described and studied by him except in a generic, abstract and atopic way. This is the case when he speaks of shopping centers, which he claims are experienced "through gestures, with an abstract, unmediated commerce; [and that are] a world thus surrendered to solitary individuality, to the fleeting, the temporary and ephemeral"[10]. Similarly, he imagines a hypothetical user of non-places as a "foreigner lost in a country he does not know (a 'passing stranger') [who] can feel at home there only in the anonymity of motorways, service stations, big stores or hotel chains"[11]. Also following this model are his descriptions of airports and stations, perhaps the spaces that are closest to the ideal type conceived by Augé.

Now, as we have seen, the non-place is defined as the negation and opposite of the place. The latter is such only if it is historical, identitarian and relational. Even this definition is questionable to say the least. In fact, by prioritizing the characteristics of history and identity, the concept of place thus refers to a narrow and potentially perverse conception of the relationship between space and community, one in which those whose histories and identities are not rooted in the place where they live – who make up a considerable and growing share of the population of every contemporary city – might in theory have no right to claim to belong to that community or territory[12].

Being representative of the current era, non-places describe what Henri Lefebvre would have defined, albeit in different words, as the production of abstract space in contemporary capitalist society. Behind the concept of non-place, in fact, there is on the one hand a general criticism of urbanization, and on the other, a yearning for the pre-industrial city. In fact, Augé's book is dominated by a clear nostalgic accent, which can also be discerned in works by many of the great critics of contemporary urbanization, including Lefebvre. It is important to give due attention to the persistent longing for the old city, as it continues to have profound effects on the way space is being produced today.

The notion of non-place developed by Augé in 1992 is part of a broader narrative characterized by nostalgia for the city of the past and by phobia of the contemporary city. Nostalgia for the city and countryside of the previous era has shaped the planning debates in Europe and the United States since their originations[13]. I will focus in particular on Lefebvre, an author who had a strong influence on the urban debate and policies

8 This is somehow recognized by Augé himself when he states: "Place and non-place are rather like opposed polarities: the first is never completely erased, the second never totally completed; they are like palimpsests on which the scrambled game of identity and relations is ceaselessly rewritten" (ibid. p. 79).

9 Weber M., "The Methodology of the Social Sciences" (trans. Shils E.A. and Finch H.A.), Glencoe (IL), The Free Press, 1949, p. 93.

10 Augé, "Non-Places", 78.

11 Ibid. 106.

12 In my opinion, the notion of place defined by Augé risks interpretation in this narrow and exclusionary sense. For a critique of such concepts of community and place, see for example: Sennett R., "Community Becomes Uncivilized", in "The Fall of Public Man", London: Penguin, 2002, 294-312; Harvey D., "From Space to Place and Back Again", in "Justice, Nature, and the Geography of Difference", Cambridge (MA), Blackwell, 1996, pp. 291-326.

13 See for example: Secchi B., "Il racconto urbanistico: la politica della casa e del territorio in Italia", Torino, Einaudi, 1984; Boyer C., "Dreaming the Rational City: The Myth of American City Planning", Cambridge, MA, MIT Press, 1983.

in Europe since the early 1960s[14]. Lefebvre's critique of contemporary urbanization is based on the Marxist concepts of work and product, use value and exchange value. While use value is related to the utility of a good, exchange value refers to its selling price. For Lefebvre, contemporary urban growth has abandoned the traditional urban model in favor of abstract urbanization. Whereas the city of the past was a work (oeuvre) and was socially experienced according to its use value, contemporary urbanization is conceived as a product to be exchanged on the market as any other good. The shift from the traditional city to urbanization, determined by the advent of industrialization, causes the disappearance of community relations typical of pre-industrial societies: in fact, contrasting with today's model, in the past the city was considered a work of art to be used and enjoyed without any consideration for profit[15]. In addition to being poorly supported in terms of historical research, this way of representing the old city is quite idealized. In contrast, the representations of the periphery provided by Lefebvre are strongly dystopian. Also, they have more than one point in common with Augé's descriptions of non-places[16].

It is not difficult to take a contrasting viewpoint and see how, in many cases, the monumental splendour of historical cities had opposite meanings to the positive ones attributed to them by Lefebvre. For example, many of the old monuments were nothing more than the architectural and urban codification of a deeply hierarchical, unjust and authoritarian social and political order. Not to mention the baroque monumentality of Haussmann's Paris, that was produced by policies of social and spatial purification of the centre of Paris, to the detriment of the lower classes. Correspondingly, it is possible to find numerous positive representations of contemporary mobility as a symbol of freedom and emancipation, both at class and gender levels.

Such a perspective on the contemporary city is deeply rooted in the urban debate in the West, and has significant effects on the way we understand and govern it. In the United States, the condemnation and demonization of sprawl and suburbs commonly perpetuated by planners and policy-makers prevented them from grasping the complexity and diversity that certainly characterizes the American suburbs, in terms of social and ethnic composition, built environment and lifestyles[17]. Only a small number of more recent studies have attempted to account for this complexity[18].

In Italy and Europe, the myth of the city of the past is even more deeply rooted. In the German context, Thomas Sieverts argues that the myth of the compact city of the past prevents us from correctly understanding and designing peripheries, i.e. the living space of most people. For this reason, he focuses his attention on the analysis and design of the Zwischenstadt, or in-between city, that is, that hybrid mixture of

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14 In the Anglo-Saxon context, the scholar who most contributed to what we could call 'suburbs-phobia' is certainly Jane Jacobs, with her landmark 1961 book "The Death and Life of Great American Cities", New York, Vintage, 1961.

15 "This city is itself *oeuvre*, a feature which contrasts with the irreversible tendency towards money and commerce, towards exchange and *products.* Indeed the *oeuvre* is use value and the product is exchange value. The eminent use of the city, that is, of its streets and squares, edifices and monuments, is *la Fête* (a celebration which consumes unproductively, without other advantage but pleasure and prestige and enormous riches in money and objects)." Lefebvre H., "*Writings on Cities"* (trans. Kofman E. and Lebas E.), Oxford, UK, Blackwell, 1996, p. 66. Author's italics.

16 "Urban reality, simultaneously amplified and exploded, thus loses the features it inherited from the previous period: organic totality, belonging, an uplifting image, a sense of space that was measured and dominated by monumental splendor. It was populated with signs of the urban within the dissolution of urbanity; it became stipulative, repressive, marked by signals, summary codes for circulation (routes), and signage. It was sometimes read as a rough draft, sometimes as an authoritarian message. It was imperious. But none of these descriptive terms completely describes the historical process of implosion-explosion (a metaphor borrowed from nuclear physics) that occurred: the tremendous concentration (of people, activities, wealth, goods, objects, instruments, means, and thought) of urban reality and the immense explosion, the projection of numerous, disjunct fragments (peripheries, suburbs, vacation homes, satellite towns) into space." Lefebvre H., "The Urban Revolution" (trans. Bononno R.), Minneapolis, University of Minnesota Press, 2003, p. 14.

17 Many scholars have a dystopian view of suburban areas. A list of works which reflect this perspective, certainly too long to be made here, would include: Davis M., "City of Quartz", New York, Verso, 1990; Duany A., Plater-Zyberk E., and Speck J., "Suburban Nation: The Rise of Sprawl and the Decline of the American Dream", New York, North Point Press, 2001; Silverstone R., ed., "Visions of Suburbia", New York, Routledge, 1996.

18 Interesting examples of this type of research are: Nicolaides B.M. and Wiese A., eds., "The Suburb Reader", London, Routledge, 2006; Archer J., Sandul P. and Solomonson K., eds., "Making Suburbia: New Histories of Everyday America", Minneapolis, MN, University of Minnesota Press, 2015.

city and countryside which is one of the main features of most suburban areas[19]. On a similar slant, Rem Koolhaas speaks of the historical centers of the past as symbolically strong apparatuses that are now completely inadequate to support articulated and complex urban systems. And yet, their cultural and symbolic weight prevents the 'new city' from being understood and designed for what it is[20].

In fact, consolidated representations of historical cities and of contemporary suburbs strongly inhibit our ability to interpret and design peripheries. Augé's book certainly belongs to this type of polarized utopian/dystopian representation and is widely used by architects and planners to describe the contemporary city in opposition to the city of the past. My thesis is that the so-called non-places (i.e. mobility infrastructures, shopping centers, multiplexes, service stations, etc.) that the French scholar speaks about and that are strictly connected to the new mobility networks play the role of 'squares' – understood as the traditional places of urban sociality – of the contemporary city. However, while the debate on the dialectics between the centre and the periphery is now quite consolidated, that on the relationship between traditional public spaces/mobility infrastructures and the new social spaces on the periphery is much less developed.

4. Designing 'non-places' as the social infrastructures of the suburbs

Our inability to understand the role and potential that so-called 'non-places' assume in contemporary society determines a more general incapacity to grasp the demand for sociality that exists in the periphery. What is it that obstructs our gaze and inhibits our planning? According to Sieverts, the persistence of the 'myth' of the old town is responsible. From Europe to the United States, suburbs and suburban areas are generally ostracized, because they do not fit with the traditional and stereotypical image of the city. To be seen in this way, a city must correspond to the urban canons of density, of mixed-use, of a certain relationship between solids and voids. These canons, codified in Jane Jacobs's urban theory and easily found in European and North American cities before the First World War, prevent us from considering as a 'place' whatever does not conform to them. From this perspective, only the square and the street possess full dignity as public spaces. Koolhaas, as we have seen, maintains that the centre, with its symbolic weight, continues to orphan the periphery and prevent us from appreciating its real importance and relative weight in contemporary urban systems. However, his analysis, just like Sieverts's, limits itself to providing an overview of the periphery as a whole without considering its social spaces. This consolidated view of traditional public spaces as the only legitimate social spaces of our cities has strong negative implications for the ways in which contemporary spaces are regulated at a functional, infrastructural and performance level, and designed at an architectural and social level[21].

Despite the recognized importance of shopping centers in contemporary society these spaces continue to be considered by many the enemies of the retail trade, the 'bad giants' who close the shops of the town

19 Sieverts T., "*Cities Without Cities. An Interpretation of the Zwischenstadt*", New York, Spon Press, 2003.

20 "Identity centralizes; it insists on an essence, a point. Its tragedy is given in simple geometric terms. As the sphere of influence expands, the area characterized by the centre becomes larger and larger, hopelessly diluting both the strength and the authority of the core; inevitably the distance between centre and circumference increases to the breaking point. In this perspective, the recent, belated discovery of the periphery as a zone of potential value —a kind of pre-historical condition that might finally be worthy of architectural attention— is only a disguised insistence on the priority of and dependency on the centre: without centre, no periphery; the interest of the first presumably compensates for the emptiness of the latter. Conceptually orphaned, the condition of the periphery is made worse by the fact that its mother is still alive, stealing the show, emphasizing its offspring's inadequacies. The last vibes emanating from the exhausted centre preclude the reading of the periphery as a critical mass. Not only is the centre by definition too small to perform its assigned obligations, it is also no longer the real centre but an overblown mirage on its way to implosion; yet its illusory presence denies the rest of the city its legitimacy." Koolhaas R., "S,M,L,XL", New York, Monacelli Press, 1994, pp. 1248-1249.

21 Alternative views were not absent in Italy (e.g. Viganò P., "La città elementare", Milano, Skirà, 1999), Europe (e.g. Sieverts T., "Cities Without Cities. An Interpretation of the Zwischenstadt", cit.) and the United States (e.g. Fishman R., 1990, Megalopolis Unbound, in *The Wilson Quarterly*, vol. 14, n. 1, pp. 24-45). However, these viewpoints are in the minority and have not transformed, if not marginally, policies for the suburbs.

centre[22]. Polemicists of the 'small shops closing syndrome' do not acknowledge the facts that the majority of the population has been living in the suburbs for some time now, and that many lack the resources to go shopping in the city centre. However, in the United States, this rhetoric has been swept away by the advent of electronic commerce and by the subsequent phenomenon of 'dead malls'. Now that shopping centres are disappearing, their loss is also being lamented. These spaces, after all, have enjoyed considerable importance in the social and cultural history of tens of millions of Americans[23]. Many shopping centers, in the United States, had a significant social function and often represented the only type of central space in suburban areas. In them were held fairs, concerts, election rallies, cultural events (Fig. 2).

Fig.2 Election rally of the then Vice President Richard Nixon at a shopping mall in Warren, Michigan, 29 October 1968

Although to a less controlled extent from an urban and architectural point of view, similar phenomena have spontaneously occurred in the shopping centers of the Italian suburbs[24]. The rapid evolution of e-commerce could quickly make Italian and European shopping centers obsolete as well. The fact remains that these centers have been and still are exclusively regulated as consumption spaces. For example, the legislation in force in Tuscany, drawn up on the basis of the national framework legislation, sets out the number of parking spaces that must be provided in relation to the selling surface. It also limits the number of large shopping centers that

22 Unfortunately this is still the dominant approach to shopping mall planning and design of Italian and Tuscan policy-makers. However some scholars, in Italy and abroad, developed considerations on the potential of shopping malls as public places (e.g. Facchinelli L., ed., "Centri commerciali, le nuove piazze" [special issue], *Trasporti e cultura*, 51, 2018). Also, Victor Gruen, who is considered the inventor of the American shopping mall, was inspired by a real social activism and conceived his commercial developments as vibrant privately owned collective spaces (Gruen V., Smith L., "Shopping Towns USA. The Planning of Shopping Centers", New York, Reinhold Publishing Corporation, 1960; Gruen V., Baldauf A., "Shopping Town. Designing the City in Suburban America", Minneapolis, University of Minnesota Press, 2017). In any case, in Italy and beyond, these insights did not affect national and regional legislation on such commercial facilities and were therefore unable to determine, in most case, their evolution into accomplished social spaces.

23 Steven Kurutz, "An Ode to Shopping Malls", *The New York Times,* July 26, 2017. Accessed November 23, 2018. https://www.nytimes.com/2017/07/26/fashion/an-ode-to-shopping-malls.html.

24 Giovannoni G., "Tuscany beyond Tuscany: Rethinking the City from the Periphery", Firenze, Didapress, 2017, pp. 109-124.

can be built. However, it does not give any guidance about the range of public and private functions that should be realized, the accessibility that should be provided for the various modes of transport (cycling, walking, driving, public transit), the necessity of creating some spaces of an exclusively public nature and that of providing adequate urban furnishings (such as seating areas and the like) (Fig. 3)[25].

Fig.3 A beautifully landscaped commercial space: Old Orchard shopping mall, Skokie, Illinois, 1968

Similar considerations, taking into account the difference in scale and the smaller radius of influence, can be made in relation to the planning of petrol stations. Although most of the petrol stations are exclusively technical facilities, some of them may well become, as recent research has demonstrated, small centers for the local community[26]. Urban planning and fuel distribution plans should acknowledge this reality and rework their regulations to recognize the difference between facilities providing simple petrol pumps and car washes, and the integrated service stations that could have a wider role in serving local communities. For the latter, functional hybridization with complementary social and commercial activities should be encouraged, and better accessibility from the surrounding residential areas should be ensured.

This reconceptualization should involve a much more varied set of 'types' of new public spaces, which would include outlet villages, airports, multiplex cinemas, service stations, large car parks and sports facilities. Outlet villages could be thought of as gates that connect the highway network along which they are located with the surrounding regions. By integrating commercial functions with tourist and social services, the economic and social benefits of these large magnets could be distributed over wider regions. The airports, usually conceived as negative elements that reduce the real estate values of the surrounding areas, could be transformed into generators of positive externalities, as places of attraction in which to dine at night while observing the air traffic, to visit exhibitions and commercial spaces, to avail of personal services, and to participate in political and social events. All that points to the broader problem of adapting operational planning tools to contemporary social, environmental, and climatic challenges (Mazzeo 2016).

[25] The issue of accessibility by public transport is particularly relevant for the elderly population, which is often prevalent in suburban areas built between the 1970s and 2000. On this topic we refer to the special issue of this same journal (Bricocoli M., Brouwer A.E., Gargiulo C., Elderly Mobility [special issue], "*TeMA Journal of Land Use, Mobility and Environment*" 2, 2018).

[26] Giovannoni G., "The Social Life of Gas Stations", The Journal of Public Space, Vol. 1, pp. 75-94.

The transformations I have described above are in part already underway. However, they are almost exclusively led by big economic actors, without any capacity for control and direction by national and local political and administrative bodies. As I have tried to demonstrate, it will only be possible to develop an adequate regulatory framework and reach design potentials once the annihilating and obscuring rhetoric of the non-place has been overcome. This would involve deconstructing the consolidated and dominant narratives on this subject and basing our knowledge of these spaces on accurate socio-anthropological work that would allow us to grasp and appreciate their social relevance and functionality.

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Author's profile

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TeMA
Journal of
Land Use, Mobility and Environment

TeMA 1 (2022) 79-87
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/8297
Received 18th September 2021, Accepted 20th March 2022, Available online 30th April 2022

www.tema.unina.it

About non-knowledge in knowledge management for planning: Towards an applied ontological approach

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Abstract
This work contains reflections on the awareness of how the lack of knowledge and the unknown are important elements to consider during any territorial and environmental planning process. The unknown can affect dramatically the effectiveness of choices and start a chain of unpredictable consequences. The awareness of such issues emerged dramatically with the recent pandemic. Plans often deal with policy decisions, planning decisions that interest collectivity, human and non-human beings, our space, our territories and our time (or portions of time). Such plans (either for households or a city or a region) have to cope with unexpected events, uncertainties, with unwanted consequences. After an exploration of some theoretical aspects of knowledge and non-knowledge, we argue about the extent to which ontologies can be a useful conceptual approach to deal with the lack of knowledge and the unknown in planning.

Keywords
Spatial planning; Decision-making support; Ontological models; Non-knowledge.

How to cite item in APA format:
Stufano Melone, M.R. & Camarda, D. (2022). About non-knowledge in knowledge management for planning: Towards an applied ontological approach. *Tema. Journal of Land Use, Mobility and Environment*, *15* (1), 79-87. http://dx.doi.org/10.6092/1970-9870/8297

1. Introduction

Reflections reported in this work are part of broader research framework that aims to improve the use of the applied ontology method in environmental and territorial planning for cognitive and practical tools useful to manage knowledge. When managing knowledge, the other coin side of non-knowledge emerges, made of uncertainty, ambiguities, deep unknowns that fatally affects the results of a strategic plan or, more in general, of the efficacy of environmental and planning choices.

This topic emerged dramatically after that the 2020 pandemic outbreak, when the SARS-CoV2 virus hit us unexpectedly. But more than anything else it was the population that was unprepared, as well as unaware. Also, the politicians and the entire administrative chain were probably unprepared for the possibility that we might be ever hit by a pandemic event. Or rather, politicians had previously been unprepared if not shortsighted, when very many little apparently unrelated and subtle clues circulated together all around the planet, in a chain of causes and contributing factors scattered in space and time not systemically readable in a coherent perspective. Even if some scientific and popular literature had tried to made the point to get the message home, it seems that no decision or choice was taken to change the course.

In a preliminary paper, we proposed a very first exploration of this topic when dealing with unstructured knowledge in informal contexts (Borri et al., 2011). Subsequently, we explored engineering and management literature, reporting methods, and tracing different approach sketches to manage this issue. The idea was to integrate existing methods for more robust decisions, starting from a knowledge base built on applied ontological approach (Stufano Melone & Camarda, 2021).

Here, we intend to keep mainly the theoretical and philosophical aspects that arose during the study of the topic, putting the non-knowledge issue in the planning decision process perspective. In this context, we will reflect on the unexpected events that emerged downstream of a famous planned development strategy, the case of Taranto steelworks, more coherently contextualized in the planning domain. Unlike COVID-19 pandemic, it was not a sudden outbreak: yet the scale of apparently unexpected events has unfortunately brought well-known dramatic consequences in the long term.

Often plans are about policy decisions, planning decisions that interest collectivity, human and non-human beings, our space, our territories, and our time (or times). Those plans (either for households, or for a city, or a territory) have to cope with unexpected events, or events with unwanted consequences. Environmental and territorial planners constantly deal with decisions that affect whole communities (both anthropic and non-anthropic ones).

Planners and policymakers face complexity in decisions for the territory and the environment (Perrone, 2010). The complex system planners cope with, the complexity of the issues and problems of planning activities push planners and decision-makers to deal with ignorance of policies and decision-making processes (Van Assche & Verschraegen, 2008; Luhmann, 1997). Luhmann's systems theory offers insight into the limits and possibilities of planning in contemporary society and creates space for a complex and fine-tuned analysis of planning practice (Luhmann, 1997). This could help in considering planning activity according to the consciousness of the non-knowledge. In Luhmann's words, we can read how for decades, planning had to deal with the problem of complexity to find better solutions using an approximate method of building models or simulations, by a slow adaptation of society to planning (Van Assche & Verschraegen, 2008; Luhmann, 1997).

This is the framework in which we develop our arguments. After our short introduction, we will explore the positioning of the definition of non-knowledge in section 2; then we deepen the concept of managing ignorance in section 3. In section 4 we propose the example of Taranto city that suffers hard consequences due to a kind of unexpected that arose in recent decades and stayed unseen when choices were taken. In section 5 we propose an ontological method to deal with un-data, also with reference to literature, whereas section 6 shows conclusions and possible follows-ups.

2. About positioning non-knowledge (or ignorance)

Territories are made of space, but also of time and of agents that inhabit them: cities are a paramount example in this concern (Borgo et al., 2021). Planning activity affects agents, non-agents, space and its objects in time: it reveals its impacts during events properly. Here, we would like to explore and try to explicit the consciousness of the huge complexity we are immersed in, and of the huge amount of contents and realities we deal with in the wider largeness of our space-time environment. To do this, we should cope with the task of listing all what is in our realm and what is beyond the reach of our direct knowledge.

In this regard, let's have a brief digression in the philosophical field, without any ambition to enter or initiate a strictly philosophical debate. In fact, some references to philosophical literature which follow (specifically to Gumbrecht's thought expressed in his book 'Our broad present') are intended just as a useful suggestion to reflect in perspective on what we do not know, and which lives in our own time without our knowledge. That will be a philosophical reflection useful to position our considerations with respect to the vast complexity in which we move. According to the 'historical thought' (Gumbrecht, 2014), the human projects themselves along a linear path that moves through time, the future appears as an open horizon of possibilities to which human tends. According to the 'short present', epistemologically the 'historical time' becomes the place where the Cartesian subject (who denies space and body and therefore the physical presence) chooses from the possibilities offered in the future itself (Gumbrecht, 2014). This experiential choice between the possibilities of the future becomes the pre-requisite and the general structure of what is called agency. According to Gumbrecht (2014), we live in a broad present made of technological hyper-communication and globalization, and we do not live in the 'historical time' anymore, our future seems to be more and more closed to any prevision, it is no more an open horizon of possibilities (Gumbrecht, 2014). But, when it seems that anything is plannable, controllable and calculable, then any unforeseen side effect is often dramatic (Schubert, 2019). Indeed, that is the ancient curse of hybris, well known and much reviled and feared in classical Greek culture: i.e., the arrogance towards the gods (we could say nature) and fate (we could say the future) that today innervates our acting - so technological and at the same time blindly defenseless with respect to the outcomes of itself.

Gumbrecht reports an example about climate change (Gumbrecht, 2014) – but we could similarly refer nowadays to the example of the COVID-19 pandemic. He assumes climate change consequences as completely known, and what remains to discover is whether humankind will be able to change its lifestyle. In this perspective of a not-open future the past fills the present thanks to the perfection of the electronic memory, the blocked present seems to become the only temporal dimension, it becomes a kind of simultaneity in expansion (Gumbrecht, 2014). It is fundamental to enable humans to control the future by planning and shaping events in desired ways. This ability is linked to knowledge, memory and creativity (Stufano Melone & Camarda, 2021).

Knowledge/non-knowledge dichotomy and the different nuances of uncertainty are around us, and in some cryptic way conditionate the time we live in and the chains of consequences that take place in the realm completely unobserved or forgotten. Knowledge defines a capacity to act (Stehr, 2002), whereby the capacity to act does not mean that the actions performed always correspond to the available knowledge. Knowledge, then, does not equate to action, but the implementation of knowledge depends on certain social and political conditions (Zimmermann, 2018).

Therefore, it seems essential to address some research efforts about environmental/territorial/urban planning according to a non-knowledge awareness. Architecture, models and tools applied for managing the uncertainty do exist somehow, for example, the ones pertaining to DMDU - Decision Making Under Deep Uncertainty (e.g., Marchau et al., 2019). Yet, at the same time, it could be useful and interesting to try to go beyond them and more deeply explore the subject of non-knowledge.

3. Dealing with the consciousness of ignorance

Broadly speaking, knowledge in planning can be split into two types: process knowledge and content knowledge. Process knowledge indicates what we learn during the interaction with other agents (von Schönfeld et al., 2019). Instead, content knowledge deals with learning about 'who knows what', and then over time, referring to 'who knows', asking them to provide context-specific advices based on their knowledge (von Schönfeld et al., 2019). Non-knowledge is the medium of 'reflexive modernity' (Schubert, 2019).

It is necessary to reflect on the ways of transforming ignorance into a usable tool in conditions of complexity, uncertainty, and multiplicity. Usable ignorance and learning experience propose an even more conscious relationship between knowledge and action (Perrone, 2010).

Planning and plans include many long-term dimensions, while environmental/territorial/urban reality changes quickly, whether planned or unplanned: the only predictable aspect about this topic is its unpredictability (Schubert, 2019). Given a problem, decision-making requires an integrated and holistic view of various alternatives, their possible consequences, and conditions (including acceptability, legislation, and institutions) for implementation (Marchau et al., 2019).

Climate change is characterised by physical, biological and chemical uncertain dynamics. While exposures to risks by individuals change, the uncertainties in preferences and values, uncertainties in vulnerabilities and uncertainties to new technologies make the exact nature of these uncertain changes (Buurman & Babovic, 2016).

A paradigmatic example is climate change. It shows a fundamental challenge to bringing analytical insights into policy decisions because of deep uncertainties. Climate change is commonly mentioned as a source of deep uncertainty for choices. And it is a consequence of actions made ignoring possible consequences and destroying natural equilibrium.

4. Exploring the known unknown: the example of Taranto steel plant

In the theory of local economic development, several models have been studied particularly aimed at the regeneration of decaying or poor local communities. In particular 20th century, with two world wars and frequent periods of depression, stimulated many reflections in this sense (e.g., Keynes, 1936; Von Mises, 1949; Hirschman, 1958). The famous 'growth poles model' was conceived after World War II just to structurally attempt to recover local economies, brought to their knees by great conflicts (Perroux, 1955). In Europe this model was operationally employed in some paradigmatic cases, starting from the 1950s-1960s, of which the case of Taranto is perhaps the most historically cited example (Schachter, 1965; Pichierri, 1990; Masi, 2012; Camarda et al., 2014; Borri & Camarda, 2017). The Taranto growth pole was part of a strategic plan for the regeneration of some depressed Italian areas, specifically for accelerating the transition to an industry-based economy. The mechanism was based on the construction of an industrial-production chain driven by a growing demand for categories of goods that were considered to be constant for the future. It was a question of generating a production process of outputs that were inputs for the production of intermediate goods oriented to support a final production of consumer goods. It was the concept of the so-called 'backward linkages', that is the identification of a horizon of certainty of consumption, in relation to which a long-term production (and development) process could be shaped backwards (Hirschman, 1958; Schachter & Pilloton, 1984). The industrial typology chosen to start this pole was the basic steel industry, which at that time was founded on the need for a large unskilled labor force, a large availability of energy, and a relatively low technological level. The Italian South (known as "Mezzogiorno") and particularly Taranto offered agricultural labor in large quantities and largely suffering after the war times, thus naturally suitable to start that alleged perspective. Moreover, the Italian state needed to fund the production of steel for its local industries (primarily for FIAT brand cars) and to found it on a 'social' purpose. In fact, in addition to the provision of wage security, it also included expectations of an automatic on-field retraining of workforce, towards more entrepreneurial attitudes.

In short, the model of the growth poles applied to the "Mezzogiorno" evoked future scenarios of liberation from the uncertainties of an agricultural economy through the certainty of an industrial wage and the perspective of a transition towards entrepreneurial activism. Yet the growth pole strategy substantially missed such articulated perspective, as constantly shown by social and economic trends in literature (Pichierri, 1990; Masi, 2012; Camarda et al., 2014). Also, it was not a zero-cost process, as it mostly promoted aggressive and transformative rather than conservative attitudes towards the use of local resources and natural environments - with dramatic impacts on human health (Banini & Palagiano, 2014; Greco, 2016; Maretti, 2014).

Looking out on the balcony of the twenty-first century, particularly from the Taranto context, we are now aware of the chain of events and the large cognitive gaps that have substantially established the rather widespread failure of the growth pole model. First of all, the increase in energy prices, initiated by the Yom Kippur war (Painter, 2013), already at the end of the 1970s led to growing employment cuts to offset the higher energy costs. Yet it was certainly not an unexpected perspective, since the growing scarcity of environmental resources was already studied in the 1960s, with collected data and alarms that remained unheard (e.g., Odum, 1953; Carson, 1962; Boulding, 1966). Then, the policy of job cuts continued in a structural way in the following decades, accompanied by increasing investments in technology as a replacement for labor. But not even this circumstance was outside the widespread scientific knowledge, following the evolutions of the last two centuries of continuous technological development (Ricardo, 1817; Samuelson, 1989; Woirol, 1996). Furthermore, in contrast to the predictions of the theoretical model, the industrial economic transition turned out to be incomplete and insufficient, often keeping agriculture active, as an ^integration' of industrial wages even generating figures of symptomatic hybridization (see the ^metalmezzadro', or iron/countryside worker) (Romeo, 1989). The circumstance reveals that the symbiotic bond of the local community with the rural identity has never actually broken in millennia of history - this was clearly evident in the expressions of regret and veiled perplexity constantly reported in the chronicles and testimonies of the time (Porsia & Scionti, 1989; Romeo, 1989). To date, however, the aspects most commonly considered as a deleterious legacy of this experience are the great environmental and health problems suffered by the local community. These were perhaps the two least predictable elements with the knowledge of the 1960s - being the environmental heritage in the post-war agricultural-rural Mezzogiorno intrinsically rich and flourishing. Yet it is well known that the problem of urban and industrial pollution had already appeared in the European steel industry from the 19th century and in the poisoning induced in the USA by pesticides in the mid-20th century (Carson, 1962; Davis, 2002).

Admittedly, it is evident that the knowledge of all these aspects was extemporaneous, unsystematic, incomplete, perhaps elitist: yet certainly not absent. They are in fact complex, low-structured yet actual forms of knowledge - to which today, however, we have learned to attribute growing and often vital importance in the decision-making process (Kain & Söderberg, 2008; Stufano Melone et al., 2019). It is difficult to say whether the awareness of that multiform and multi-source knowledge could have made it possible to avoid the failure of the growth pole - also because an essential knowledge factor was also discretionary political power, after all. However, it seems important to note that a more structural consideration of complex knowledge, using complex and articulate support models such as ontologies and ontology-based models, would certainly have allowed more aware decisions and strategies, able to produce a more manageable process overall.

5. Modelling 'un-data', how to implement taxonomies and ontologies? Literature retrieve

Today system elements are tightly connected, and black swans (Taleb, 2007) seem to be more numerous than previously: we could even assume that they are neither so rare nor so unexpected any more. Precisely we are more conscious in these years that unpredictable events happen, even though we do not know in what form

they will take place and when. We cited the examples of climate change or the last COVID pandemic event still affecting the world today.

Probably, the best aim could be to prepare and adapt (to prepare for uncertain events) by monitoring how events evolve and allowing adaptations over time as knowledge is gained (to implement long-term strategies) (Marchau et al., 2019).

We previously hypothesized to use an architecture starting from a knowledge base built on applied ontological analysis and referring to a foundational ontology like DOLCE (Gangemi et al., 2002). Here we intend to explore the literature in this scientific field about the use of ontologies in managing non-knowledge, uncertainty, ambiguities and different interpretation.

Concerning the knowledge of space, the tools developed on an ontological basis allow the use of 'form' and 'relation' objects, as terms themselves inserted within the ontological structure.

Among the foundational ontologies that have offered the most widespread and interesting applicative results we find the ontology DOLCE - Descriptive Ontology for Linguistic and Cognitive Engineering, developed at the Laboratory of Applied Ontologies in Trento (Italy) as part of the wider international WonderWeb project (Guarino, 1998; Masolo et al., 2002; Borgo & Masolo, 2009; Gaio et al., 2010). DOLCE was developed to capture the ontological categories that emerge in natural language and common sense.

The ontological categories of DOLCE intend to reflect the structures of language and cognition of the human being (Gaio et al., 2010). DOLCE was used as a starting point to develop ontologies for the chosen domain: in this procedure the categories of DOLCE were assumed within the structure and the concepts of the reference domain were added to them from time to time (Gaio et al., 2010; Borgo & Masolo 2009; 2010).

Ontologies provide common vocabularies or terms, as well as their relationships, to enable the formal representation of domain-specific knowledge (Noy & McGuinness, 2001; Wang et al., 2019). This made ontologies a fair candidate to manage the huge amount of data and relations among different agents (human and non-human). In the last decades, there was a progressive use of an applied ontology to different fields pertinent to humanities, medicine, social sciences, archaeology, environmental planning, geography, urban studies, architecture. As put down by McKeague, "Spatial information is increasingly used to guide heritage management policies, from urban design to rural planning and tourism" (McKeague et al., 2019).

In our research work, we hypothesized to apply ontological analysis and ontologies to support the decision in the creative process in architecture, as well as in the clarification and sharing of knowledge in planning processes having as a reference DOLCE foundational ontology. The idea of managing uncertainties and unknowns with ontologies is a step further in this research path.

The management of the uncertainty in decision processes with ontologies is an explored topic in literature. A certain number of publications deals with this issue applying it to environmental managing (Minhas & Berger, 2014), about managing uncertainty in integrated environmental modelling (Bastin et al., 2013), or about how to cope with uncertainty in a designing process (Wang et al., 2019). A few results in the literature have been achieved, with interesting outcomes and perspectives.

6. Conclusion

The emergence of SARS-CoV2 virus and of the following dramatic pandemic outbreak posed the focus on how planners deal with the unknown in organizing our cities and our territories and our habits too. We saw how the way we live, use and organize our spaces and our social relations were changed by this pandemic. Could anyone have foreseen it? It is not possible to reduce the set of non-knowledge. But as humans maybe we can't stop planning, designing for the future. On one side, we can challenge the non-knowledge with our imagination, and interesting examples can be put down about it (Stufano Melone & Camarda 2021; Hactuel et al., 2018; Stufano Melone & Rabino, 2014).

As said we have to cope with non-knowledge and the unexpected. In order to act directly on available knowledge and 'stress' it in different dimensions to activate new connections and relations that stay latent and invisible, we hypothesize to use an ontology-based method. An effort to organize and manage such 'knowledge/non-knowledge' entities, issues and relations in an ontological based system seems to be suitable to deal with the inherent complexity of structures at hand.

Indeed, in previous works about non-knowledge and its role in planning actions, we examined available models and tools to mitigate lack of knowledge and unknown aspects. For example, we explored the potentials of a Neuronal scenario-building approach, employing an artificial neural network (ANN) tool starting from a knowledge-based built on applied ontological analysis, using a foundational ontology – i.e., DOLCE (Gangemi et al., 2002; Stufano Melone & Camarda 2021).

Starting our reflection from the paradigmatic crisis following the pandemic outbreak, we tried to generalize about the consciousness of the unknown and unexpected that are around us in our time. We broadly explored the theoretical and philosophical implication of the lack of knowledge and the unknown in decision processes. We also explored literature in the ontological field to retrieve results of the efficacy of the proposal of using ontologies to manage non-knowledge. Of course, this work is at a very first explorative step, even if literature seems to confirm a fair number of suggestions and potentials in favour of the importance of the path to follow. Therefore, the future directions of this research will be devoted to this interesting perspective of knowledge modelling.

Author's contribution

The present paper is the outcome of a research work carried out jointly by the two authors. Nonetheless, D. Camarda wrote chapter 4, whereas M.R. Stufano Melone wrote all other chapters.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 89-110
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/8322
Received 12th October 2021, Accepted 28th February 2022, Available online 30th April 2022

www.tema.unina.it

Sustainable urban regeneration in port-cities. A participatory project for the Genoa waterfront

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Abstract
Urban regeneration is an increasingly emerging topic in our urban realities. The challenge that the port-cities have to face lies in the disposal of large areas (often located on the waterfronts), in which it is necessary to establish new functions, to overcome the condition of marginal and degraded areas and become an integral space of the cities and of interaction with the element of water.
The paper reports research developed in the university field starting from a public competition. The research starts from an in-depth study in the literature of the definition of urban regeneration, from the analysis of virtuous international case studies to arrive at the identification of an approach and key issues to be able to develop a regeneration process that is sustainable and leads to an improvement in quality of life of its inhabitants. Particular attention is paid to current policies and strategies related to concepts such as: sustainability, circular economy, resilience and new technologies. According to the "learning-by-doing" approach, the Pra'-Palmaro case study is analyzed here to highlight the strategies implemented for a multi-disciplinary and multi-stakeholder urban regeneration project. The research can therefore help other port-cities in the world to realize sustainable urban regeneration, also attentive to the participation and involvement of stakeholders.

Keywords
Regeneration; Port-cities; Sustainability; Participation.

How to cite item in APA format
Pirlone, F., Spadaro, I., De Nicola, M., Sabattini, M. (2022). Sustainable urban regeneration in port-cities. A participatory project for the Genoa waterfront. *Tema. Journal of Land Use, Mobility and Environment*, *15* (1), 89-110. http://dx.doi.org/10.6092/1970-9870/8322

1. Introduction

1.1 Urban regeneration in a port-city: international sustainability policies and participation

The research reported in the paper explores the theme of urban regeneration in a city-port: an increasingly emerging topic in our urban realities.

Our cities, or port-cities, represent the crucial areas in which to intervene to improve living conditions and promote sustainability. The current COVID-19 pandemic, combined with the climate emergency, translate into an urban emergency, where it is important to intervene (Barbarossa et al., 2014).

Today, 55% of the world's population lives in urban areas, a proportion that is expected to increase to 68% by 2050 bringing the city's resident population to 2.5 billion people. This phenomenon of population growth will raise demand on services (transportation, infrastructure, waste management, etc.), energy consumption and emissions, leading to increasing pressure on sustainable urban planning (Aslan & Ince, 2019). Urban regeneration is carried out through actions aimed at the recovery and requalification of urban space, limiting the land's use with a view to environmental sustainability. It has the primary aim of improving the life's quality of the people, through an intelligent use of urban spaces, without losing focus of the peculiarities of the context. It can be considered as the virtuous outcome of the interplay between the different elements that characterize urban systems, such as: political power, physical components, social dynamics, environment and economic context (Bottero et al., 2017). Indeed, it represents a sustainable practice, as it operates improvements on the environmental sphere, reducing the anthropic and energy impact on the ecosystem, social, creating new places of gathering, and economic, bringing value to places (Carta, 2008).

In particular, regeneration has taken place in degraded peripheral areas and in disused industrial sites, urban voids which, once regenerated, return to the citizens and increase the value of the context (De Giovanni et al., 2016). This need for recovery today is increasingly felt, not only for the lack of new spaces and the regulatory limits for new buildings, but especially for the spread of a new culture of environmentally friendly recovery. In addition, it has in several cases proved to be an opportunity to promote policies of active participation of the community, contributing to employment and improvement of the social and cultural context. This is one of the aspects that differentiates the broader concept of urban regeneration from that of redevelopment, which for intent is not dissimilar, but which lacks this meaning of integration of environmental, economic, social and cultural aspects, with the involvement of the communities that will live the regenerated places.

The paper intends to explore the issue of urban regeneration of a port city, especially with regard to the waterfront area, that sort of "permeable urban surface" evolves from contact with the water until to involve the internal parts of the city (Pirlone & Erriu, 2016). «Port cities are cities which grow up in close connection with their ports. Over the years, ports influenced cities development becoming the main driver for urban sprawl» (Ugolini et al., 2017). In many cities, history teaches us that for different political reasons, such areas have sometimes been poorly planned or managed.

The regeneration of the waterfronts is a complex issue, a plurality of multidisciplinary aspects and the resolution of numerous problems are involved. Careful study in the functional, social, economic and cultural fields therefore requires (Greco, 2009).

By restricting the discussion of the topic to the port-cities, we are referring to those realities that have a close link with the port system and can be considered born and sup-ported by this activity. In these cities the sea is the place from which threats of conquest had come, but also possibilities of commercial traffic and, above all, fundamental cultural contributions, which have shaped the character of the cities themselves. Taking action in these realities is not easy, because they are complex spaces where two systems interact, the urban center and the port, which present different needs and are often in conflict with each other (Conca, 2013). Also

«investment decisions must strike a balance between the demands of the Public Authority, which seeks to take full advantage of urban transformation in terms of public services and the subject private oriented to maximizing profits and reducing risk» (Rosasco & Lombardini, 2020).

Due to the quantity and complexity of the activities carried out in the past, this meeting place between city and sea has always tended to be uncrossable, in particular for the presence of areas for port or industrial use. Only in recent decades, thanks to the decommissioning and relocation of some sites, there has been a transformation, which has led the waterfronts from being a place of physical limit to becoming the axis of the new urban structure, an integral part of the city and a space of interaction with the water element. Waterfront regeneration is also fundamental for urban mobility and tourism. Port-cities can use old ports' areas to promoting sustainable mobility - develop new transport infrastructures, bicycle lanes or pedestrian zones - or offering new activities for tourists near the sea. This evolution has restored centrality to these places, which become spaces of everyday life and attraction, for the convergence of a plurality of cultural, economic and social incentives, acting as generators of urban quality (Carta, 2008, 2010, 2016).

To improve the existing urban regeneration processes in the light of current international sustainability policies and strategies is therefore necessary. And understanding the urbanization trends that are likely to develop in the coming years is crucial for the implementation of the 2030 Agenda for Sustainable Development, including efforts to forge a new urban development framework.

Sustainable urbanization and /or regeneration is key to successful development. As the world continues to urbanize, sustainable development depends increasingly on the successful management of urban growth. This aspect is more important, especially in low-income and lower-middle-income countries where the pace of urbanization is projected to be the fastest. The main challenges facing these countries are related to ensuring access to infrastructure (transportation, energy systems) and social services for all such as education, employment, health care and a safe environment.

Policies and funding to manage urban growth is important that they are fully shared, inclusive and therefore centered on urban areas, guided by local needs for which to propose local solutions. In parallel, to develop integrated policies that simultaneously strengthen the links between urban and rural areas is important. These strategies must therefore be built on the basis of their existing economic, social and environmental links.

The research therefore proposes a sustainable urban regeneration, where the latter term also means the involvement of stakeholders.

Local Agenda 21' (LA21), introduced by Chapter 28 of the' Action plan for sustainable development 'adopted at the Earth Summit in Rio in 1992, taught us the importance of participation in improving decision-making processes. «Chapter 28 is an appeal to 'local authorities' to engage in a dialogue for sustainable development with the members of their constituencies. This dialogue seeks for a new participation process where the communication between local authorities and all local stakeholders goes beyond existing and traditional consultation. By nature LA21 is therefore a participatory reform» (Coenen, 2009).

Agenda 2030 makes us reflect about on the importance of investing in cities. In particular, SDG 11 ("make cities and human settlements inclusive, safe, resilient and sustainable") «with its ambition for cities to become inclusive, safe, resilient and sustainable until the year 2030 points to the emerging international consensus that good urban governance has become a matter of global concern». All aspects present in this objective are important for the research developed.

SDG 11 includes a series of sub-objectives that are directly linked to a circular approach at the urban level. Target 11.b then introduces another important aspect in the research developed here, that of resilience.

In summary, the aim of this work is to report result of a systematic analysis of practices and models in the current context of urban planning and to detect the main challenges in adopting sustainable practices and community-based models in the urban regeneration of our port-cities.

Subsequently, according to the "learning by doing" approach, the Pra'-Palmaro case study is analyzed here, at a local level, to highlight the winning strategies for urban regeneration (Salizzoni et al., 2020; Coaffee et al., 2018).

The result of the research is a methodological approach (which suggests the introduction of some new aspects) to support the implementation of an urban regeneration process. This approach is attentive to current policies and strategies related to the concepts of sustainability, circular economy, resilience and new technologies. The research therefore proposes a sustainable urban regeneration, also attentive to the involvement of stakeholders. But also an approach that considers in a circular way the themes of urban planning (transport systems, energy, waste,...), planning sustainable urban development and regeneration that closes production cycles.

1.2 Virtuous experiences of urban waterfronts regeneration at international level

The research analyzed several international case studies that can be considered good practices with respect to the theme of urban waterfront regeneration. Specifically, this section considers three cases: the waterfront of the French city of Lyon, the redevelopment project of New York and that of the city of Genoa, where the methodology presented later in the paper was applied.

Lyon is an important city in France, located at the intersection of two major rivers, the Rhône and the Saône. In recent decades Lyon was interested by an intensive urban and landscape design activity, with the achievement of high-quality results. This process began in the 1990s and particularly involved the redevelopment of public space, giving priority to the relationship between city and nature, the improvement of mobility and the increase of cycle and pedestrian paths. In order to manage the planning of the city, an organisation called Grand Lyon was set up in 1966. It gathered 55 townships and took action on different areas to enhance the regeneration of Lyon. In those years the environmental and cultural changing of Lyon began, with the implementation of a sequence of plans for the government of the territory. In 1991, an overall project was approved for the development of the Rhône and Saône waterfront, which in 1998 merged into the so called Plan Bleu (Ferretti, 2020). Meanwhile the Plan Vert was drew up (Fig. 1).

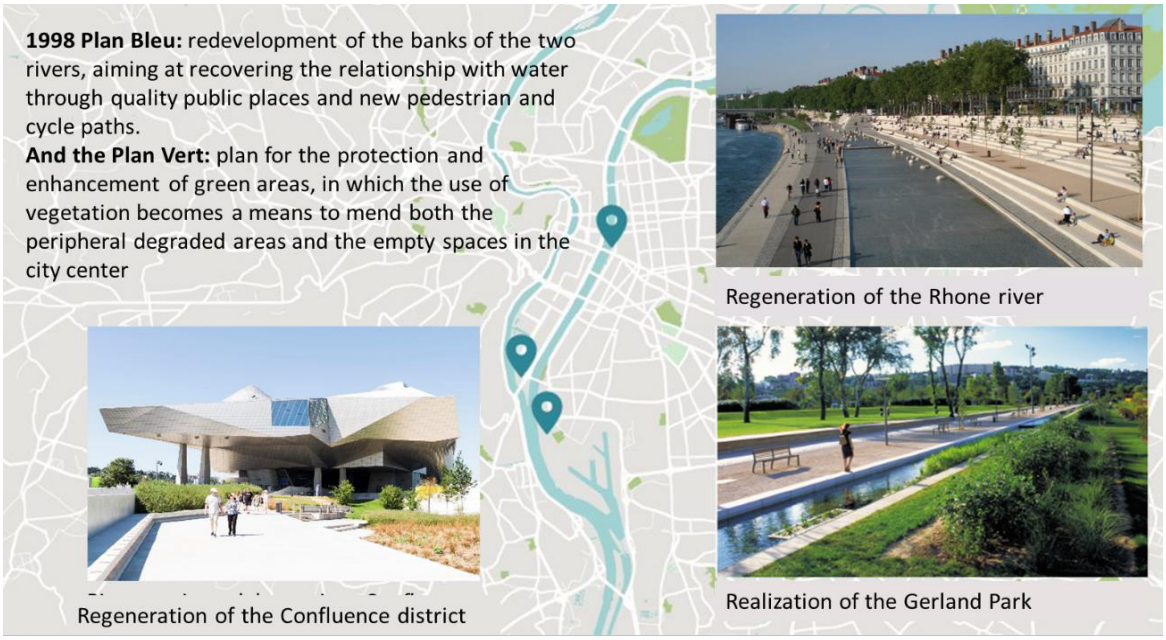


Fig.1 Participation and the main projects of waterfront's regeneration in Lyon

Lyon was studied in depth because it represents a case of participatory urban regeneration, which focused mainly on the relationship with water and vegetation, making public spaces the starting point for the regeneration of the entire city. Despite the extension Lyon is a reality where the typical degradation of large cities is not felt and it represents an exemplary case of integral regeneration of public space.
The redevelopment of the Long Island, ex-industrial area, with the Hunters' Point South Park, is one case of waterfront reusing make them accessible, resilient and sustainable to climate change. The city park has been included in a planning strategy that uses the area as both an urban park and a residential area hosting 5000 residential units. The plan took shape through the succession of two construction phases: the first phase (2011-2013) redeveloped the area by equipping it with green spaces, games for children; the second phase (2015-2018) involved the southern lot by providing "wetlands" and a cantilevered platform that offers a remarkable view of the Manhattan skyline (Hilburg, 2019). The entire project is characterized by different green ecological bands that develop longitudinally for the entire lot, creating multiple path systems. The articulation of the routes also allows a variable relationship with the water, in some panoramic and elevated points, in other proximity points. In the area there are a café and a vaporetto stop The roof houses photovoltaic panels that provide enough energy to support the needs of the pavilion and the lighting of the park. The design of the park also considered the future and inevitable rise of the water level, the sustainability of the materials and the maintenance of the places after construction. In fact, the points of contact with water, cliffs and platforms, have been designed to allow a progressive increase in the water level in a controlled way and in such a way as to allow the use of the park in safety. The vegetation of the park consists of salt marsh plants that do not require active irrigation, reducing maintenance costs, and also act as a natural buffer to floods. The vegetation also has the role of cleaning and filtering the river waters. The materials used to fill the cliffs and the paths derive from the reuse of the aggregates already present on the site, as in the nineteenth and twentieth centuries the area was used as a landfill to dispose of the soil excavated by neighbouring railway yards (Fig.2).

Fig.2 Resilience to climate change: Hunter's Point South Park in New York

After the industrial crisis of the 1970s and 1980s, Genoa started a process of urban, economic and social regeneration, thanks above all to events for which it received funding from the European Union.
The value of these events lies in the fact that they didn't end with the event itself, but were a springboard for subsequent long-lasting development and regeneration projects. In this way entire areas of the city have been reconverted, through restorations of facades and urban renovations in the historic center, changes in road system and pedestrianization projects.
A milestone was the "Colombian Expo" (1992), the manifestation held for the 500th century of the discovery of America. On this occasion, the reconnection between the historic center and the city waterfront was realized by the recovery of the Area of the Porto Antico.
Renzo Piano's project has provided a multifunctional destination of the site, through the recovery of the buildings, the creation of public space and a connection with the historic center, also realized thanks to the burying of the roadway behind. In addition, the project has planned the construction of an iconic structure such as the Bigo, capable of connoting the image of the city, as well as the Aquarium, which has become one of the major attractions of Genoa. Other projects in the area have been implemented in view of the G8 Summit in 2001.
For Genoa European Capital of Culture in 2004 the projects focused on the western side of the port, in implementation of the Dock Redevelopment Program, with the construction of the Galata Maritime Museum.
In conjunction with the interventions carried out in view of big events, other transformations have been undertaken thanks to the so-called "complex programs" of urban regeneration. These interventions have made possible to achieve an integration between the redevelopment of buildings, public space and an overall social, cultural and economic revitalization of places.
The role of the University of Genoa was important for the regeneration of the historic center and the waterfront. The establishment of facilities in these areas has led to a complete renewal, attracting students and leading private investors to open new activities. In this way the image of these neighbourhoods was revived, from the point of view of tourist attendance, real estate value and quality of life.
Important urban transformation interventions have been carried out also in the suburbs of Genoa. The Fiumara project was significant, built on an industrial site in disuse for 20 years.

Fig.3 Urban empties to rebuild the link with the sea: the main projects of urban regeneration in Genoa

The project was promoted through a special Urban Recovery Program in 1998, after the signing of a Program Agreement between the Municipality and the construction company. The result was the construction of large green spaces, pedestrian areas, urban furniture, as well as the realization of residences and various commercial and leisure activities.

Municipality of Genoa has recently approved an Urban Resilience Strategy, called "Genova Lighthouse" (2020), a strategic vision document of the city's resilience, intended as a smart paradigm of urban transformation. This document will enable the city to be prepared to face the global change: climate, demographic, technological / digital, starting at the local level.

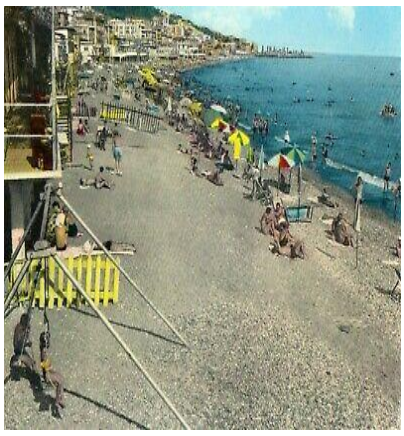
The urban regeneration policy of the city of Genoa is taking action on various areas, reasoning to environmental and energy priorities and avoiding the consumption of new land. The target in the central area is to rebuild the link with the sea, through the reconnection with the Porto Antico area (Blue Print project), strengthen the Port-City axis with the Hennebique and Caruggi projects and finally improve the Ponente area with the Erzelli Great Campus Project and the Val Polcevera Masterplan (Fig.3).

1.3 Case study: "Give back the sea to Pra'-Palmaro"

The public competition and the research, thanks to the use of a participatory approach by different institutions, is aimed at proposing a regeneration project in an area west of the port city of Genoa. The case study is Pra'-Palmaro, a site that due to the presence of the port and railway infrastructure has lost contact with the sea and needs an extensive and participatory regeneration project, to improve the quality of life for the residents of the neighbourhood.

The construction of the Port of Pra' began in 1968, while the first container ship docked in 1994. After 51 years from the beginning of the works, the east side of the port embankment is not yet docked and large areas are still unpaved and unused.

Until the 70s in the area there were several beaches at the service of residents, but also of tourists who came from outside the region. The implementation of the port infrastructure has led to a deterioration in the quality of life for the inhabitants of the area (Fig.4). The situation is critical because port and rail operations take place at any hour of the day and night in front of homes, causing dust and noise.



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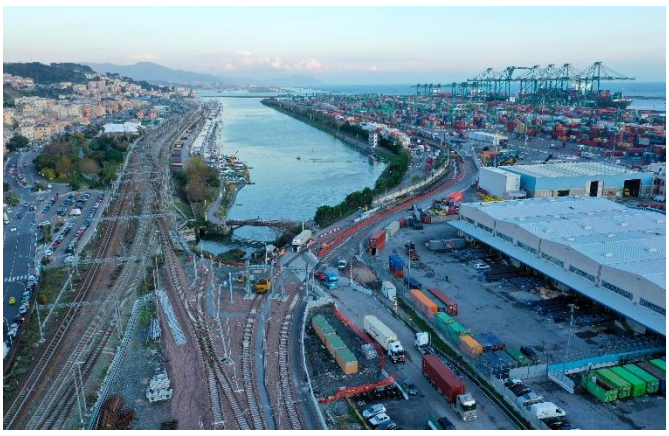


(b)

Fig.4 (a) An historical postcard of Pra' before the '70s and (b) Pra' nowadays (source: www.liguria.bizjournal.it)

In recent years, significant investments have been made for Pra' by the Municipality of Genoa, for the construction, for example, of new green areas, a navigable canal that can be used for competitions and rowing training and also home to the tourist port of Pra', and a promenade that runs along the canal, called Fascia di Rispetto.

The presence of the railway, leaning against via Pra', has prevented recovery and enhancement operations in the coastal area. Only recently, the institutions began to plan the shift to the sea of the Genoa - XX Miglia stretch of railway. The idea of the competition comes from the need to design the free area.
In February 2020 FondAzione PRimA'vera and Comunità Praese (a participatory foundation of the community of Pra'), under the coordination of the Municipality VII Ponente and the Municipality of Genoa, have held the competition entitled: "*Ridiamo il mare a Pra' – Palmaro*/ Give back the sea to Pra' Palmaro". This initiative intends to regenerate the Praese waterfront, in order to improve the livability of the neighborhood through the construction of a promenade with "water blade" and rows of trees, for the separation from the port and the railway. The project plans to maintain the aesthetic style, materials and urban furnishings present in the Fascia di Rispetto and used for the Pra' Marina project, funded by the Regional Operational Program.
The University of Genoa was involved in the competition and made itself available to collaborate in the case Study with its students, in order to further develop the idea with graphic and design works during the course of Urban Planning and Laboratory (teachers: Prof. Pirlone and Prof. Spadaro) of the Master's Degree Course in Building Engineering – Architecture of the Genoa (Department of Civil, Chemic and Environmental Engineering).
In March 2020 there was the telematic launch event, due to the health emergency, and the project works were completed in June 2020, with the consequent award ceremony in December 2020.
This initiative was developed as part of a technical working group composed of various actors: Department of Port and Maritime Economic Development – Logistics of the Municipality, Directorate for Economic Development of Innovation Projects of the Municipality, Municipality of Genoa and Commissioner for Reconstruction, Port System Authority of the M.L.O., Italian Railway Network (RFI), Highways for Italy,...
The projects that have been developed are therefore real "participatory projects", which bring together the needs of the various actors who live and work in the area.

2. Methodology

The methodological approach proposed for a participatory project of sustainable urban regeneration was structured according to different phases: State of the art; Context analysis, Planning and design part and Monitoring part (Fig.5). Then there is the transversal phase of participation which involves the various stakeholders - public and private, referring to both the port area and the urban territory - as responsible for the elaboration, monitoring and subsequent implementation of the plan.
Stakeholders should be consulted during all phases. In this case Stakeholders involvement is aimed at formulation, at sharing the contents and ensuring the achievement of the objectives of the plan.
In the first phase, to define the Strategy is necessary to start from the analysis of the territorial context and its needs. At the same time, as presented in section 1.2, it is essential to investigate the experiences of other port-cities and, through the construction of multilevel governance, create partnerships and identify common objectives for port and urban development, in line with the objectives of the International Agenda. Using this type of approach: integrated, systemic and participatory, it is possible to resize the two individual strategies into a single and consistent one with the requests a «local strategy coherent with the European requests and expectations as well as the global trends, in order to enhance the bond between urban territory, climate and environment» and also to innovate the offer of the waterfront services.
In the State of the art part is important to consider: the territorial framework, interest points, the destinations of use, the pedestrian and vehicular accessibility, the mobility, the transport and the presence of green areas. In this section it is crucial to find and analyze the existing urban plans at different scales or other useful tools for the case study. The inspection with related photographic documentation is also fundamental.

The second phase concerns the Context analysis, which can be split into two parts. The first consists in the identification of problems from an objective point of view, through the well-established methodologies of SWOT and PEST analysis.

SWOT analysis, short for Strengths, Weaknesses, Opportunities and Threats, as you know, «is a business strategy tool to assess how an organization compares to its competition. The strategy is historically credited to Albert Humphrey in the 1960s, but this attribution remains debatable… Beyond the business world, SWOT Analysis can also be applied to the individual level to assess a person's situation versus their competition further». «SWOT analysis, a commonly used tool for strategic planning, is traditionally a form of brainstorming». SWOT has been described as the tried-and-true tool of strategic analysis.

The SWOT analysis or matrix allows to evaluate Strengths, Weaknesses, Opportunities and Threats of a project, when an organization or an individual must make a decision to accomplish a goal.

The SWOT analysis begins with the definition of the objectives or purposes to be achieved. Next we define its main points:

- S) Strengths: all the factors present that are useful to achieve the goal;
- W) Weaknesses: all the factors present that are harmful to achieve the goal;
- O) Opportunities: external conditions that are helpful to achieve the goal;
- T) Threats: external conditions that could cause damage to performance.

By combining these aspects we can define the actions to be carried out to realise the desired purpose.

Once the SWOT matrix has been created, it will be necessary to consider whether this purpose is achievable and, if so, the several prescribed actions will be carried out; in negative case, however, a new matrix will have to be made in order to succeed in the task.

The four points referred to are somewhat interrelated and can be grouped into two categories: internal factors and external factors. The former include the strengths and weaknesses that characterize the organization, while the latter depend on external factors from which one can try to derive advantages or, on the contrary, limit the disadvantages.

Another interesting tool proposed to better analyze the reality object of the study is the PEST analysis, short for Political, Economic, Socio-cultural and Technological. It is a strategic tool for an external analysis. It describes a framework of macro-environmental factors to be taken into consideration for understanding market growth or decline, business position, potential and direction for operations. It is also known as Quantitative Analysis or also STEER, which considers sociocultural, technological, economic, ecological, and regulatory factors, but does not specifically include political factors. The model has recently been extended to STEEPLE and STEEPLED, with the addition of demographic and education-related factors.

Regarding the political tendencies, particular attention should be paid to the legislative measures governing their functioning, such as trade restrictions, political stability and fiscal policy. Relating to economic scenarios, it is required to look at market movements, disposable incomes, prices and inflation. From a social point of view, on the other hand, the characteristics of the community are analyzed, which can influence the demand for products or modify management strategies. In the case of the technological scenario, investments in strategy and development can influence business approaches (Joseph Kim-Keung Ho, 2014).

The PEST analysis, together with the SWOT analysis, allows you to have a broad objective view of the positivity and negativity that could arise when creating a new business or planning a territory or re-generating a pre-existing one.

At the same time, it is interesting to proceed with participatory analysis that identifies problems and potentialities starting from moments of dialogue between the different stakeholders (forums, interviews, ...). The analysis phase is fundamental to develop objectives and actions of the Planning and design part.

The research proposes an interaction between the results emerged from the individual analyzes, that will result in the identification of the main themes / aspects on which to focus to implement a sustainable regeneration of the waterfronts.

The last phase involves planning and identifying the interventions to be implemented in the short, medium and long term, through a general design (masterplan) and focus areas.

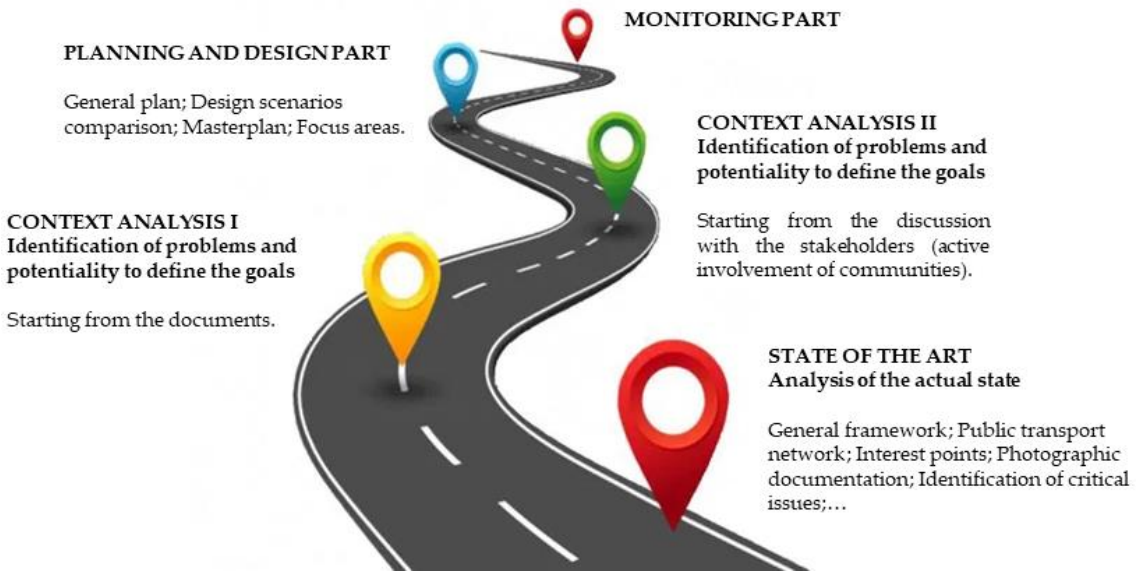


Fig.5 The main phases of methodology proposed

3. Application and Results

The methodological approach presented in section 1.3 is applied below to the case study of Pra'-Palmaro neighbourhood, in the city of Genoa. This reality is affected by a series of infrastructural criticalities and by the presence of the port, which over the years has negatively influenced the quality of life of the inhabitants.

The participatory project of sustainable waterfront (port-cities) regeneration was carried out following the following phases: State of the art; Context analysis, Planning and design part.

In the first phase, the current state of the area was examined, through research, inspections and specific meetings and interviews with associations representing the population. With regard to the participatory process, since the site is shared with different bodies (port, railway, motorway and public administration infrastructure system), for the definition of the area's regeneration project, technical tables have been created to which the University of Genoa participated. These technical tables meet periodically in order to favour the coexistence of the plurality of interests at stake of the various entities and citizens. Another important aspect from a social point of view is in fact the considerable commitment and strong participation of the inhabitants in the political activities of management and transformation of this area.

In Genoa Pra 'the creation of the buffer around the calm channel, a zone which allowed a separation between the port and the inhabited area, was of considerable importance (Fig.6). This redevelopment work did not continue in the nearby area of Pra'-Palmaro, the subject of the study. The urban fabric adjacent to the site is characterized by a highly heterogeneous and anthropized configuration. In addition to the port, there are various road infrastructures, such as the Aurelia road and a motorway flyover for accessing the port area, which overtakes the area itself. These structures coexist with the consolidated urban fabric. The site is compressed by two bands of tracks: to the north there are those serving the Genoa-Ventimiglia route, while to the south, there is a freight yard available to the Port.

As regards the mobility, Pra'-Palmaro area is well served by public transport. In fact, several bus lines pass along the state road and there are two railway stations near the area: Genova Pra' and Genova Voltri. With

regard to private transport, the Genova Pra' motorway exit is a crucial link. Finally, as concerns cycling, there are short sections of a dedicated cycle path, interspersed with mixed cycle-pedestrian paths, which are interrupted in the project area.

Over time, the neighbourhood has changed considerably, reaching its current conformation. Surely the strongest connotation is given by the port basin, which constitutes an important regional and national economic pole, although it also represents a great problem for the liveability of the place. Another distinctive feature is the cultivation of basil, of which Pra' is the main producer, and the presence of numerous villas dating back to the seventeenth century, located along the Aurelia road. Finally, various spaces dedicated to sport and recreational activities have been created in the Pra' buffer zone.

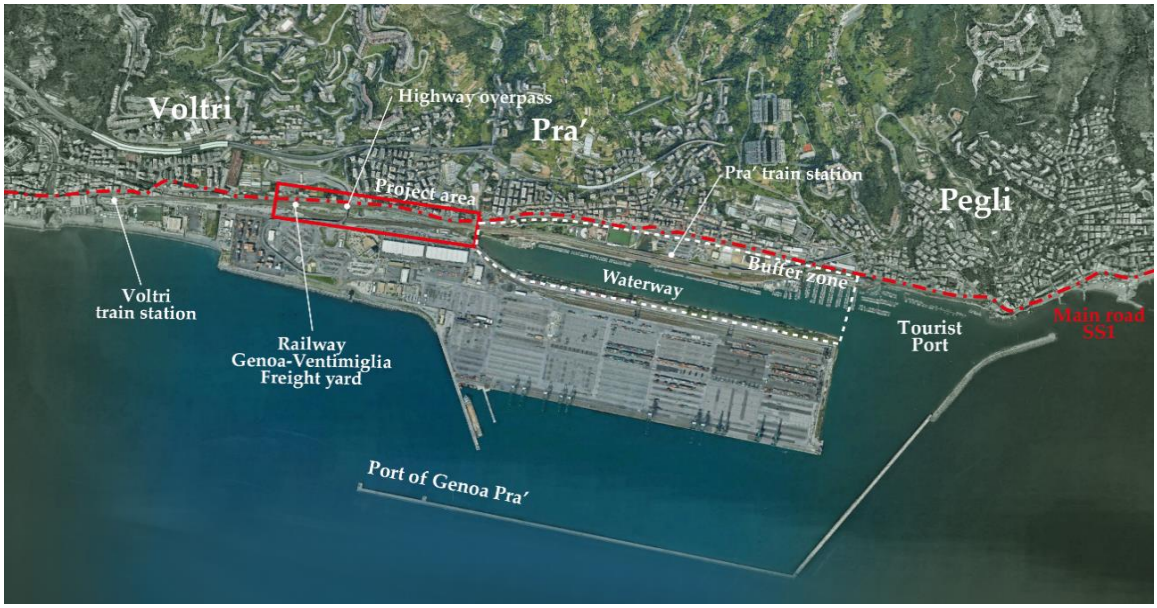


Fig.6 Framework of the study area

Fundamental to the study of the territory was the analysis of planning tools, both those relating to the urban reality and those of the port. Municipal, metropolitan and regional regulations were taken into consideration, which contained indications on the project area.

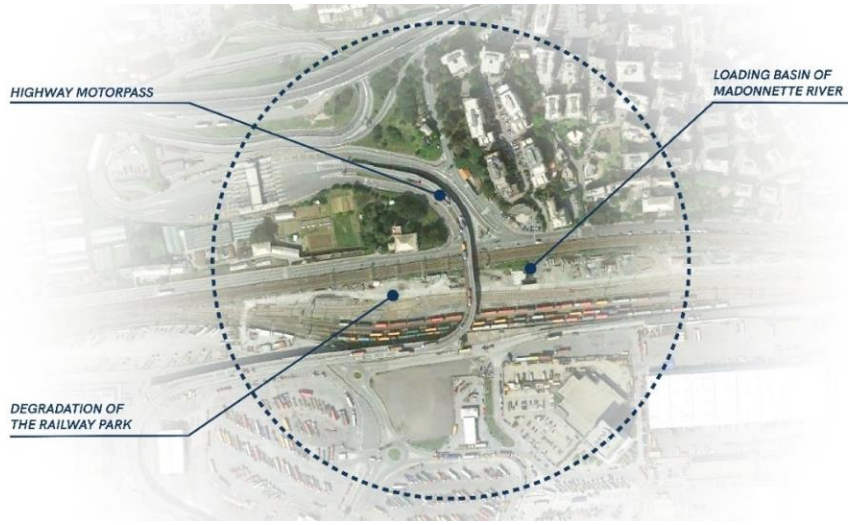
At the urban level, the provisions contained in the Municipal Urban Plan are important, which among other indications, in the area in question envisage the modification of the access road to the Port and the addition of a railway stop. With regard to mobility, the Sustainable Urban Mobility Plan (SUMP, 2019) is analyzed, which for cycling provides for the creation of a path to connect Voltri and the buffer zone of Pra'.

As concerns the port, a plan of interest is the Port Regulatory Plan of the city of Genoa, which for the Voltri-Pra' territorial area indicates among the objectives the enhancement of the waterfront and a rearrangement of the tracks, with the translation of the Genoa-Ventimiglia line to the sea, to create the buffer zone between the town and the port under study. Finally, with the Regional Operational Program (POR-FESR) 2007-2013, Pra' Marina was selected among the urban development projects admitted to contribution. This project has led to the implementation of numerous redevelopment interventions, such as parks, squares and areas used for recreational activities and sports.

As part of the design, the issue of the management of the site's water resources was also investigated. This choice derives from the desire to introduce the water element in the area's redevelopment project, as an ideal reference to the past presence of the sea in the site. Therefore, the technical and economic feasibility of the possible viable solutions was investigated, based on the characteristics and constraints of the area.

Once the characteristics of the site were identified, the second phase of analysis was undertaken through an analytical and participatory process to determine the main criticalities and strengths present.

Summarizing the problems of the site, the main one concerns the cycle-pedestrian viability, as at the moment it is insufficient, given the small size of the sidewalk, occupied by parked cars. As for accessibility to the port area, with the exception of the viaduct, it consists only of a very long path, a factor that discourages the use of public transport by port workers. In terms of environmental impact, the motorway viaduct certainly represents a critical element. Furthermore, the presence of a loading tank for the Rio Madonnette water, positioned in the center of the site, represents a factor of interference with the project. Finally, the east end of the area is a particularly complex node due to the intersection between the mouth of the Rio Branega, the railway tracks and the end of the pedestrian and cycle paths coming from the nearby Dapelo Park, which it is essential to connect with the future area of intervention (Fig.7).



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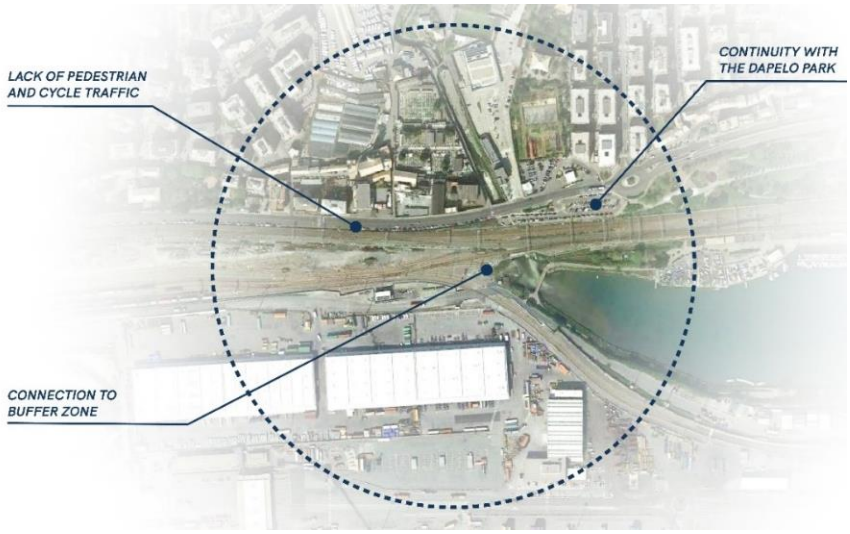


(b)

Fig.7 The critical issues of the central (a) and the east final (b) part of the site

By drawing up the SWOT analysis, an image emerged of an area subject to many problems, but also with great potential to develop. A crucial issue is certainly the port, which represents a strong point due to its commercial importance, but at the same time it is a source of great inconvenience. Among the weaknesses there is the lack of a pedestrian and cycle path in the area, with great risks for safety. The creation of a buffer zone, with paths for soft mobility, vegetation and water, would represent an opportunity to address these problems. The construction of the new railway stop in Pra'-Palmaro also constitutes a great opportunity,

allowing a direct connection both to the port, for workers, and to the project site, with a view to intermodality (Fig. 8).

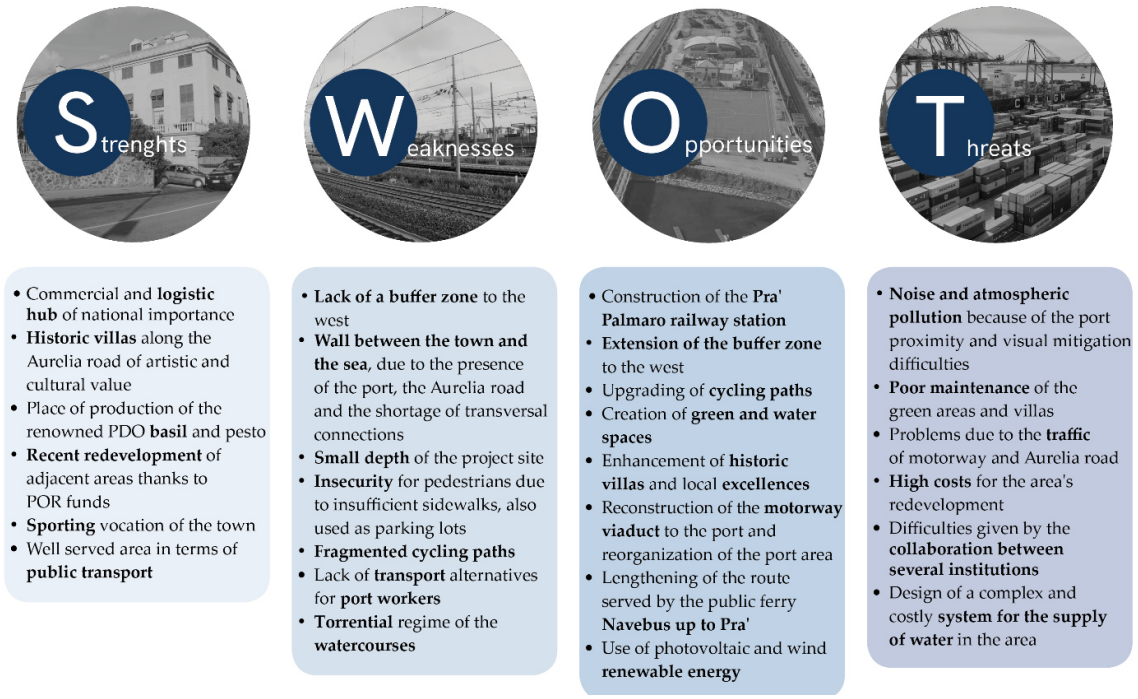


Fig.8 SWOT analysis for the Pra'- Palmaro case study

The PEST analysis summarizes the site transformation forecasts: by railways network (Ferroviaria Italiana) with the construction of the Pra'-Palmaro railway stop, by Motorways for Italy (Autostrade per l'Italia) with the project for the new viaduct and by the local associations, which ask for the redevelopment of the site. With regard to the implementation of the new project, there is the possibility of resorting to European, national and regional funds, as previously happened for the realization of the Pra'-Marina project. Ultimately, the need to implement an energetically sustainable project must be included, thanks to the use of plants and technologies that exploit renewable resources (Fig. 9).

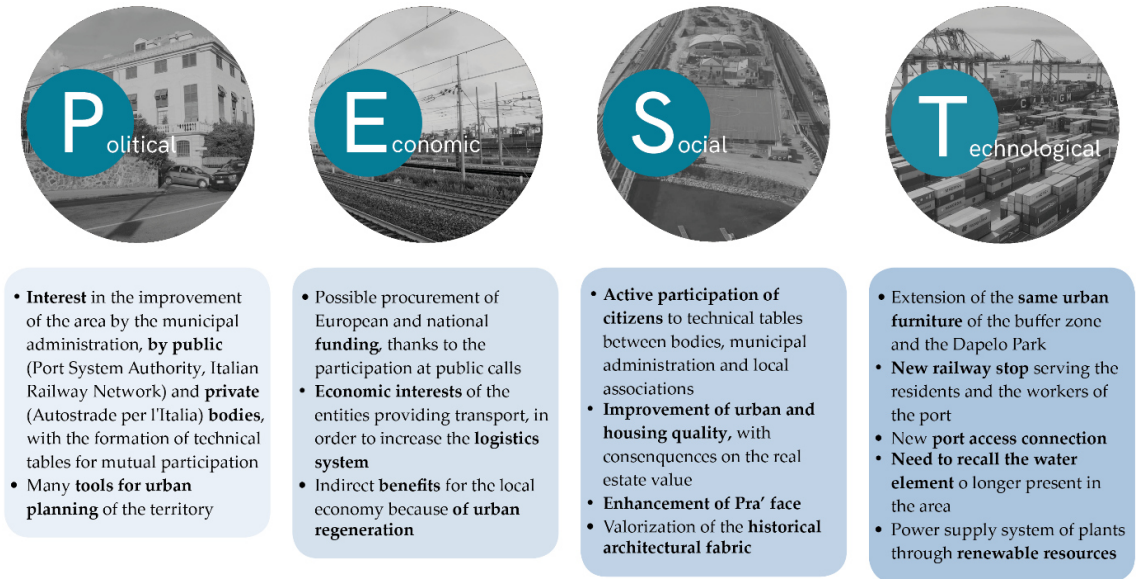


Fig.9 PEST analysis for the Pra'-Palmaro case study

Knowledge of the context and critical analysis of the factors that act on it led to the development of the design phase. It consisted in the preparation of a masterplan of the area, subsequently deepened in detailed documents. The aspects considered for sustainable regeneration in the case study are: sustainable mobility, accessibility, the arrangement of green areas, the identity of the place and the presence of the water element. The project area, due to its morphology and the set of boundary conditions, consists of a complex place to be designed. The biggest challenge is managing the various flows (vehicular, pedestrian, cycle), in order not to create interference and guarantee the safety of the users. Therefore, the first concern was to create pedestrian and cycle paths separated from the road, also thanks to the use of green. The same separation work was carried out on the front of the railway park where earth dunes were created hosting many types of trees and shrubs, in order to mitigate the noise and visual impact caused by the passage of railway trains and port operations.

Green is an element that takes on particular importance within the project, as in addition to perceptually characterizing the experience in the area, it performs different functions. First of all, it is used as a physical separation between the public space and the road and railway arteries, to mitigate the visual but also the acoustic impact of these two nearby realities. Furthermore, it is well known how urban vegetation also affects the quality of the air we breathe locally, being able to absorb carbon dioxide, filter pollutants and control the microclimate, both in summer and in winter. Finally, the large trees present guarantee shading in summer and favour the reduction of the "heat island" phenomenon, ensuring higher thermal comfort. The vegetation present in the area creates a system with the greenery of the context, consisting of the dense trees of the historic villas along the Aurelia road, the public gardens, the Dapelo Park and the green areas along the calm canal.

One of the main objectives of the project is to improve sustainable mobility through the creation of pedestrian and cycle paths, as well as exploiting the concept of intermodality between the different possible forms of mobility (bus, foot, bike, train, ...).

In this sense, the integration of the project with the existing context is fundamental, thus reasoning on the concept of continuity, in particular with the recent interventions that have led to the requalification of the Pra' buffer zone.

Continuity was also guaranteed with respect to existing materials, vegetation species and urban furnishings. For this reason, the area provides for the articulation of two pedestrian paths, main and secondary, a cycle path and a life path. These itineraries allow to cross the entire area longitudinally, but at the same time transverse links ensure the relationship with the urban fabric behind it. With regard to the intermodality of transport systems, a fundamental point is the construction of the new railway stop in Pra`-Palmaro, directly connected to the city center and the port area via an underpass.

It represents an opportunity to increase the accessibility, reachability and usability of the area. This is in line with the aim of redeveloping the site and of encouraging the use of sustainable means (public but also private using the new cycle and pedestrian routes) by the inhabitants and port workers. For the latter, it is currently difficult to reach the port by alternative means to a private car, because of the absence of pedestrian connections. In the building of the railway stop, the construction of a covered parking for bicycles is planned, which allows both to favour intermodality and to improve the usability of bicycles throughout the entire Pra'. In this regard, a bike-sharing service, including electric vehicles, can also be envisaged.

Still with regard to mobility infrastructures, the project includes the maintenance of parking spaces for vehicles, inserted in way to make them safer from the viability of the principal road.

The project also uses constructive solutions that make the park accessible to all. In this case, the connecting ramps between the various paths and the avenues have a reduced slope to facilitate their travel.

Finally, at the strong request of the population of Pra', which was deprived of contact with the sea due to the construction of the port, a water channel was planned to cross the site for its entire length.

The main function of the canal within the project is that of an ideal lure to the sea.
In addition to the aesthetic purpose, the environmental one was also pursued, as the water allows, together with the green areas, a local reduction of the "heat island" effect. In addition, the flow of water allows for greater oxygenation of the mouth of the Branega stream. The water blade begins at the western end of the park and is articulated along the area having a variable section from 2 to 4 meters. Along the canal there are numerous areas of contact with the water, such as seating with steps and games, which afford interaction in different ways.
As regards the origin of the water, different hypotheses were analyzed, such as the collection of rainwater, the use of water from the purification system and the interception of waterways. These systems proved to be impracticable in the project, leading the choice towards the construction of a seawater pumping plant, possible thanks to the proximity of the site to the sea.
It is certainly an economically disadvantageous hypothesis, both in terms of construction and management costs, but the only one capable of guaranteeing the necessary range and in a constant manner. To ensure the sustainability of the intervention, the construction of a photovoltaic system above the roof of the new Pra'-Palmaro railway stop is considered. This system would allow the supply of the seawater lifting system for the canal and the park services, such as public lighting, bicycle parking and more.
As can be seen in the masterplan of Figure 10, the project gave absolute priority to the creation of a public space, trying to minimize the new construction, so as not to aggravate an already highly urbanized area. For this reason, the focus was on adding vegetation, seating, play areas, limiting the new constructions to the building that houses the ticket office of the Pra'-Palmaro station, a coffee and a covered parking for bicycles, functions considered useful in the area.
Sports activities have also been privileged, with the creation of spaces dedicated to a life path and a cycle path. Urban gardens have also been added, which constitute a social and also educational opportunity, being a place where children and young people from the schools of Pra' can be brought to know and personally grow fruit, vegetables and aromatic plants typical of the Ligurian territory.

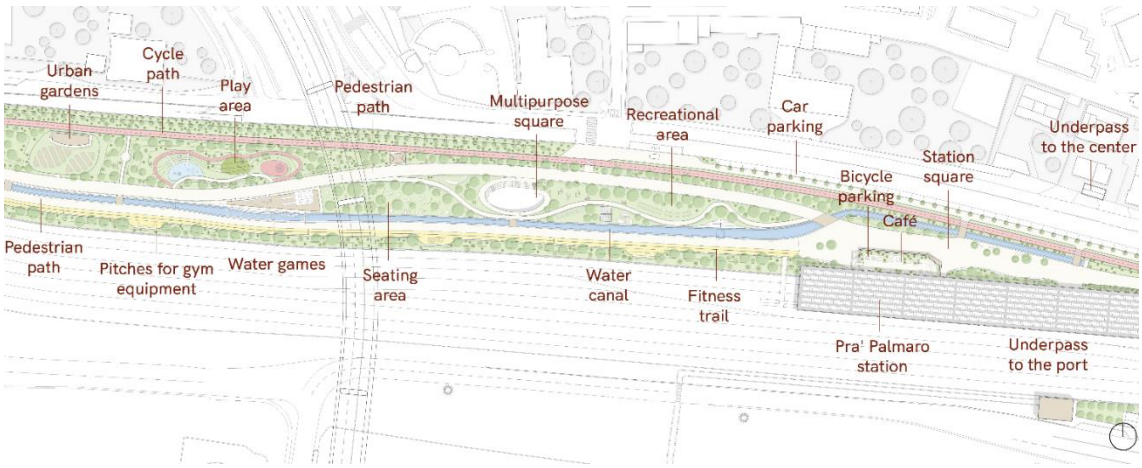
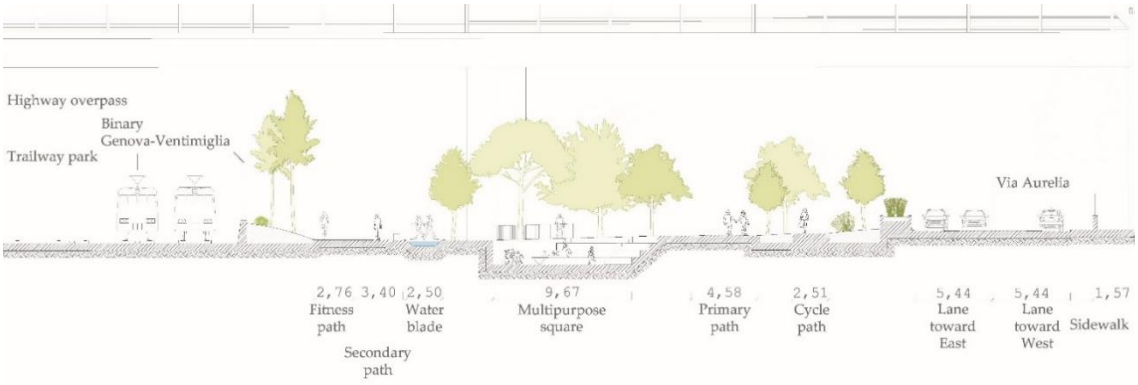


Fig.10 Masterplan of the regeneration project

Finally, the multi-purpose square in the center of the site is the most versatile place of the project. It can normally be used as a play area and skating rink, but can also host small events, such as open-air cinema or exhibitions.
Furthermore, this square can perform the function of a rolling basin, a place capable of collecting excess water volumes during flood events. The result is a place that interprets the definition of resilience in the urban environment, making the space less vulnerable to climatic and social stresses (Fig. 11).



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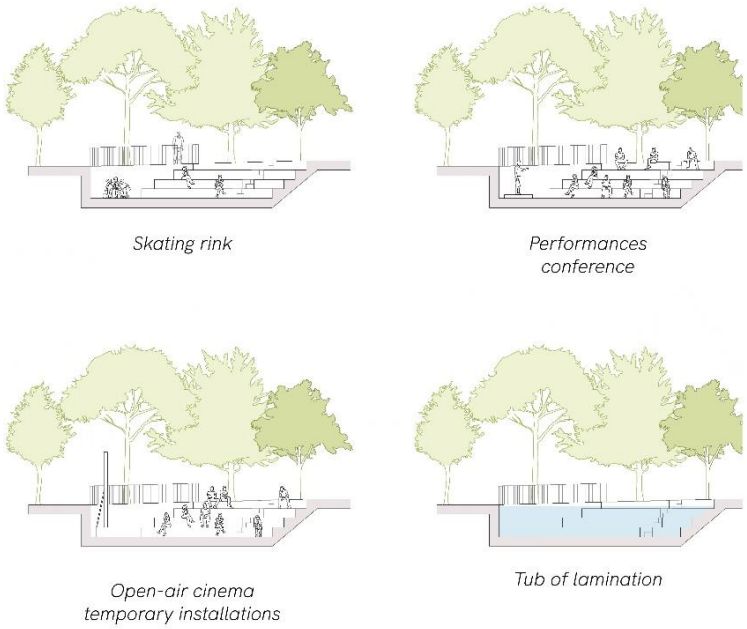

(b)

Fig.11 (a) Cross section of the project and (b) The functions of the multi-purpose square

In summary, the aspects considered in the definition of the Pra'-Palmaro regeneration project were: accessibility, soft mobility, relationship with water and the network or presence of green.

4. Discussion

The European Union, as anticipated in Introduction, promotes and finances urban regeneration, addressing recommendations for less land use and the redevelopment of urban areas in a sustainable key.

Even Italy with the Green New Deal 2020-2023 fund in the 2020 State Budget has made 4.2 billion euros available to «carry out economically sustainable projects that have as their objective the decarbonization of the economy, the circular economy, urban regeneration, sustainable tourism, adaptation and mitigation of risks on the territory deriving from climate change and investment programs and projects of an innovative nature and with high environmental sustainability».

From the analysis of the application of the Pra'-Palmaro case study approach (Section 2), there are several aspects to consider in order to carry out sustainable regeneration projects, which aim to a real improvement in the quality of life. Among these: the redevelopment and recovery of the area; the reduction of the anthropic and energy impact according to a circular approach, as well as the participation of the local community. From the researches developed it emerges that urban regeneration projects often arise from public initiative with

the participation of private subjects and professionals, who collaborate by putting together the various skills in order to an inclusive and sustainable requalification.
Other important aspects to focus on concern (Fig.12): the identity of the place, accessibility, sustainable mobility and soft mobility, the continuity of greenery, the use of ICT tools and obviously, being areas close to the sea, water element (Bamani & Ronsivalle, 2018).

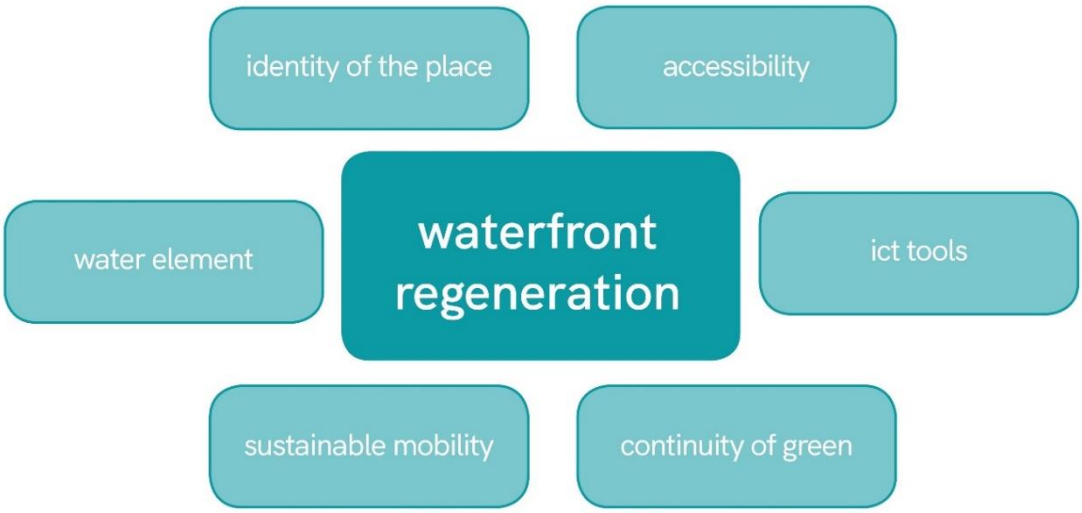

Fig.12 The regeneration of port-cities

Due to the current importance that waterfronts can assume, in their transformation to take into account the balance of multiple aspects is necessary. First of all, to be aware of the legacies of the past and assimilate them to build the future space is essential for intervene consciously. In fact, modernity does not mean denying tradition, but knowing how to integrate it into an evolving system, in which the identity of the place remains recognizable and the new constitutes a continuation of the city, avoiding caesuras (Giovinazzi & Moretti, 2010). In particular, the enhancement of industrial archaeology can represent the hinge between these redeveloped areas and the historic center, favouring the good practice of safeguarding the artefacts over time. The permanence of these local elements also has consequences on the economic level, allowing the creation of a network with the cultural assets of the territory and favouring tourism, thanks to the function of attractors that these places often come to assume. On the other side, this does not mean that innovation does not find space in the waterfronts; on the contrary, they often welcome the most actual and international economic and cultural activities. Therefore, they are a place of meeting and cultural exchange on the one hand and a place of identity and connection with history on the other (Russo, 2014).
Another relevant issue is the environmental one, as the design of the territory must safeguard the natural landscape of the waterfront and provide for a sustainable management of the water resource, from an integrated environmental-landscape planning perspective. In fact, water is an added value, as well as from an aesthetic point of view, especially from an environmental one, representing a fundamental resource for a city, in terms of improving the quality of life. From a social point of view, the involvement and participation of the community is important in the transformation of a waterfront, to meet the needs of citizens. Therefore, horizontal integration between public administrations, private investors and the population should be encouraged, which should be involved throughout the project process.
As regards the regulatory aspect, we can find two models regarding the governance of port. «These two models determine the decisive differences between the European countries. In the centralized model (that we can find in port cities of Southern Europe such as Genoa, Marseille and Lisbon), the State is the major leader and is often responsible for the Port Authorities board. In this case, the central government takes the majority of choices regarding the strategic planning excluding local municipalities from the decision-making process

and the relationship between the city and its port is weak. According to this model the PA and the city do not control the port revenues and do not decide the investments to make. In northern European countries, on the other hand, cities have a fundamental role in the control of Port Authorities». Wanting to develop regeneration projects on waterfronts, it is therefore important to develop integrated tools, plans and programs that can manage port-cities' common problems. It is also important to fully identify the invariant characteristics of the territory and integrate the various components: cultural, environmental, economic, mobility, etc, in order to carry out interventions with a view to sustainability (Iovino, 2016). Peripheral and degraded intervention sites, often such as disused port areas, represent an opportunity, but at the same time there is the risk of developing phenomena of marginalization. This generally occurs when the design does not adequately consider the connections with the city center and the super-local level. It is important to try to escape from conventional solutions, which do not look at the intrinsic characteristics of the territory, derived from economic and political interests. Sustainable development of port areas should be developed on the basis of the synergy principle (Girard, 2013). For this reason, the paper proposes a new multi-disciplinary e multi-stakeholders approach capable of assessing and managing the complex regeneration topic by considering cities and ports as a single entity. The creation of such an instrument requires first of all a joint work among the various local stakeholders – in the urban and port context – which currently does not exist.

What the research proposes in this context is an urban regeneration participated by the different actors, according to the principle of the triple, quadruple, up to the quintuple helix, they must be involved: public authorities, researchers, enterprises, citizens and associations. Each actor of the quintuple helix is responsible for the implementation of the actions foreseen in the plan and the involvement, and therefore the participation, of the five identified players is fundamental in all phases of regeneration project.

A multi-disciplinary e multi-stakeholders approach is welcome, as buildings and open spaces have to be considered as a whole when it comes to urban sustainable regeneration. «An inclusive approach where stakeholder are co-ownership and leadership, the main initiatives of a city should provide for participatory enabling process to reach a better working on the ground». Participation is essential to support for planning processes and to gain awareness of the real problems, seen by the various stakeholders who use the area and the services present, and thus define a shared and inclusive strategy. Furthermore, participation can also be useful in identifying priorities to focus on and the tools to transform challenges into opportunities, increasing the quality of the outcome of planning (Hartmann et al., 2018). From an urban planning point of view, we have gone from the concept of recovery (recovery of the urban fabric) of the late 70s, to the concept of urban redevelopment (putting quality of life at the center) of the 90s, to the regeneration of the 2000s to the recycling of parts of cities (with the application of the circular strategy).

In summary, the projects focused on the regeneration of an area of Genoa with a view to a sustainable city, that is, a resilient, smart and circular city (Fig.13).

Fig.13 Concept of sustainable city

The resilient city introduces a new aspect different from the smart city. It arises from the need to respond consistently to the stresses caused by critical events such as sudden shocks and chronic stress conditions, to become a model of sustainable urban development. Resilience, therefore, does not only imply response and adaptation strategies, but also transformative paths aimed at improving the city and its territory both during its "negative" and "positive" phases, targeting prevention policies and governance through a process that requires the development of knowledge, flexibility, differentiation, integration, inclusiveness and adaptation.
If the smart city, in fact, focuses on efficiency and, therefore, on the elimination of "repetitions" which represent a cost for the community, the resilient city presents characteristics of redundancy and diversity, enhancing the creation of alternatives and aiming to prevent situations of stress and shock for all its communities to guarantee high standards of quality, attractiveness and competitiveness.
Both the Smart city with its specializations and the Resilient city with its character of urgency, innovation and proactive evolution look carefully and contribute as prominent elements to the "Human City", a city on a human scale in which the human being will be at the center of a more liveable ecosystem designed specifically to make his life better, in order to avoid further depletion of resources and allow a renewal of the urban environment in favour of high standards of quality of life (Hoyle, 1988).
Finally, a city must be circular, that is, designed to be regenerated. A circular approach considers topics of urban planning: transport systems, water, sanitation, waste management, disaster risk reduction, access to information, education and capacity-building in a circular way, planning a sustainable urban development and regeneration that close the production cycles (Pirlone, 2020).
The circular strategy / economy is an opportunity to redevelop the territory. Disused factories converted into centers for the recovery of bulky objects, former railway sites transformed into cycle or pedestrian paths, abandoned buildings entrusted to associations that deal with environmental education are some of the examples of circular economy for the redevelopment of the urban environment. These transformations constitute a good practice that can be transferred to other realities.
For now, these are isolated experiences which, if included in an urban plan, could become a valid solution for the systematic regeneration of abandoned areas and premises, while contributing to the development of a new environmental awareness among citizens.
Circular solutions could not spread if they were not supported by an adequate infrastructure. The types of infrastructures are different:

- transport infrastructure (roads and motorways, railways, airports, ports);
- digital infrastructures;
- energy networks.

These are fields in which the circular economy can play a fundamental role in the design, construction, maintenance and eventual disposal.
The concept of circularity should finally be taken up in the presented approach (section 1.3) of urban regeneration. After analyzing and planning objectives and interventions (phase 1, 2 and 3), thanks to the subsequent monitoring phase it is possible to calibrate the effectiveness and efficiency of the proposed actions and, if necessary, make improvements by returning to the planning phase in a circular perspective.
Finally, in this context, the importance of Information Communication Technology for a circular city and the role of innovation of the idea or technology in the regeneration project are fundamental.

5. Conclusions

The article therefore reports a research developed in academic field, which describes the different meanings of urban regeneration. This phase is preliminary to the identification of an approach and key issues that can be applied to the Genoa Pra'-Palmaro case study, an area that, due to the presence of the port and railway

infrastructure, has lost contact with the sea and needs an extensive and participatory regeneration project to improve the quality of life for the residents of the neighbourhood.

According to the "learning-by-doing" approach the Pra'-Palmaro case study, at the local level, is analyzed here to highlight the strategies implemented for urban regeneration. The results can help other cities around the world to understand what aspects investigate and aim for, adapting resiliently, to natural, economic or in general the possible changing events thanks to the collaboration of all the public and private stakeholders involvement. Urban resilience has become an important objective for cities, particularly to face climate change (Savino, 2010).

But, this approach may also be important to consider in the current context of health emergency linked to COVID-19. Cities and citizens of the whole world have been increasingly confronted with rapid alterations in their physical and social environment by profound natural and human hazards like climate change, hi-tech innovation, pandemic events, and economic recessions. As a consequence, cities cannot survive and prosper if buildings and urban spaces are not reconsidered and reshaped according to climatic-response procedures and sustainable strategies. In this case, the concept of urban resilience and sustainable regeneration is important to increase in the post-emergency phase, but also during the peace period.

Another relevant element that emerged from the research is that of participation. Having dealt with associations (PRimA'vera Foundation and Praese Community) and local population from the beginning (the overall technical and public opinion assessment involved 4000 people who took part in the project), Public Administration (VII Municipality of Ponente, Port Department and Maritime Economic Development - Logistics of the Municipality, Economic Development Directorate for Innovation Projects of the Municipality, Municipality of Genoa and Commissioner for reconstruction for Genoa) and local and national authorities (Port System Authority of the Western Ligurian Sea, Italian railway network RFI, Highways for Italy, ...). All the stakeholders participated according to their skills (as anticipated in Introduction) in the meetings and planning works leading to the definition of a shared project of sustainable urban regeneration.

Despite a period of lockdown, the competition represented a participatory opportunity towards a sustainable rebirth. The decision-making process is based on the participation and involvement of the various stakeholders, the main player being the population. With regard to the future developments of the area under study, starting from the works carried out, the Municipality of Genoa has developed a project for the recovery and enhancement of the Pra'-Palmaro district by participating in the Italian National Innovation Programme for the quality of living (PinQua Programma innovativo nazionale per la Qualità dell'abitare) promoted by the Ministry of Sustainable Infrastructure and Mobility, for a loan of 15 million euros. This project was submitted in March 2021 and presented to citizens in June 2021. The involvement and research and cooperation of the various actors therefore led to a participatory regeneration project and hopefully soon realized thanks to national funding.

Author Contributions

Introduction, Methodology, Discussion, Conclusions, F.P. and I.S.; Application and Results M. D. N. and M. S.. All authors have read and agreed to the published version of the manuscript.

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Image Sources

Fig.1: "Participation and the main projects of waterfront's regeneration in Lyon." is an elaboration of the authors;

Fig.2: "Resilience to climate change: Hunter's Point South Park in New York." is an elaboration of the authors;

Fig.3: "Urban empties to rebuild the link with the sea: the main projects of urban regeneration in Genoa." is an elaboration of the authors;

Fig.4: "(a) An historical postcard of Pra' before the '70s and (b) Pra' nowadays": source: www.liguria.bizjournal.it;

Fig.5: "The methodology proposed by the paper" is an elaboration of the authors;

Fig.6: "Framework of the study area" is an elaboration of the authors;

Fig.7: "The critical issues of the central (a) and the east final (b) part of the site" is an elaboration of the authors;

Fig.8: "SWOT analysis for the Pra'- Palmaro case study" is an elaboration of the authors;

Fig.9: "PEST analysis for the Pra'-Palmaro case study" is an elaboration of the authors;

Fig.10: "Masterplan of the regeneration project" is an elaboration of the authors;

Fig.11: "(a) Cross section of the project and (b) The functions of the multi-purpose square" is an elaboration of the authors;

Fig.12: "The regeneration of port-cities" is an elaboration of the authors;

Fig.13: "Concept of sustainable city" is an elaboration of the authors.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 111-124
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/8232
Received 19th July 2021, Accepted 25th March 2022, Available online 30th April 2022

www.tema.unina.it

Investigation of extreme reflections of metal features and salty soils using object oriented Sentinel-2 L1C satellite image processing and SVM classification method

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Abstract
The Sentinel-2 provides available multispectral bands at relatively high spatial resolution. In this study, using Sentinel-2 images, the reflectance of metal roofs has been investigated and the differences between these reflections with other high reflections such as saline and dry soils have been evaluated. Bands 2(Blue), 3(Green), 4(Red) and band 8(VNIR), which have a resolution of ten meters, are the most used in extracting different types of reflection. The result of the research shows that using the reflection of materials, it is easy to identify and harvest samples for the purpose of classifying the controlled sample by object-oriented processing. The results show that there is a significant difference between the reflection of the salty soil and the metal roof in the near infrared range, although in the image with the natural color combination, both types of material show same reflection. This paper presents a new approach for extracting training samples from metal roofs compared to saline soils. The classification of SVM (Support Vector Machine) as the best method of classification with an accuracy of 96.9% and Kappa coefficient of 0.9 for categorization in this study was selected among other classification methods. This study compared two types of reflections from metal and saline soils.

Keywords
Sentinel-2 Images; Object oriented processing; Segmentation; Reflection; SVM classifier.

How to cite item in APA format
Imani, B. & Jafarzadeh, J. (2022). Investigation of extreme reflections of metal features and salty soils using object oriented Sentinel-2 L1C satellite image processing and SVM classification method. *Tema. Journal of Land Use, Mobility and Environment*, *15* (1), 111-124. http://dx.doi.org/10.6092/1970-9870/8232

1. Introduction

Nowadays, remote sensing users could be able to derive different land use/cover maps from satellite images by using specific interpretation techniques. In recent years, a land use map has been created using conventional satellite images such as Landsat and Hyperon. Satellite imagery that has been used in most of the past research, such as Landsat, has a long return period and low spatial accuracy. The satellite images used must have high resolution, spatial and temporal resolution so that the most frequent short-term effects can be detected. Satellite Sentinel 2 is considered as such. This satellite is the newest multi-lens imaging satellite. Sentinel 2 is in four bands, including the visible spectrum, 11 meters in pixels and in six bands of 21 meters in pixels, which is less than the size of the 31-meter pixel landscape. In addition, the return period for Sentinel 2A and Sentinel 2B is in total 5 days, less than the 11-day Landsat period. In total, the images of this satellite have spatial, spatial, temporal, and radiometric resolution higher than those of other similar satellites. Sentinel (RUS) provides a set of pre-installed open source tools on virtual instruments for accessing and processing data from the Copernicus Sentinel satellite orbit (ESA Sentinel-2 Team 2007). Most satellites used for Earth observation, such as Landsat, Spot, IKONOS, Quickbird, Formosat, GeoEye and Orbview, use panchromatic bands to achieve higher spatial resolution than multi-spectral mode (Gašparović & Jogun, 2018). The mission is aimed at meeting the various needs of the user and improving the practical applications of the Copernicus mission (ESA Sentinel-2 Team 2016), which include: Land use observation applications include: LULC status and land use change; environmental and physical parameters assessment; forest change review; urban surveying; spatial planning; environmental and human monitoring; natural resource monitoring; carbon stocks / Estimation of soil carbon content; Global monitoring of agricultural products; Monitoring of coastal areas. Natural disaster management includes: flash floods and forest fires, landslides, eruptions of volcano, droughts. Food security, warning systems; Water resource management; soil protection; Ground Mapping for Humanitarian Assistance and Advancement. Despite the relatively short period of satellite monitoring of Sentinel-2 land-based land surveys, many researchers have already experienced high levels of Sentinel-2 data for classifying vegetation and types of trees (Immitzer et al. 2016), The monitoring of natural and human vegetation (Bontemps et al., 2015; Greco et al., 2018; Song et al., 2017(; map of glaciers (Paul et al., 2016) and waterbodies (Du et al., 2016; Toming et al., 2016; Yesou et al., 2016; assessment and monitoring of water resources (Dörnhöfer et al., 2016); classification of fires (Fernández-Manso et al., 2016; Huang et al., 2016)); Residential maps (Lefebvre et al., 2016; Pesaresi et al., 2016). In general, these data have been proven in various geological studies (van der Werff and van der Meer, 2016). The basic pixel processing of images, single pixel data, and benchmarks are based on. This processing method is the basis of processing in object-oriented processing using similar pixel values and information, to which that object or phenomenon is said to be (Eisank & Drăguţ, 2016). The Sentinel-2A satellite was launched from the launch station on June 23, 2015, and the Sentinel-2B satellite was launched on March 07, 2017 (Arianespace 2017; Copernicus 2015). The Sentinel-2 satellite has a multi-spectral optical instrument sampling in 13 spectral ranges. The bands of this satellite capture the spatial resolution of 10, and 20 meters. Images with a spatial resolution of ten meters in four bands, a resolution of 20 meters in six bands, and a resolution of 60 meters in three bands (Richter et al. 2011). High spatial resolution satellite imagery is widely available for free (agriculture, urban and rural planning, natural resource management, etc.) on a local and national scale (Korhonen et al, 2017). Object-oriented processing of satellite images is one way to study the extent of change on earth (Bahram et al; 2020) This is a prerequisite for creating environmental and weather data archives to obtain continuous products and coordinated series (Berger et al., 2012; Simoniello et al., 2015; Rosa et al. 2018). During the two-year effort, much work has been done by the ESA team and the Sentinel-2 mission groups to enhance the performance of Sentinel-2 data and products. Many refinements have been made to obtain high signal-to-noise ratios in L1C bands. In particular, in the case of SWIR B10, the scattered pixels were modified as "no data" due to the

noise in the data harvesting tool. Sentinel-2 cloud masks are currently adjusted to minimize under detections, which leads, on the other hand, to over detections (Clerc et al., 2018; Rosa et al. 2018).

Blaschke and Strobl (2001) discuss the error in pixels. This debate was nothing new (Cracknell, 1998; see also Blaschke and Strobl (2001), Burnett and Blaschke (2003) and Blaschke et al. (2004) for a more detailed discussion). They saw something like addiction to applications higher than pixels. The common feature of all these applications is that they are made by image segmentation (see also Burnett and Blaschke (2003), Hay et al. (2003), Benz et al. (2004), Liu et al. (2006), Blaschke et al. (2004), Hay et al. (2005), Blaschke and Lang (2006), Lang and Blaschke (2006), Lang (2008), Hay and Castilla (2008) and Blaschke et al. 2008). Image segmentation is nothing new, but it has its roots in industrial image processing that was not used in Geospatial applications in the 1980s and 1990s (Blaschke et al., 2004). OBIA-based image processing techniques focusing on identifying and classifying urban features are numerous, some of which are outlined here. One of the most prominent of these studies is the research of Thomas et al. (2003) for estimating storm-water runoff rates, employing three different methods to obtain land cover / land use information using high spatial resolution images for Scottsdale, Arizona. In this study, they showed that increasing the amount of spatial information in images with a resolution of less than one meter or less increases the image classification resources using supervised and unsupervised spectral classification algorithms. Topaloglu et al (2016) in a study titled Sentinel-2 and Landsat 8 for the accuracy of land cover classification / for map use, covered the accuracy of different classification methods for user land extraction and the results of their work they studied. Their research results show that the Maximum Likelihood Classification method and the SVM classification method perform better than other classification methods. Ting and Young (2015) surveyed urban land use changes and urban development using satellite imagery and GIS. They concluded that the combination of measurement methods and GIS could well reflect changes in urban land use. Figure1, illustrate Sentinel-2 bands accordingly to Richter et al. 2011.

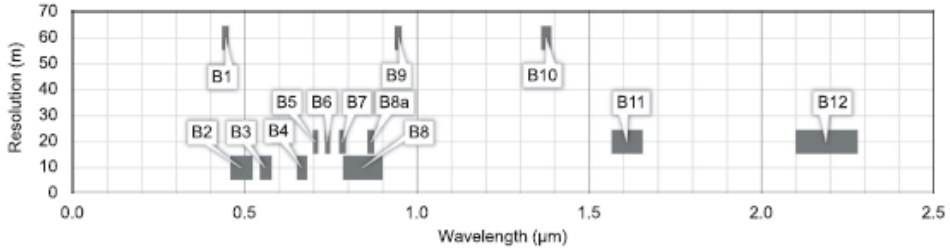

Fig. 1 Sentinel-2 bands accordingly to Richter et al. 2011

In this study, we have tried to investigate the difference between the reflection of metal roofs of buildings and the reflection of saline-containing soils using Sentinel satellite image processing. This research is unique in its kind. It has no similarity and is considered an innovation. In this study, by examining the spectral reflectance of metal roofs and saline soils, we were able to obtain the difference between these two elements. This research can be of great help to researchers in studies related to urban issues as well as issues related to tillage. This method compares different image representations using RGB and HSI display.

One of the questions raised in this research is whether it is possible to investigate the spectral difference of mixed levels by using object-oriented processing of satellite images with high spatial resolution and using intelligent classification methods such as SVM (Support Vector Machine)?

Some characteristics of Satellite images such as: digitally format, production up-to dated data, wide viewing angle (swath width), multispectral as well as multi temporal and revisiting time of data acquisition with high speed on data transformation make those be considered as valuable information on the natural resources management. One of the important applications of remote sensing images is to compare the reflection differences between different uses or to study the differences between the reflections of the electromagnetic spectrum from different levels, which can be used to identify different materials on the ground without direct

physical contact or visiting the desired location. One of the important goals of this research is to use the processing of remote sensing images with high spatial resolution, such as Sentinel 2 images, to find the difference between the spectral reflectance of saline soil surfaces and the surfaces related to metal roofs. Reflection from saline soil surfaces in areas where metal-roofed buildings are constructed is spectrally mixed, making it difficult to separate the two. Therefore, this research tries to identify and eliminate this difference to some extent by processing the images obtained from the Sentinel 2 satellite, which has a high spectral resolution. .

2. Pre-processing of satellite images

Figure 2 shows the process of doing the research as a flowchart. First, the Satellite-2 satellite image was downloaded on 08/29/2018 with Tile T39STC number from the study area with a cloud cover of less than 10 percent and without geometric errors downloaded from the ESA website. Sentinel-2 satellite images are pre-processed using the Level-2A algorithm in the Sen2Cor toolbox (version 2.2.3) with the Sentinel application framework (SNAP, version 6.1). Level 2A image processing has two important tasks: scene classification (SC) pixel classification map (Main-Knorn et al. 2015; Pflug et al. 2016) and atmospheric distortion correction (AC) (Mayer and Kylling 2005). By specifying the user-defined pins on the image, the general categories of plowed soil, vegetation, asphalt roads, salty soil, bare soil, wet soil, metallic roofs in blue, red and gray colors each individually and finally regions water was defined in the region.

To extract useful information from an object-oriented image, the segmentation process separates the primary and main phenomena into an unclassified image. First, we segmented the Sentinel-2 images using the eCognition software. Segmentation method is a multi-resolution segmentation method. Then, different color combinations were created in the two-color systems RGB and HSI. A total of nine color combinations were identified. Finally, we analyzed the results using Snap software.

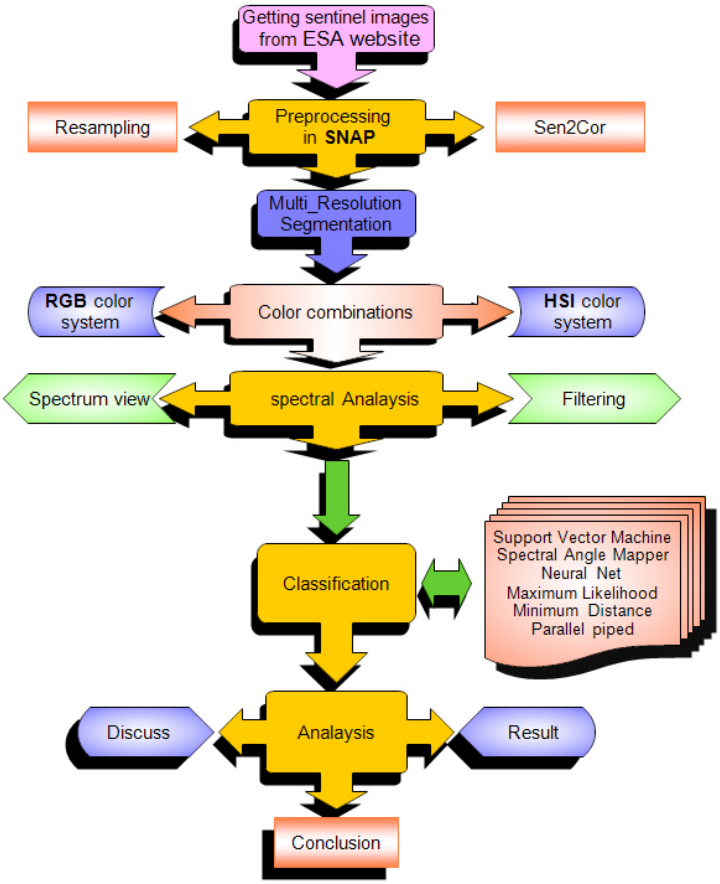

Fig.2 Research process

2.2 Support-Vector Machine classifier

In machine learning algorithms, support vector machines (SVMs, support vector networks) (Theodoridis & Cotterbass, 2009) are related learning models whose task is to analyze the data used for classification and regression analysis. SVMs can perform nonlinear classification in addition to linear classification using the kernel method (Campbell & Ying, 2011). The SVM algorithm is categorized as a pattern recognition algorithm. SVM algorithm can be used wherever it is required to recognize a pattern or categorize objects in particular classes. SVM theory is mainly derived from the problem of binary classification. Its main idea can be concluded as the following two points: First, it constructs a nonlinear kernel function to present an inner product of feature space, which corresponds to mapping the data from the input space into a possibly high-dimensional feature space by a nonlinear algorithm. Thus, it is possible to analyze the nonlinear properties of samples in the feature space with linear algorithm. Secondly, it implements the structural risk minimization principle in statistical learning theory by generalizing optimal hyper-plane with maximum margin between the two classes. While this method is visually simple, the idea actually plays the role of capacity control and makes the machine not only learn a few experimental aberrations but also has good generalization performance. The SVM classification method has many advantages both fundamentally and practically (Xiao et al., 2000).

3. Results and discussion

3.1 Results

Remote sensing images obtained at different times can be used to detect the type of changes as well as the spatial distribution created in the landscape (Friedl et al., 2002; Zhan et al., 2002). Pixel processing is based on images, single-pixel, benchmark and base information. This is where in object-oriented processing, the values and information of a similar pixel set, called the object or phenomenon, are the basis of the processing (Nazmfar & Jafarzadeh, 2018). As such, the algorithms use both spectral and spatial information simultaneously (Herold et al., 2003; Hodgson et al., 2003a; Tullis and Jensen, 2003). The first threshold is in the spectral range of B2 blue band (band 2, 0.490µm), which is related to dense vegetation with little reflection. To avoid confusion between salty soil and metal roofs, SWIR channels B11 (band 11, 1.610µm) and B12 (band 12, 2.190µm) are also used because wet soil has a high reflectance at these wavelengths. Salty soil and metal roofs have both a high reflectance in the bands B11 and B12, an additional threshold on B10 (1.375µm). In Tab.1, bundle combinations, as well as the factors of shape, compactness, and scale in segmentation of the image are shown. Also, the number of segmented pixels is also given.

			B1	B2	B3	B4	Shape	Comp	Scale	N of Obj
Combining bands	A	R		*	*	*	0.9	0.1	35	1501
		G			*					
		B				*				
	B	R	*				0.6	0.04	20	1480
		G		*						
		B			*					

Description: B1= band2 sentinel; B2= band3; B3= band4; B4= NIR band; Comp= Compactness; N of Obj= Number of Objects

Tab.1 Band constituents and shape and compactness values and number of pixels

In Figure 3, segmented images using eCognition software are shown. Figure 3(A), image with RGB color system. Figure 3(A') shows the segmentation image. Figure 3(A") shows the illustrated segmentation image. Also, in Figure 3(B), the image shows an HSI-colored system. Figure 3(B') shows the segmentation image. Figure 3(B") shows the illustrated segmentation segment. Segmental image is used to extract precision

components for object-oriented processing as well as detecting pieces with different reflections. The difference between Figure 3(A') and 3(A") is that Figure 3(A") has been selected to remove additional segments. This is also true for Figure 3(B') and 3(B").

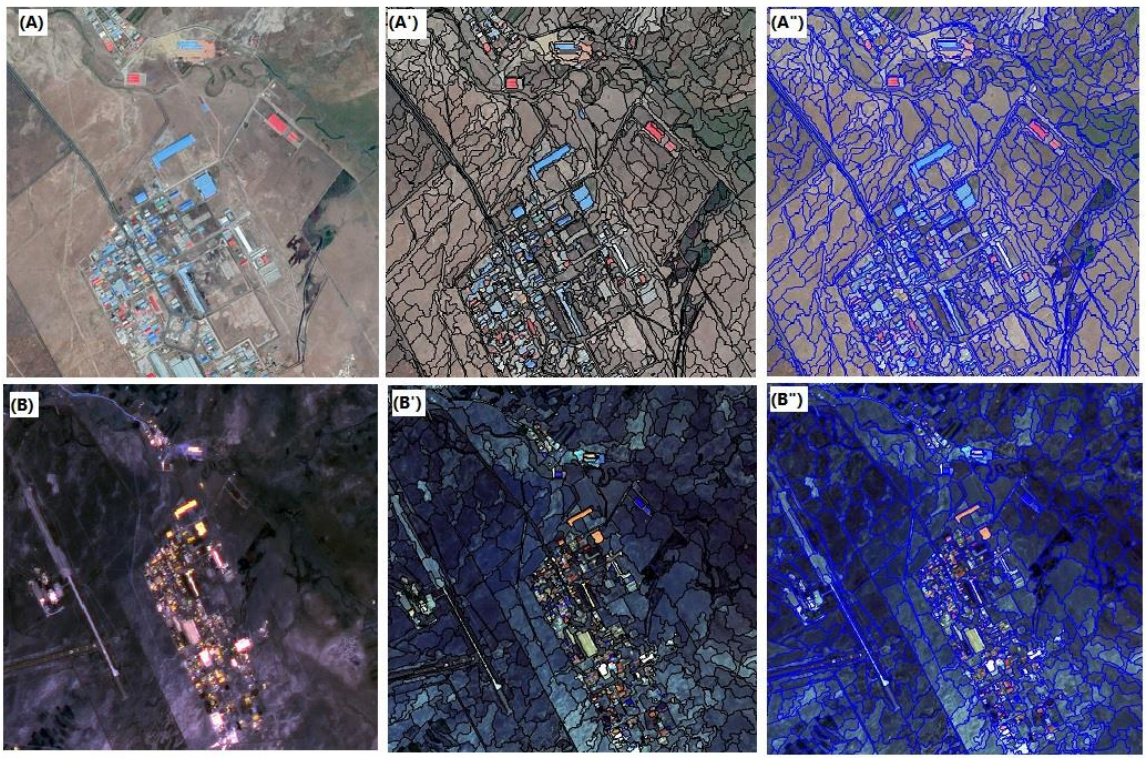

Fig.3 Segmented images using the eCognition software

Figure 4 shows the magnified segmented image. In this image, the red boxes represent a sample of segmentation pieces that display the precision.

Fig.4 Segmented image zoomed

Then, in the SNAP software, nine different colour combinations were created in both the colour scheme of the RGB and HSI. Figures 5 and 6 shows the colour combinations, as well as Tab.2, the type of compounds and the combined bands.

	Colour System	Fig name	a	b	c	d	e	f	g	h	i
Composite Colour	RGB		4-3-2	8-4-3	8-11-2	8-11-4	11-8a-2	11-8-4	12-8-3	12-11-3	12-11-4
	HSV		4-3-2	8a-4-3	8-11-2	8-11-4	11-8-2	11-8-4	12-8a-3	12-11-3	12-11-4

Tab.2 The type of compounds and the combined bands

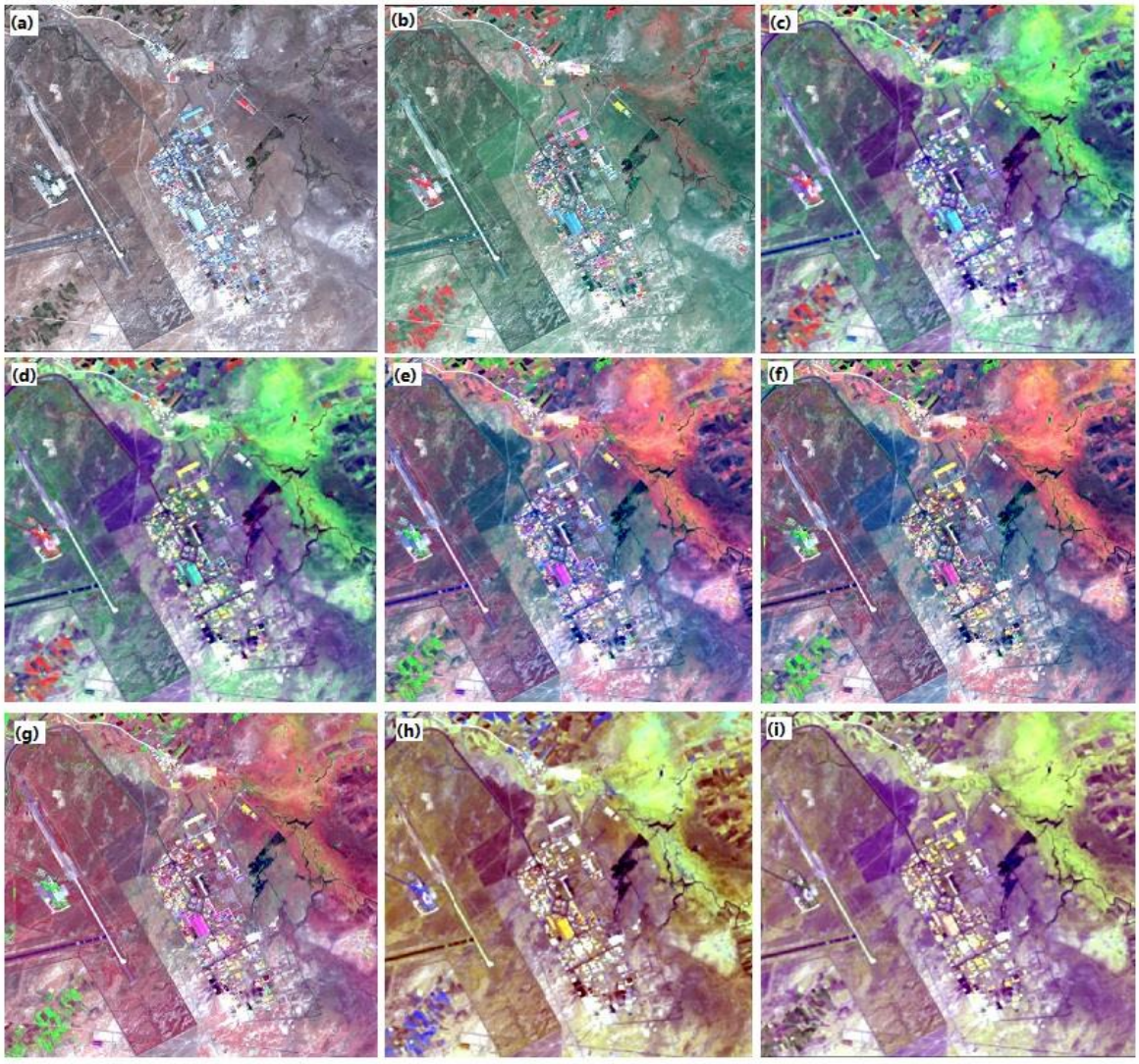

Fig.5 Nine different colour combinations in both colour systems of RGB

In Figure7, the spectral reflection spectrum of different materials is shown. Figure 7(X) represents the total reflection curve in the full range. Figure 7(Y) shows the reflection of materials in the 430-nanometer range and Figure 7(Z) shows the reflection in the range of 1375 nm.

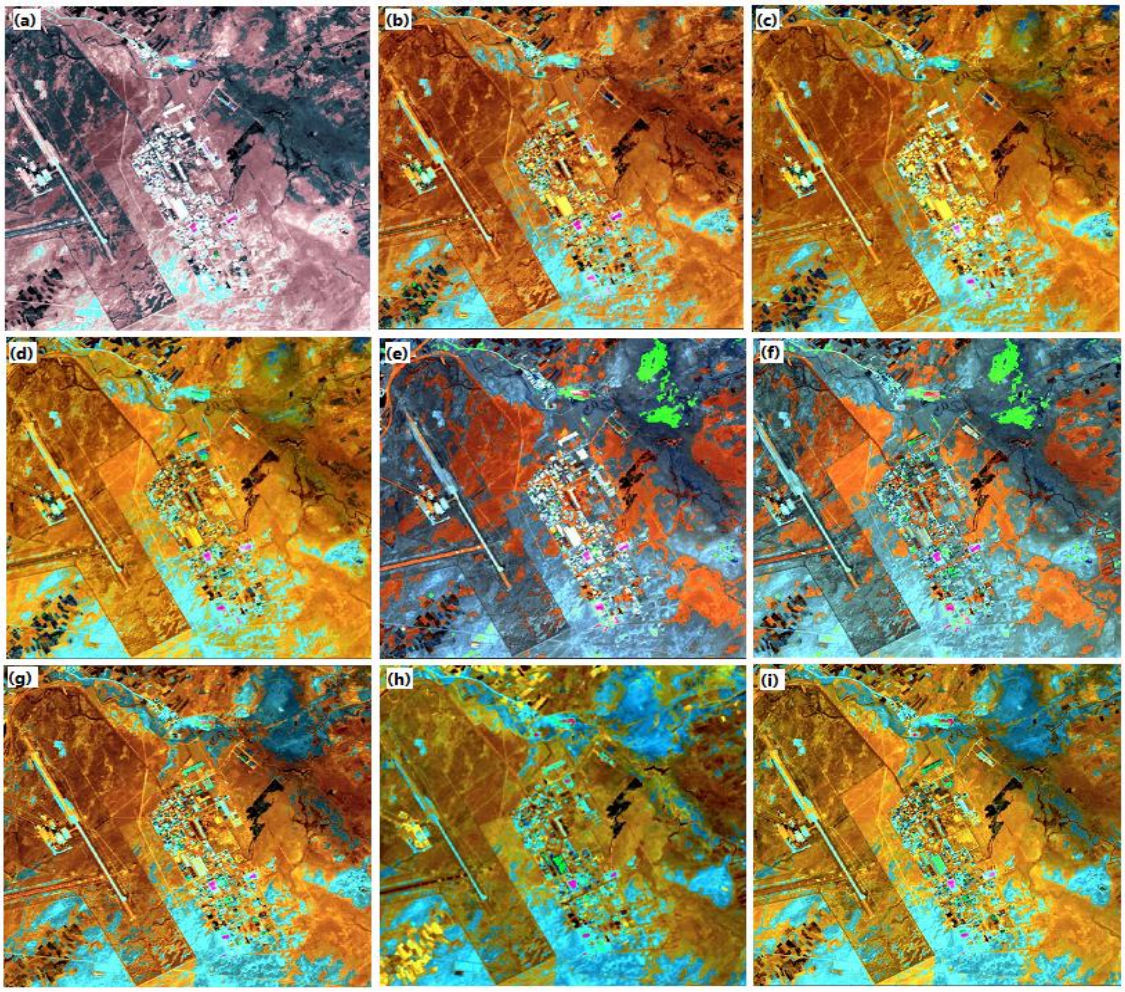

Fig. 6 Nine different colour combinations in both colour systems of HIS

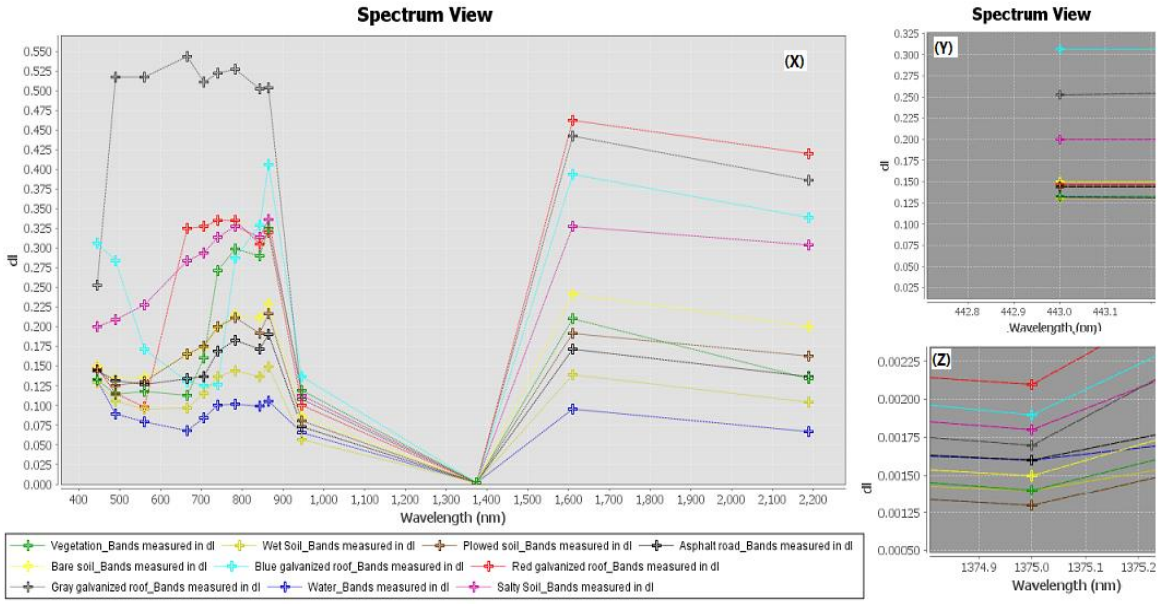

Fig.7 The spectral reflection spectrum of different materials (Wavelength versus DN number)

Figure 8 shows the spectral reflection curve of Fig. 7 in the form of a zoomed-in visible light (range from 400 to 700 nm).

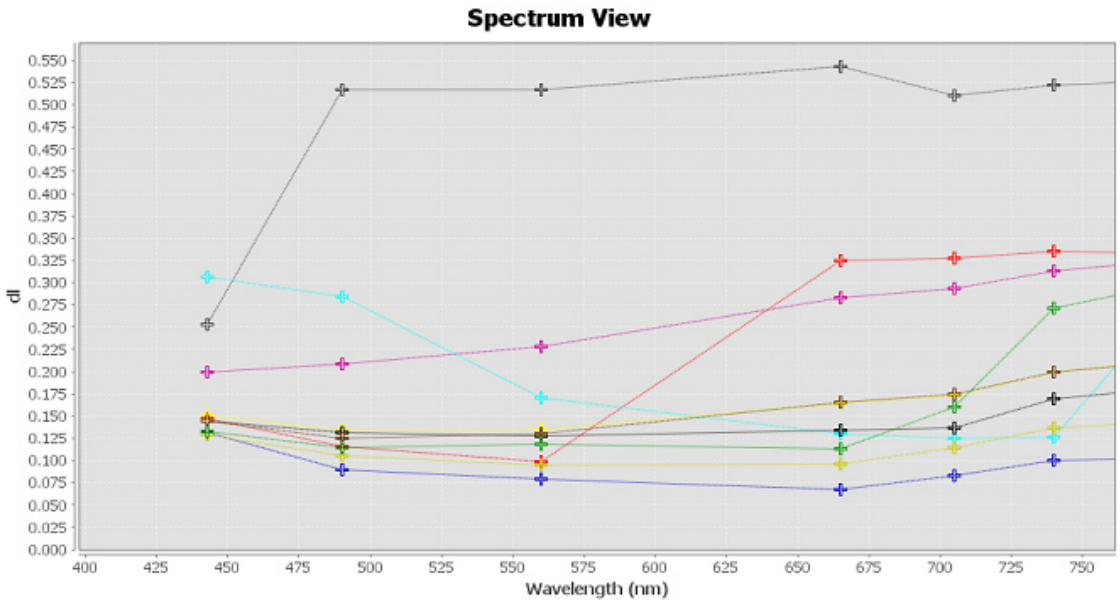

Fig. 8 The spectral reflection spectrum of different materials in visible light

Then, by applying a high-Pass filtering, we highlighted the areas of metal ceilings. The convolution filter of type 5 in 5 kernel size as high-pass filtered and used with ENVI software. Figure 9(1 and 2) shows the filtered image.

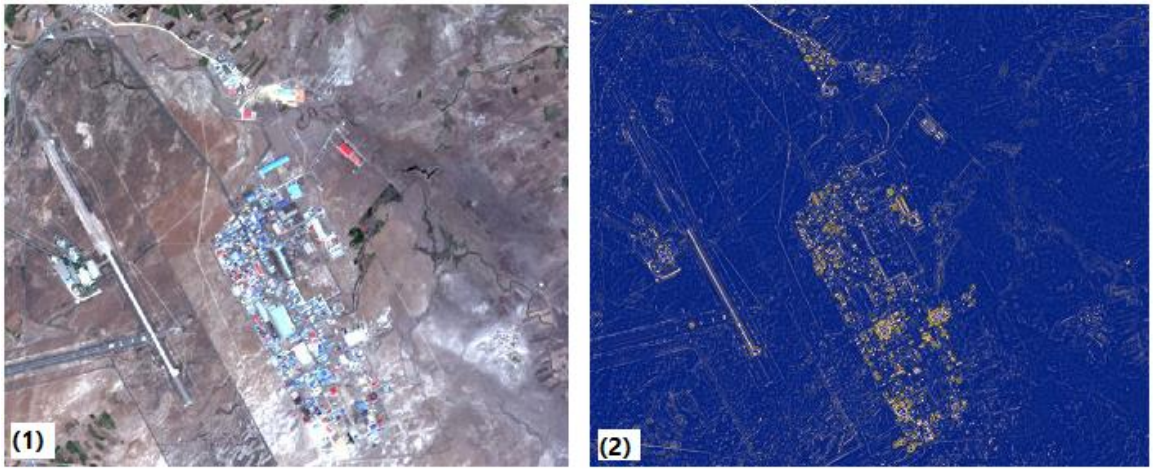

Fig. 9 The spectral reflection spectrum of different materials in visible light

Finally, we chose the SVM method for classification by testing different classification methods and choosing the best classification method based on Overall Accuracy and Kappa coefficient. In Fig. 10, the classified image is displayed in an SVM method. Table 3 also shows the Overall Accuracy and Kappa coefficients for the six types of supervised classification. It is noteworthy that the SVM method with a total accuracy of 96.9% and a Kappa coefficient of 0.9 has the highest accuracy among other methods. So, to continue working, we use the supervised classification method with the SVM method.

Accuracy Type	Parallel piped	Minimum Distance	Maximum Likelihood	Neural Net	Spectral Angle Mapper	Support Vector Machine
Overall Accuracy (%)	71.25	77.27	90.51	92.09	63.26	96.91
Kappa Coefficient	0.58	0.69	0.86	0.88	0.53	0.90

Tab. 3 Overall Accuracy and Kappa Capacity for Different Supervised Classification Procedures

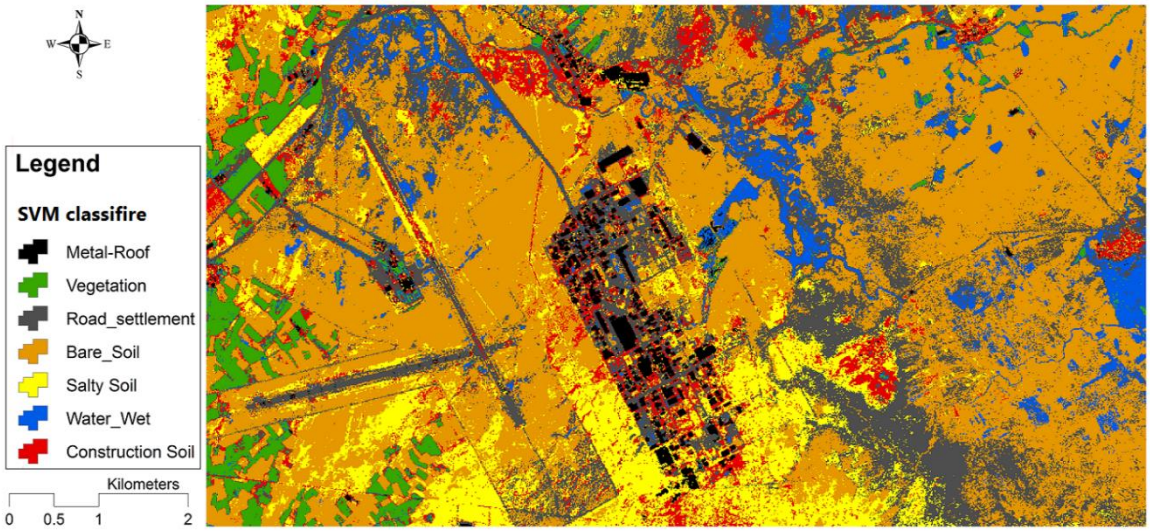

Fig. 10 Image classified by using SVM

3.2 Discussion

This research has been conducted to extract educational samples for supervised classification. Considering the results obtained in the previous section, we will analyze and discus the findings. First, by observing Figures. 3(A) and (B), we can say that reflection varies in different materials, and this reflection difference causes different parts in the segmentation process. Although, apparently, the reflection difference cannot be clearly seen. Although the reflection of a metallic ceiling with a reflection of salty soil, both appear to be the same in the natural color image composite (4.3.2), but in the process of segmentation by multi-resolution, the components are well-recognized.

Also, in the segmented image shown in Figure 3(B), which has been color-coded in 4.3.2 in the HSI color system, metal ceilings (roofs) have become very bright. Second, according to Figure 5, it can be seen that by applying different color combinations of the Sentinel-2, the extraction of complications is well-established. This difference in the representation in Figure 5, (f), (h), and (g) is well known and it can be seen that the reflection of the metal ceiling is completely separated from the spectral reflection of the surrounding saline soil. Also, in Figure 6, the (d), (e) and (i), have shown a good difference in the spectral reflection of metal ceilings and saline soil.

Third, Figure 7 shows the spectral reflection curve of different materials. Additional markup colors are described below. Figure 7(X), is shown in Figure 8 as a zoom. With regard to Figure 8, which shows the visible range, it can be seen that the spectral reflection of the metallic ceilings in blue and red, and the reflection of salty soil is high and almost interrelated. But these reflections vary in the infrared range. In the infrared range (Figure 7(Z)), the red and blue metallic roofs are above the reflection of salty soils, but reflection of the salty soil, in contrast to the visible light range in which the metal ceiling was higher, is higher than the gray ceiling Color is placed.

Figure 9 shows the filtered image by the high pass filter method. In this form, metal ceilings are well separated from other features in the image. Reflection of metal ceilings from salty soils and other reflections of natural features around metal ceilings have also been isolated. Due to the fact that high pass filters highlight the details of the effects in the image, the study also uses a convolution-high pass filter with a 5-in-5 kernel. Finally, in Figure 10, the sketch image is shown in the SVM method.

In this picture, according to the map guide, the black spots represent metal-colored roofs (red or blue or gray) and are well-spaced from high reflection salts (yellow in the map) around these areas. In this study, interesting results were obtained by studying the spectral reflectance of metal roofs and saline soils using object-oriented

processing. First, the best samples for use in classification were extracted using the multi-segmentation method by eCognition software.

Then, by examining important and different methods of classification of satellite images, the best classification method was obtained using kappa and overall accuracy coefficients. Finally, using the Support Vector Machine classification method, a classification was performed on the image and different uses were extracted. In the last step, i.e. classification, the use of metal roof and saline soil was clearly obtained and is shown in Figure 10.

In this research, the method of visual interpretation of satellite images has also been used. This method compares different image representations using RGB and HSI display methods.

4. Conclusion

Sentinel-2 is a high-resolution imaging satellite designed to support data continuity as well as enhance Landsat data and other missions ESA's recent launch of the Sentinel-2 sensor will increase the availability of medium to high resolution free images for use in a variety of applications. Compared to the spatial, spectral, and temporal resolution of satellites in the Sentinel -2 sensor presents new and interesting properties.

The results of this research demonstrate the added value of the Sentinel -2 red and NIR bands to improving segment mapping and encourage multi-sensor for next researches.

This paper presents a new approach for extracting training samples from metal roofs compared to saline soils. In this paper, the spectral behavior of different materials, in particular metal ceilings and saline soil, and the comparison of different color combinations from the images in the two-color systems of the RGB and HSI, the spectral reflection of the materials extracted and used for research work it is possible to use a supervised classification map.

Finally, the classification method of SVM as the best method of classification with a general accuracy of 96.9 and a Kappa coefficient of 0.9 for categorization in this study was selected among other classification methods. The results obtained from Figure 8 and Figure 10 show that the spectral reflectance of saline soil with a very high metal roof has been resolved using the Support Vector Machine classification method and this difference is well separated by this classification method.

The results of this study could pave the way for further studies in the field of using intelligent classification methods such as Support Vector Machine as well as the use of satellite images with high spatial resolution such as Sentinel_2. In future studies, it is also possible to study the methods of intelligent integration of satellite and radar images in the separation of spectral unmixing of different levels by referring to this research.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 125-140
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/8629
Received 22nd November 2021, Accepted 29th March 2022, Available online 30th April 2022

www.tema.unina.it

A sustainable approach for planning of urban pedestrian routes and footpaths in a pandemic scenario. Evidence from Italian cities

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Abstract
The coronavirus (COVID-19) pandemic has forced national and local governments to reconsider the relation between mobility, urban space, and public health, in order to ensure physical distancing while meeting the travel needs of inhabitants. Limitations associated with the perceived risk of infection influenced significantly travel behaviours, pushing a modal repositioning in demand to active mobility (walking, cycling, and use of micro-mobility). On the other hand, the World Health Organization (WHO) guidelines on mobility during the COVID outbreak are mostly directed at dedicating more urban space to cyclists and pedestrians, especially in densely populated urban areas, with the intended aim of avoiding crowding on public transport, or the use of private cars as an alternative. The National Association of City Transportation Officials (NACTO, 2020) went in the same direction. In the given conditions, walking became predominant for a sustainable mobility scenario, and structural measures (as widening of pathways) or regulatory measures (as the regulation of pedestrian flows) can be adopted withing the given strategy. Current pedestrian infrastructural offer is severely limited in functional terms by urban planning and development, therefore measures oriented to enhance non-motorized mobility require firstly the development and planning of new public spaces and infrastructures for pedestrian mobility within the urban layout. Policy makers and town planners need to rethink urban spaces and mobility in a pedestrian perspective. A methodology for the classification of pathways, by capacity and level of service, is presented, which can be used to verify pedestrian mobility demand for specific measures, strategies, and policies.

Keywords
Social distancing; Pedestrian behaviour; Level of service; Pedestrian infrastructures; Walkability.

How to cite item in APA format
Cirianni, F.M.M., Comi, A. & Luongo, A.S. (2022). A sustainable approach for planning of urban pedestrian routes and footpaths in a pandemic scenario. Evidence from Italian cities. *Tema. Journal of Land Use, Mobility and Environment*, *15* (1), 125-140. http://dx.doi.org/10.6092/1970-9870/8629

1. Introduction

The coronavirus disease (COVID-19) pandemic has fundamentally changed lifestyles and habits, and it is likely to have lasting effects on our society. Everyday life has been strongly influenced by safety measures introduced as social distancing, also called "physical distancing," which consists in keeping a safe space between yourself and other people from a different household. All the measures taken have generated a number of serious social and economic implications in all fields, including transport, travel, and mobility (Anastasiadou et al., 2021; Cieśla et al., 2021; Paydar and Kamani Fard, 2021; Fenu, 2021, Jones et al., 2021; Vittelo, et al., 2021). The state of emergency has obliged governments to prohibit "unnecessary" circulation, and to restrain mobility, limited to essential workers and goods, for the sake of public health and to contain the propagation of the virus.

In Italy restrictions on public transport were enforced from the 9th of March 2020, enforcing limitations on vehicle occupation, on private and public transport where a limit on 50% of all seats per vehicle was introduced. Restrictions included limitations in numbers for passengers also on platforms and transit spaces.

Fear of infection and perceived risk also significantly influence travel behaviours, particularly for transit use, and the influence varied based on the infected area and demographic characteristics of the people (Kim et al., 2017, Cahyanto et al., 2016).

The National Association of City Transportation Officials (NACTO, 2020) highlighted that during periods of stabilization and long-term recovery, when restrictions are relaxed and businesses are starting to re-open but the risk of infection is still present, cities will need to focus on how to help people maintain physical distance while moving around the city. As shown by Paydar and Kamani Fard (2021), many cities around the world have expanded their cycling/walking infrastructures to increase their resilience in the face of the COVID-19 pandemic. Furthermore, the benefits of active urban mobility never as during such last year have been seen as a topic to push city users towards a more sustainable mobility style. Active urban mobility benefit individuals through reduced health care costs, and therefore benefits authorities by reducing health care expenses. Research results indicate that every kilometre travelled by car in EU countries, in relation to the costs associated with the treatment of diseases caused by pollution, accident risk assessment, et sim., costs society € 0.15 on average, whereas every kilometre travelled by cycling, or walking, benefits society in the form of € 0.16 thanks to the improvement of public health and the absence of the negative effects associated with car use (UNECE, 2020). Therefore, the opportunity to have a methodology for analysing pedestrian routes as well as to identify footpaths emerges. It can be a useful tool for cities proposing attractive travel options different than cars, and can put the basis for a more resilient urban transport system.

The pandemic scenario and the related containment measures have substantially impacted on the perception of safety on people, and particularly on Public Transport users, even influencing travel mode choice (e.g., De Vos, 2020; Isfort,2021). For example, in Italy, the analysis of modal repositioning in demand after the lockdown shows that pedestrian mobility has captured 23.4% of trips out of public transport and 41.3% of private vehicle/car. Also, in 2020 the proximity demand marks a peak, shorter journeys (less than 5 minutes on foot) have gone from 6% in 2019 up to 17% in the lockdown period, reassessing on 10% in the following months (Isfort, 2020).

Even if this were to be only a temporal situation, given the great uncertainty on the duration, we can expect that active mobility (walking, bicycles, micro-mobility) has an opportunity to grow steadily in the modal share during this period: people have already experienced healthier, less expensive and environmentally friendly solutions for getting around and have rediscovered the value of territorial proximity (Isfort, 2020).

It is therefore clear that Walkability – intended as "the extent to which the built environment supports and encourages walking by providing for the pedestrian's comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout

the network"–should assume a relevant role on the cities' mobility (Southworth, 2005; Cirianni et al., 2018; Comi, 2021; Comi et al., 2022).

It is not infrequent that walking is the "last mile" mode in multimodal trips, assuming a main role in the transport system assessment for quality as perceived by the users. "The last mile" is a term used in transportation planning to describe trips of people and goods from a transportation hub (railway station, bus depot, ferry slip, etc.) to a final destination (home, work, etc.) (Goodman et al. 2005; Cirianni et al., 2021). It is known that in many cities users have, in standard conditions, difficulty getting from their starting location to a transportation network and vice-versa, in relation to the low quality and functional characteristics of the pedestrian infrastructure. In this situation the "physical distancing" could further minimize the quality of service of the pedestrian walkways, which should guarantee a safety standard for all users, whether walking as the main mode of transport, or as a means of access to other modes.

However, it is quite clear that the term "safety", is used with two different ways - in the most common sense of road safety, in preventing pedestrians from road accidents, and in the wider health prevention given by the exposure to risk of covid contagion.

In order to provide safe mobility while maintaining distance, wide and accessible road spaces are needed for all city residents (Comi et al., 2019; Nuzzolo et al., 2019; Rakhmatulloh et.al., 2020; Comi et al., 2022). The pedestrian walkways should be part of a network with appropriate level of service and safety on all the sections of the route, taking into account the needs of all potential users.

Therefore, in the short term the focus is to manage and regulate infrastructure, and in the medium/long term to plan streets and public spaces so to rethink and to guarantee spatial capacity standards for potential demand.

The present paper, using an Italian case, introduces traditional approaches, as found in literature, to define design criteria and indicators for pedestrian pathways (Section 2). The authors intent to present an analysis of the influence of the new parameters, related to the measures as social distancing, on traditional approaches. Then, an application to the Italian cities is presented (Section 3). Section 4 reviews the impact of social distancing on the existing infrastructure. Then, on the basis of the results, a set of measures are suggested in order to provide sustainable short-term urban mobility and transport planning interventions in order to plan a smart pedestrian network (e.g., increase of infrastructure capacity, flows and queue management, information to users by technology, etc.; Section 5). Finally, conclusions are presented along with policy implications and limitations (Section 6).

2. Design criteria and indicators for pedestrian pathways

A walkable network has several of important attributes including safety, both from traffic and social crime, the quality of path, including width, paving, landscaping, signing, and lighting, etc.. The ideal pedestrian path will provide for the comfort and safety of pedestrians of varied ages and physical abilities (Southworth, M., 2005). According to Lian et al. (2021), attractiveness seems to play an essential role in improving urban vitality and is highly correlated with urban redevelopment.

In particular, a walkable neighborhood can encourage active walking behaviour (Saelens et al., 2008) and generate active street life (Speck, 2013). Some studies show that the presence, proximity, and quality of the attractive destinations can play a key-role in stimulating walking activities (Sugiyama et al., 2010; Giles-Corti et al., 2005). Moreover, less traffic volume and lower speed (Appleyard, 1980), presence of service or stores (Jia et al., 2014), and visual enclosure (Wang et al., 2019) are supporting evidence. Many studies identify characteristics of the built environment that are associated with physical activity, particularly emphasizing walking as a widespread population-level means of getting physical activity (see Dalmat et al., 2021 and references therein quoted).

In this sense the separation of the pedestrian from motorized traffic is an essential design feature of a safe and functional multimodal roadway. Sidewalks, pathways, footpaths are all facilities for pedestrian traffic.
The framework in which criteria and indicators proposed are developed, are directly related to the approach of safety and user classification.
Common to all research in the field of road design, whatever the mobility mode involved is the prioritization safety for users, and in this are included policies of modal priority for road users, particularly in urban areas, the hierarchy being based on safety, vulnerability and sustainability. Walking should be at the top of the hierarchy, followed by cycling and use of public transport. The indicator which is mostly adopted to assess pedestrian facilities and give a measure of the comfortability level of them is the Level of Service (LOS), as defined in the LOS approach (Sing and Jain, 2011, Frazila et. al., 2019, Bansal et.al., 2020). The LOS approach describes the existing conditions and allows a qualitative measure to relate the quality of traffic service (Asadi-Shekari et al., 2012).
The advantage of such approach it is that it measures multiple facets: customer satisfaction, environmental requirements and legal requirements (Raad N., Burke M., 2017). The approach for pedestrian facilities is in relation to the approach used to analyze roadways and intersections by categorizing traffic flow and assigning quality levels of traffic (HCM, 2020).
Pedestrian facilities can be classified in two classes: uninterrupted and interrupted. Uninterrupted pedestrian facilities include sidewalks, walkways, stairways and queueing areas, while interrupted facilities are crosswalks, which are further categorized into signalized intersections, un-signalized intersections and midblock crosswalks. The LOS thresholds for each category are different, but all are based on the concept of special occupation per pedestrian, which is a measure of pedestrian comfort and mobility. The combination of footways (sidewalks) beside carriageways and dedicated crossing points identifies a route in which pedestrians have a dedicated right of way.
The level of service (LOS) for pedestrian facilities has been defined on the basis of capacity and pedestrian volume. Factors like personal body shape, type of flow and dimensions of pedestrians have been considered in order to define service levels (Fruin, 1971).

Fig.1 Interdependence among various factors influencing LOS (Source: Bansal and Goyal, 2018)

In the course of time, the definition of LOS has evolved and modified many times so as to incorporate new factors such as freedom to manoeuvre, traffic interruptions, comfort, and convenience. The literature suggests

that the quantitative approach alone for evaluating the LOS is insufficient to find the appropriate results and the qualitative factors which contribute significantly in the analysis of pedestrian LOS (Bansal and Goyal, 2018). Pedestrian perception and behaviour are linked to socio-demographic variables (gender, age of pedestrians, education, employment etc.) which are, as shown in Fig.1, in turn interrelated to each other by numerous factors, such as pedestrian flow, pedestrian density, area occupancy, speed, walkway/sidewalk width, presence of obstacles, walkable area, land-use accessibility, etc.

The set of characteristics which affect the service quality of the pedestrian facilities, are interdependent with the indicators which define the Level of Service. Therefore, there is a bidirectional relation between the behaviour, speed and perception of the pedestrian flow and the accessibility, operational and traffic characteristics, which varies in function of the sociodemographic parameters, and in relation to user behaviours.

Furthermore, the variation in the quality of service affects the pedestrian facility factors. In the present infrastructural scenario, in which most streets and sidewalks are not designed on the basis of pedestrian demand, nor in function of the design capacity, qualitative factors mentioned in the introduction, as fear of infection and perceived risk, will further affect the perception of the facilities quality.

The first space parameter which could be affected from the "physical distancing" is the effective walkway width defined as the portion of a walkway that can be used effectively by pedestrians.

Effective walkway width is the portion of a walkway that can be used effectively by pedestrians. Various types of obstructions and linear features, discussed below, reduce the walkway area that can be effectively used by pedestrians. Fixed objects can be continuous such as a fence or a building and also can be discontinuous like trees, poles or benches.

The effective walkway width at a given point along the walkway is computed as follows:

$$W_E = W_T - W_O \quad (1)$$

- W_E= effective walkway width,
- W_T= total walkway width at a given point along walkway,
- W_O= sum of fixed object effective widths and linear feature shy distances at a given point along the walkway.

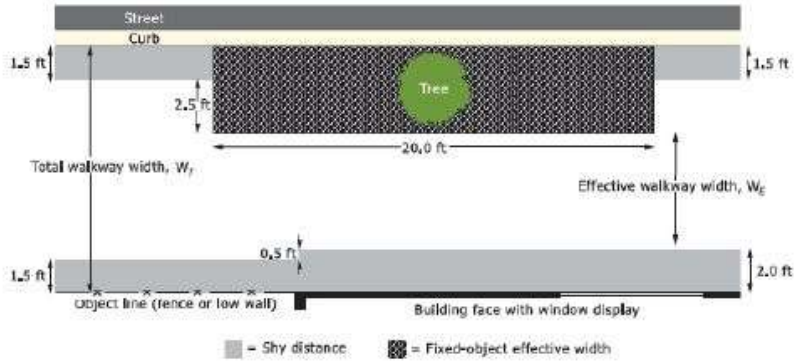

Fig.2 Instructions for calculating effective sidewalk width (Source: HCM 2010 Exhibit 17-17)

The Highway Capacity Manual (HCM, 2020) provides a function to calculate effective sidewalk width in account of fixed objects and shy distances, as shown in Figure 2. The shy distance on the inside (curb side) of the sidewalk is calculated measuring from the outside edge of the paved roadway or face of curb, if it exists (generally, considered to be 1.5ft/0.45 m). Shy distance on the outside of the sidewalk is considered 1.5 ft/0,45 m if a fence or low wall exists. If a building is present, it is considered to be 2.0 ft./060 m, if window

display exists 3.0 ft./0.90 m, otherwise it is 0.0 ft/ 0 m Other sources consider more fixed objects as street lamps (0.70 – 1.0m), traffic signs (0.60-0.70 m), fire hydrant (0.70-0.90 m), (Brilon et al., 1994).
The HCM states that effective sidewalk width is an average value (HCM,2020). The above-mentioned shy distances value is obtained by observing the pedestrian's behaviour by walking on different type of facilities and flow conditions. It has been confirmed that the pedestrians keep a certain distance from other pedestrians and from the edges of roads, walls or obstacles. This distance is reduced in the case of hurry or density increasing (Helbing et al., 2001).

3. Application to sidewalks in Italian Cities

If compared to the sidewalk dimensions in most Italian cities, it can be observed that in average the given shy distances aren't respected. Furthermore, it is not an adopted practice in path-way design to have planting strips between the sidewalk and the curb.
With regards to sidewalk dimensions the Italian law sets the minimum obstacle free sidewalk width in 1.50 m, which becomes 2.00 m in the case of the presence of newsstands, bus stops or similar (D.M. n. 236 14/06/1989, D.M. 05/11/2001).
Common guidelines indication is that the pedestrian zone must provide continuous clear space for walking and be entirely free of obstacles. It is well known that the curb dimensions near a crosswalk will substantially influence the waiting area in term of square meters available per person.
The above-mentioned regulatory instructions have been applied for roads and areas built after the adoption of the regulations, but it is not unusual that the functional and dimensional requirements of pedestrian facilities differ significantly, and also of a critical amount. In central districts and adjacent areas, the sidewalks quite often have a width inferior to 1.50 m. In Figure 3, examples of sidewalk in consolidated residential areas, where total effective width is less than 1.00 m. In this case walking width is limited to a single person, without bags or bulk and, and there isn't space for another pedestrian coming in the opposite direction who often must walk on the road.
The minimum widths prescribed by legislation doesn't appear sufficient to guarantee in peak conditions a comfortable outflow. A width of 5.0 ft/1.50 m o is the bare minimum required for two people in a line. Technical regulations in USA prescribe for locations as schools, sporting complexes, leisure parks, and shopping districts, a minimum width for a sidewalk of 8.0 ft/ 2.40 m (FHWA, 2006).
It follows that if by comparing the space occupied by a person, given the need of physical distance from other people and street obstacles, and the effective width a on pedestrian infrastructures, it is foreseeable that unregulated pathway flows are subject to congestion and flow disruption.
The minimum required distance kept between people for comfort is defined Personal space (or personal distance), and it ranges from a minimum of 45 to 120 cm, corresponding to an arm length. In free flow conditions people try to keep this distance from others, allowing this distance to reduce for people in close relationship. If personal space is invaded without consent it causes people to feel uncomfortable (Frohnwieser, 2012). The Italian Technical Fire Prevention Standards assume a value for the medium size person which is is identified as an elliptical surface, vertical projection of the human body, having the major axis equal to 60 cm and the minor axis equal to 45 cm. This ellipse encloses an area of 0.218 m^2. Other bibliographic sources. recommends a simplified body ellipse of 50 cm x 60 cm for standing areas, with a total area of 0.30 m^2 as standing buffer zone, and of 0.75 m^2 as walking buffer zone. (HCM, 2010).
If we assume two people moving in the opposite direction without any bags and add the above minimum values of shy distance (W_O), personal distance (W_D) and person size (W_P), we get a sidewalk width $W_E = W_O + W_P + W_D + W_P + Wo$ = (0.45 m + 0.60 m + 0.45 m + 0.60 m + 0.45 m) = 2.55 m, which is larger than the Italian standard width. It should be however considered that pedestrians, in a standard situation, like to

keep a certain distance between each other and change their walking speed to maintain those distances. They are also very good in finding the fastest path through a field of obstacles (Frohnwieser, 2012).

Fig.3 A frequent sidewalk type with bidirectional flow in non-renewal residential area of Potenza, a medium-size regional capital of a City of South Italy region, infrastructure characterized by a width just enough the walking of just one person

4. The impact of social distancing on the existing infrastructure

Taking into account the preventive measures taken to stop the COVID-19 spread by authorities around the world, where different protocols have been adopted to restrict the turnout at diverse venues such as markets, public venues or even crowded open air places (streets, squares, beaches, and so on). This social distance is country-specific and it ranges from 1.00 m (e.g. China and France), as recommended by WHO, up to 2.00 m (e.g. UK and Canada), being 1.50 m in the Netherlands. In USA physical distancing guidelines recommend a distance of at least 6 feet (1.80m, about 2 arm lengths) from other cyclists or pedestrians who are not from your household (Centre for Disease Control and Prevention, 2020).

If we assume the smallest value of the above social distances given, namely 1.00 m, and use it as interpersonal shy distance in the given formula, the result is a sidewalk width of about 3.10 m (0.45 m + 0.60 m + 1.00 m + 0.60 m + 0.45 m), in absence of fixed obstacles. If we assume that the pedestrians walk keeping a distance of 1.00 m from each other in the travel direction, the space needed per person is about 2.05 square meters.

Taking in account the space of 2.05 sq. mt, and the LOS given in Table 1 and represented in figure 4, it can be assumed that to walk safely as limit is required level D (low comfort, flow that can start to be unstable).

In Table 1, the level of service is related to the pedestrian speed in meters per minute (in a rage which varies between 2.7 km/h and 4.7 km/h), the pedestrian flow rate (per minute) for unitary width in meters. Therefore, the flow rate is given multiplying the unitary rate by the width of the sidewalk/pedestrian infrastructure in meters. The assumed space occupied by a pedestrian, which is the reverse of the pedestrian density, and the range of the ratio between pedestrian flow and capacity. Although slope could influence the walking speed, due to the low values of pedestrian, it is not fully considered in the capacity HCM (2020), opened the road for further improvement.

LOS	Speed [m/min]	Unit width flow rate [ped/min/m]	Space [m^2/ped]	*v/c* ratio
A	> 78	≤ 16	> 5.60	≤ 0.21
B	> 76 - 78	> 16 - 23	> 3.70 - 5.60	> 0.20 - 0.31
C	> 73 - 76	> 23 - 33	> 2.20 - 3.70	> 0.31 - 0.44
D	> 68 - 73	> 33 - 49	> 1.40 - 2.20	> 0.44 - 0.65
E	> 45 - 68	> 49 - 75	> 0.75 - 1.40	> 0.65 - 1.00
F	≤ 45	varies	≤ 0.75	varies

Tab.1 Pedestrian levels of service boundaries on sidewalk (adapted from the HCM 2010)

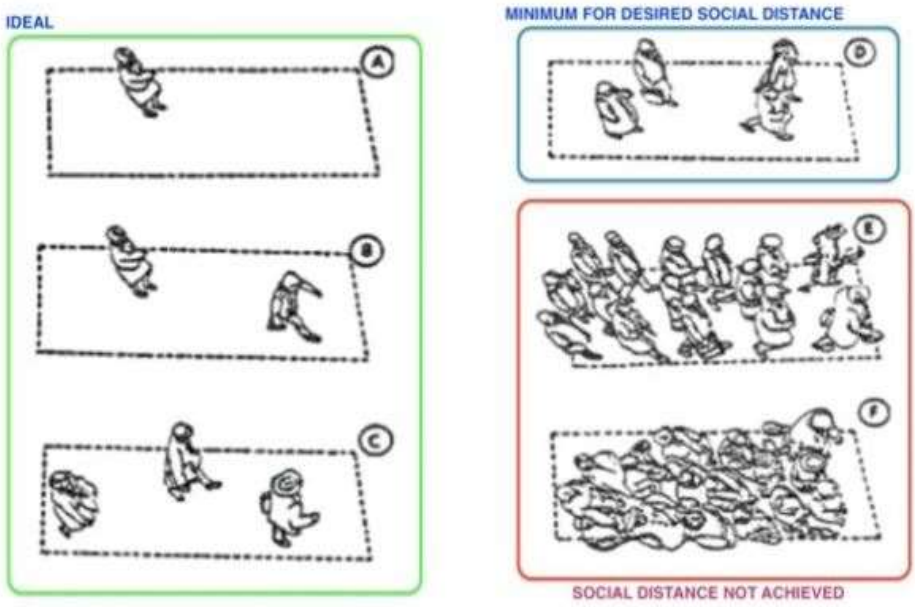

Fig.4 Minimum pedestrian spacing, ideal spacing and situations when the desired social distance is not achieved, referred to the LOS (Source: https://d0ctrine.com/2020/03/14/level-of-service-los-and-social-distance-for-pedestrians/)

The pedestrian unit flow rate is related to pedestrian space as follow:

$$V_P = \frac{S_P}{A_P} \quad (2)$$

- V_P = pedestrian flow per unit width (ped/m/min).
- A_P = pedestrian space (m^2/ped), and
- S_P = pedestrian speed (m/min)

Therefore, by using *eq. 2* and the average values of the pedestrian speed and pedestrian space of LOS D, p S_P = 70.5 m/min and A_P = 1.80 m^2/ped, the associated maximum flow is approximately 2,350 ped/m/h, that for an effective sidewalk width of 3.00 m is equivalent to 7,050 ped/h, therefore a width of 1.50 m comes to 3,525 ped/h (in this case all movements in a single direction). In the same way the maximum pedestrian flow in LOS F, assuming the limit values of the pedestrian speed and pedestrian space, SP =45 m/min and A_P = 0.75 m^2/ped, the associated maximum flow is approximately 3,600 ped/m/h, that for an effective sidewalk width of 3.00 m is equivalent to 10,800 ped/h, and t for a width of 1.50 m is to 5,400 ped/h. The maximum flow value of 2,350 ped/m/h is intended as the number of people per hour in both directions associated with a LOS D, and in compliance with the minimum social distance rules, it is almost 65 % of the flow value related to LOS F, equal to 3,600 ped/m/h. When sidewalks are narrower than the minimum recommended social distance between two or more people it is difficult to maintain the distance. Compliance with the social distance restricts, when sidewalks are narrower than the minimum recommended distance between two or more people, the freedom of people to move in the presence of other pedestrians easily, not only jay walking has

to be excluded, but flows are conditioned, and walking faster or change their direction to greater degrees may represent a violation of social distance. An analysis was conducted in order to assess the feasibility of safety distances for COVID19 on Italian sidewalks, based on the width of many Italian cities' sidewalks data set out on information and maps available in the national Open Data Portal. The project, that is an adaptation of the work done on New York (https://www.sidewalkwidths.nyc), aimed to identify safe pathways and support intervention policies. The project. This processed map drawn in the portal shows the width of the pedestrian spaces, of those cities which have shared the data, and a classification that identifies critical spaces in which social distancing is not applicable (https://rivistageomedia.it/2020052016888/Dati-geografici/mappa-della-larghezza-dei-marciapiedi-italiani-dagli-open-data). The classification worked out in order to identify critical infrastructures indicates, in relation to the sidewalk width, the level of difficulty in maintaining social distance:

- very difficult (minus 2 meters);
- difficult (between 2 and 4 meters);
- possible (between 4 and 6 meters);
- easy (between 6 and 8 meters);
- very easy (more than 8 meters).

Fig.5 Extract from the maps of Rome and Bari (Italy) (Source: https://rivistageomedia.it/2020052016888/Dati-geografici/mappa-della-larghezza-dei-marciapiedi-italiani-dagli-open-data)

In Fig.5, an extract from the maps of Rome and Bari, which show that many streets in the two cities do not provide enough space for safe physical distancing for pedestrians (corresponding to orange and red streets in the map).

Therefore, as previously highlighted, the pedestrian infrastructure network of most Italian cities is not structured for a use in safety and comfort under the pandemic circumstances.

5. Objectives, strategies, and measures for an optimal network management

In consequence of the Coronavirus pandemic, the objective of regulators is to reduce the diffusion of the virus, whilst allowing trips e travelling for primary and necessary activities.

Therefore, pedestrian trips become relevant not only for the shortest path but also the safest.

For pedestrian movements the main strategy adopted in most countries is social distancing. To fulfil this strategy the measures which can be adopted depend on:

- physical dimension of the infrastructure (pathway and lanes);
- composition and separation of pedestrian flows.

On this assumption, to fulfil the objective of reduction of the diffusion of the virus, physical measures (width of the pathway) or regulatory measures (regulation of pedestrian flows) can be adopted withing the given strategy. Many tips are given for practicing social distancing which should impact the pedestrian's behaviour, that somehow influence many of the trip's variables. The above tips could be effectively summarized into the following (Centers for Disease Control and Prevention - CDC, 2020):

- distance should be kept at Events and Gatherings: It is safer to avoid crowded places and gatherings where it may be difficult to stay at least 6 feet away from others who are not from your household. If you are in a crowded space, try to keep 6 feet (about 2 arm lengths) of space between yourself and others at all times, and wear a mask. Masks are especially important in times when physical distancing is difficult. Pay attention to any physical guides, such as tape markings on floors or signs on walls, directing attendees to remain at least 6 feet apart from each other in lines or at other times. Allow other people 6 feet of space when we pass by them in both indoor and outdoor settings;
- to stay Distanced While Being Active: Consider going for a walk, run or cycling in a neighbourhood or other safe location where at least 6 feet of distance between pedestrians and cyclists can be maintained.

Current pedestrian infrastructural offer is severely limited in functional terms, and it is clear the need to adopt measures oriented to enhance non-motorized mobility as well as the provision of public spaces and services within the city. In particular, the most widespread measures adopted in many cities are oriented to change urban streets and public spaces and enhance the residents' safety (Barbarossa, 2020). It emerges that what originally started as temporary measures, including the conversion of road space into pedestrian walkways and cycle lanes, has found widespread support and is leading to permanent infrastructure changes (UN-Habitat,2021). These types of measures as broader sidewalks, addressing urban space and alternative usage of curb sides, taken from car usage and assigned to pedestrians and cyclists (Lozzi et al., 2020). Most measures are contained in a new guide to street design for the ongoing pandemic and future recovery, released by the National Association of City Transportation Officials (NACTO). The key principles in rethinking streets and public spaces for a post pandemic city are: supporting public health guidance, considering physical distancing, increasing the outdoor space available for people, creating safer street that prioritize public transit, cycling and walking, supporting local economies and bringing communities into the process. Most of the implemented are recorded in the Shifting Streets database come from the "Local actions to support walking and cycling" dataset. This dataset, initiated and managed by Tabitha Combs and supported by the University of North Carolina's Pedestrian and Bicycle Information Center (PBIC), documents 841 actions taken by 394 cities, states, and countries between March 10 and July 15, 2020 (http://pedbikeinfo.org/shiftingstreets). Value frequencies for the above application shows that the most common application, 13% of all recorded mobility response, is reallocation of some but not all traffic lanes to walking and bicycling, followed by full and partial street closures for walking and bicycling, each with 11% of all recorded mobility responses (Combs et al., 2021) .

In synthesis, the most effective measures adopted by many cities, are:

- removing motor vehicle lanes from residential streets and extending sidewalks near shops, schools, and parks to make walking safe and enjoyable for transit and exercise.

- establishing safe cycling routes to and from schools, offices, and close to main roads, by closing roads and carriageways where necessary, so that people can have a safer alternative to private cars and public transport;
- creating safe access routes on foot and bike as well as safe public spaces and green areas at the neighbourhood scale, closing roads and squares to motorized traffic.

Figures 6 and 7 show some of the above solutions for pedestrians adopted in Milan and - Brookline (MA, USA). The type of Policies to consider in the evolving pandemic scenarios indicated by NACTO, are shown in Table 2.

All mentioned actions involving just the management of the infrastructures do not provide the efficient achievement of the objectives. In this regard the management of the whole pedestrian's system is needed, also involving the demand, and more specifically pedestrian demand. Like driver monitoring and information systems, the design and implementation of a monitoring system for pedestrian is suggested, developed using ITS. Such systems require two integrated components: a traffic monitoring system and a demand management system, connected continuously with a main data center.

The information of the two integrated sub systems should be matched and enable the "traffic manager" to monitor and control traffic in areas or corridors of high pedestrian use, and by continuously getting traffic information feedback in real time to users also to direct to alternative routes. The system should include a sub system of dynamic monitoring on the walkway density situation and real time assessment of available walkways with an acceptable LOS (level D), and dynamic information using message transfer on public and personal devices about the real-time pedestrian's density and alternative routes. The implementation of the proposed measures, with ITS systems, should be designed in order to support a Smart Pedestrian Network (SPN), promoting sustainable mobility.

The SPN system provide information on suitable walking routes aiming to satisfy potential users' needs, and reduce congestion.

Fig.6 Construction works for the new cycle lane on Corso Venezia -Milan (04/30/2020) (Source: https://www.comune.milano.it/documents/20126/7117896/Open+streets.pdf/d9be0547-1eb0-5abf-410b-a8ca97945136?t=1589195741171)

Fig.7 Brookline (MA, USA) used cones and temporary signs mounted on freestanding delineator posts to extend sidewalks and create bike lanes along four high-volume streets (Source: https://nacto.org/wp-content/uploads/2020/07/200708_Sidewalk-Extensions.pdf)

6. Conclusions

The Covid Pandemic, among its effects on the world community, has led to new patterns in transport, and measures have been adopted to reduce the risk of infection. However, we do not know how long these measures will be enforced for, and whether or not subsequent pandemic waves can be expected. It is very likely that people might still fear social contact when social distancing rules are no longer compulsory, affecting activity, participation and travel (De Vos, 2020). In any case COVID-19 prompted cities to create safe spaces for walking and bicycling through the redesign of road infrastructures, the possibility the recuperation of the capacity

One of the strategies adopted in most countries is social distancing. To fulfil this strategy the measures which can be adopted depend on physical dimension of the infrastructure (pathway and lanes), composition and separation of pedestrian flows.

To hold in due account social distancing and guarantee adequate Level of Service, in designing pedestrian pathways, the capacity of infrastructure has a decrease of up to 35 % in standard conditions.

Based on the patterns observed, a set of measures are suggested in order to provide sustainable short-term urban mobility and transport planning interventions in order to plan a smart pedestrian network (e.g., increase infrastructure capacity, flows and queue management, information to users by technology).

The most effective measures adopted by public administrations are to remove motor vehicle lanes from residential streets, extend sidewalks, establish safe cycling routes to and from schools, offices, and close to main roads, create safe access routes on foot and bike, and the implementation of ITS systems designed to develop smart pedestrian networks.

The methodological results given are useful in the scientific framework of walkability. The calculation of required widths should be adopted for the verification of existing infrastructures and the design of pedestrian ways, in accordance to the desired flows and the forecasted pedestrian infrastructure capacity. It would be useful to verify the application of the results in conditions were spacing variables are introduced, as in health and emergency conditions, and stress situations of the system, as evacuation plans.

The policies presented by NACTO in the Table 2 expose a set of different scenarios in function of the infrastructures "dimensions and characteristics", In cases of Covid 19 pandemic, from lockdown to reopening in vaccine and non-vaccine scenarios. And pedestrian infrastructures in the different categories of streets.

Public Health Response	**Neighborhood Streets** (local/residential)	**Neighborhood Main/High Streets** (small retail/office, residential, schools, institutions)	**Major Urban Streets** (transit, retail/offices, institutions, schools)	**Edge Streets & Boulevards** (in/alongside parks, waterfronts, etc.)
Stay-at-home orders in place	• "open streets" (pop-up parks) • slow streets or local access only • speed management (movable barriers, gateway treatments, signs) • Wi-Fi hotspots • open-air cooling zones/sanitation	• sidewalk expansions for queuing, outdoor markets, & access • pop-up bike and roll lanes • temporary pick-up/drop-off delivery zones	• sidewalk expansions for access & queuing • temporary pick-up/drop-off zones • shorten signal cycles • put pedestrian signals on recall	• street closures to vehicular traffic, for medical services, recreation, markets, etc.
Pre-vaccine re-opening	• local-access only treatments • lane removal/ street closures for schools & religious/cultural service providers	• tactical lane/parking space removal, street closures for outdoor restaurant seating, outdoor markets, etc. • sidewalk expansions for queuing & access • tactical bike lanes • designated pick-up/ drop-off delivery zones • bike & shared micromobility parking corrals • lane removal/street closures for schools & religious/cultural service providers	• bus-only lane, tactical islands/in-lane stops, bus priority signals, expanded bus stops • lane removal/parking space removal for outdoor restaurant seating, outdoor markets • sidewalk expansions for queuing & access • protected bike lanes speed management	• street closures to vehicular traffic, e.g. for recreation, markets, schools, etc. • expanded bike lanes & bike/shared micromobility parking zones • speed management
Vaccine/post COVID-19	• speed management (e.g. speed limit changes & geometry) • play streets, slow streets, and local-access-only policies & design	• sidewalk widenings • speed management (e.g. speed limit changes & geometry) • expanded bike lanes & bike/shared micromobility parking zones	• bus-only lanes with offboard fare collection, bus islands, and amenities • high frequency bus service • expanded bike lanes & bike/shared micromobility parking zones • sidewalk widenings • speed management	• open space expansions • expanded bike lanes & bike/shared micromobility parking zones • speed management

Tab.2 Types of Policies to consider (NACTO, 2020)

The results shown in such a research open the road for further investigation aiming to create a more walkable cities/towns which encourage the active mobility. Then, the further development of such a study is addressed to point out the walkability measures. It should involve the review and comparison of walkability measures. Component measures of walkability indices such as density of services and pedestrian infrastructure would be of particular interest. Therefore, the correlation and assessment methods of walkability and urban vitality should be studied, focusing on their theoretical and practical implication for urban design, policy, and decision making.

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Acknowledgements

The authors are grateful to the anonymous reviewers for their valuable comments.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 141-148
print ISSN 1970-9889, e-ISSN 1970-9870
10.6092/1970-9870/9037
Received 10th March 2022, Available online 30th April 2022

www.tema.unina.it

REVIEW NOTES – Urban planning literature review

Climate adaptation in the Mediterranean: Where are we?

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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 first contribution aims to outline the scenario of climate risks faced by cities on the Mediterranean coasts. The *mare nostrum* region is particularly sensitive to global warming-related phenomena, both because of its position exposed to oceanic, Saharan and polar currents, and because of its intrinsic vulnerability, the roots of which are to be found in the history of conflicts and migrations, of development visions that are antithetic yet complementary. The first contribution of the Review Notes for TeMa vo. 15 highlights the need for integrated action to address the climate crisis in the Mediterranean region, bringing together the strengths and weaknesses of its shores, despite social, economic and political differences.

Keywords
Ecological Transition; Urban planning; Strategies.

How to cite item in APA format
Guida, C. (2022). Climate adaptation in the Mediterranean: Where are we?. Tema. Journal of Land Use, *Mobility and Environment*, *1* (2022), 141-148. http://dx.doi.org/10.6092/1970-9870/9037

1. Introduction

The word climate derives from the Greek word *klima*, meaning "trend", and does not refer to weather forecasts but to the average state of the sea-land-atmosphere system over a relatively long period (at least thirty years). During the first Earth Summit in Rio de Janeiro in 1992, celebrating the birth of the United Nations Framework Convention on Climate Change (UNFCC), climate change was recognised as "directly or indirectly caused by human activity [...] altering the composition of the Earth's atmosphere" and is in addition to normal "climate variability" (UNFCC, 1992). Although this well-known and established definition makes a distinction between "climate change" attributed to human activities and "climate variability" addressable to natural causes, many researchers agree that human activity is a dominant cause of the phenomena observed since the middle of the last century and closely related to global warming.

The trigger is scientifically and culturally recognised. The increase of gases (commonly known as greenhouse gases – GHG) in the atmosphere, such as carbon dioxide (CO2) and methane (CH4), causes more solar energy to be retained in the seas, landmasses and atmosphere, changing the flow of heat energy in the earth's climate system. It is interesting, as well as profoundly dramatic, to study how human activity from the second industrial revolution to the present day (quantified in terms of climate-changing gas emissions into the atmosphere) has contributed to triggering irreversible phenomena and how political strategies on a global scale have tried (and in some cases succeeded) in limiting damage and danger to the world's population.

As indicated in a recent report by the Intergovernmental Panel on Climate Change (2014), the total GHG emissions due to human activity increased from 1970 to 2010, with a larger absolute increase for the last decade (Budescu et al., 2014). It is worth noting that about half of the equivalent carbon dioxide released into the atmosphere between 1750 and 2010 was produced alone in the last 40 years. This issue highlights how human activity has contributed to the intensification of climate change.

What emerges from these data is that economic and population growth are the main drivers of increases in GHG emissions. Researchers affirm that the contribution of population growth in the first decade of the 21st century has remained roughly the same as in the previous three decades, while the underlying contribution of economic growth has increased significantly. In this respect, the increase in GHG emissions in the first ten years of the century is most likely linked to the production activities of China and other emerging economies. As a result, atmospheric concentrations of GHGs have increased significantly, extending and intensifying the natural greenhouse phenomenon, with proven negative influences on life on planet earth.

According to these data, and without implementing new and innovative actions and strategies, climate-changing gas emissions are expected to grow, driven by unstoppable economic activities. Scientists and researchers predict that the average temperature of the earth's surface could increase by 3.7°C to 4.8°C by 2100, compared to the temperature in the pre-industrial period. These climate changes are followed by widespread consequences and effects on the entire earth's surface: rising sea levels, burning forests, melting glaciers, violent hurricanes, tropical storms, droughts, heatwaves, and an increase in hot days.

We are already paying the price for these events, but the greatest burden falls on the population's poorest and most vulnerable groups. Moreover, the problems caused by climate change are accelerating at a rate that is difficult to estimate, and technicians and policymakers do not have a suitable ledger to measure them as well as cope with them. Although we are now aware of climate change, the most significant political, ecological, social and economic consequences have yet to happen. Analysing and anticipating these consequences is a huge challenge because planetary politics is extremely complex, as climate science and the history of the last forty years demonstrates this.

The consequences of these phenomena on physical and natural environments, as well as on urban environments, in the coming decades are difficult to predict because how the climate will change and how much society will be able to absorb its impacts are highly controversial issues, despite the efforts of technological development and scientific research. For example, different groups of experts often reach

different conclusions when defining the risks due to climate change. Some experts believe that the consequences of climate variability over the next few decades will be small, as they predict a combination of stabilising effects, reduced sensitivity of physical systems, biological resources, policy responses to climate change, and good community responsiveness to the economic and social impacts of phenomena related to climate and weather variability. This latter quality depends partly on the considerable scientific and technological capabilities of international communities.

Other experts see climate change as much riskier because of the speed at which the phenomenon is advancing and will lead us to climatic conditions never before experienced in human history. Moreover, the planet's physical characteristics, the biological resources on which society depends, and the social systems are highly adapted to the existing conditions since they have been stable for thousands of years. This instability increases the disturbance potential of climate change. Moreover, the succession of events has shown that even slight changes can have significant consequences for local and/or regional societies, leading to the increasingly frequent occurrence of real natural disasters (Disse, 2020).

Even in the absence of the profound uncertainty about the consequences of climate change, as evidenced by the divergences between experts on the subject, the phenomenon still represents a complex challenge in managing its risks. Policy responses necessarily complement objective information on the relationship between the sea-land-atmosphere system and the societies in which we live with subjective judgements that have to do with the heterogeneous awareness of the phenomenon, the equity between nations and peoples and the consideration we give to cultural heritage and/or non-human species. All this contributes to the complexity and often controversy of managing the risks associated with climate and meteorological variability on the planet (Busch, 2019; Chen et al., 2020; Glasser, 2020; Sillmann, 2021).

Policies adopted to limit climate change fall into two broad, non-mutually exclusive categories of action:

- Mitigation, to reduce the emissions of climate-altering gases and prevent potential increases in near future (Mi et al., 2019; Ivanova et al., 2020);
- Adaptation, to increase society's capacity to respond to climate change, also with the support of geoengineering or climate engineering (Lin, 2020), for the management of territorial systems, at different scales, in order to limit the impacts of the high concentration of GHG in the atmosphere (Aguiar at al., 2018).

In many cases, the boundaries between one type of action and another are blurred: actions aimed at reducing emissions may increase the adaptive capacity of territorial systems and vice versa. Possible strategies to manage natural, social and economic risks related to climate change are strongly contaminated by each other: decision-makers can simultaneously work on integrating practices and/or policies aimed at mitigating GHG emissions and adapting territorial systems according to the dictates of geoengineering. However, as the political dynamics of the past decades show, many efforts have been made to implement mitigation actions aimed at limiting and reducing GHG concentrations in the atmosphere, but adaptation actions are gaining more and more space in the international political and scientific landscape.

The adaptive capacity of a social and economic system, such as a city, depends on its response to climate change to limit damage and potentially benefit from it. Climate adaptation actions include changes in community behaviour, resource use and technology. In addition, working on climate change adaptation seems to be a critical path since some consequences seem to be irreversible, even if this strategy involves much more cognitive and decision-making efforts to design suitable tools to adapt the cities to phenomena of different magnitude and nature.

Given these preliminary considerations, the next paragraph focuses on the climate conditions of Mediterranean cities. The main hazards facing the coastal areas of the basin are outlined. In addition, the characteristics that contribute to the increased vulnerability of the area to climate change-related phenomena are presented.

The aim of this first contribution to TeMA Vo. 15 is to present interesting scientific literature in the field to define state of the art, the exposure to the impacts of global warming and the vulnerabilities of the Mediterranean territory in order to explore opportunities for growth and development in response to the climate crisis, which will be further analysed in next contributions.

2. The risks of a changing climate for Mediterranean coastal cities

The Mediterranean basin is one of the most sensitive regions to global warming. It has been defined a "Hot-spot" (Giorgi, 2006), based on the results of global climate change projection scenarios. The latest report of the International Panel on Climate Change (IPCC, 2018) highlights that the Mediterranean area is among the most vulnerable in the world, with respect to the impacts of climatic and meteorological phenomena. The global panorama underlines the need to estimate the possible consequences for this region, which will be increasingly hot and dry. During the 20th century, the air temperature in the basin was observed to have increased significantly, by 1.5°-4°C, depending on the area (Meyssignac et al., 2011).

Over the same period, and with a clear acceleration since 1970, temperatures in south-western Europe (Iberian Peninsula, southern France) have increased by around 2°C. The same phenomenon has been recorded in North Africa, although it is more difficult to quantify given the discontinuity of the natural and man-made environments in the area. A key element for the climate of the Mediterranean region is the presence of the sea, which represents an important energy and moisture resource for the atmosphere, although the recorded anomalies of the Sea Surface Temperature (SST) govern, at least partially, the air temperature and precipitation phenomena for the surrounding areas (Balaban & Şenol Balaban, 2015; Satta et al., 2017; Pérez-Andreu et al., 2018). The region is located in what is defined as a transition zone between the subtropical and mid-latitude weather and climate regime. The territories bordering the Basin are characterised by a complex and heterogeneous orography, as well as dense and extensive population centres.

The Mediterranean is a shallow sea, so its waters warm at higher rates than those of the oceans (WWF, 2019): in recent years, in fact, the temperature of surface waters has increased by as much as 1.4°C (as of 2018), compared to the temperatures recorded at the end of the last century, reaching as high as 30°C in summer, while that of deep waters by 0.2°C.

Among the consequences of overheating in the entire Mediterranean region, much more frequent and intense heat waves have been recorded, as well as longer periods of drought. Another effect, not negligible for coastal cities and the region's blue economy, is the significant rise in sea level. In the last two decades, a rise of 3 cm has been recorded every ten years. This is not an outlier compared to the global trend, and climate experts say that it is mainly due to the North Atlantic Oscillation (NAO), i.e. the atmospheric variability between the Andorra and Iceland, which is responsible for climate phenomena over a large area of the northern hemisphere. However, this is a significant increase, compared to the increases in the periods 1945-2000 and 1970-2006, when increases of 0.7 mm and 1.1 mm per year, respectively, were recorded.

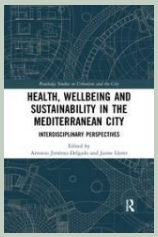
In addition, the Mediterranean Sea will suffer, due to an increased concentration of CO2 in the atmosphere, from significant acidification: the pH of the waters is predicted to decrease from 0.018 to 0.028 units every ten years (Giorgi & Lionello, 2008; Lionello & Scarascia, 2018; Brownlee et al, 2021). Even if we succeed in limiting the rise in temperature to below 2°C, as established by the Paris Agreement, the Mediterranean region will still feel the dramatic effects of this phenomenon. Researchers and scientists predict that these changes will result in more frequent heat waves, as well as more frequent hot days, characterised by temperatures above the seasonal average (Gaaloul, 2020; Diodato et al., 2020; Ogaya & Peñuelas, 2021).

In particular, return periods of heat waves in the eastern Mediterranean region could decrease from two years to less than one year. In addition, a reduction in rainfall of about 10-15% is expected for southern France, northwestern Spain and the Balkans, and up to 30% for Turkey and Portugal. The scenarios are considerably more dramatic if the temperature increase were to be between 2°C and 4°C: by 2080, the whole of southern

Europe will suffer from widespread decreases in precipitation, up to 30% (especially in spring and summer months), and even ice absence over the Balkans (Grillakis et al., 2020; Soto-Navarro et al., 2020). The global temperature increase of 1°C is estimated to result in a decrease of about 4% in rainfall for much of the Mediterranean region, especially in the south. At the same time, precipitation is expected to increase considerably, by up to 10-20%, for all seasons except summer. Global trends estimated by the IPCC (Fifth Assessment Report - AR5) predict that sea level rise will be between 52 and 98 cm, compared to the current average level (IPCC, 2014; Robertson, 2021). In contrast, a semi-epirical model developed by Vermeer and Rahmstorf (2009) predicts a sea-level rise between 75 and 190 cm. Several models and scenarios have been developed for the waters of the entire planet, but the results can be very different, given the large number of variables involved and the complexity of their interrelationships. For the Mediterranean, the contributions of water transport across the Strait of Gibraltar, regional changes in river outflows, significant land movements in the eastern part of the basin, as well as the potential increase in salinity can all influence sea level rise, to varying degrees. Long-term predictions are therefore very imprecise and unreliable. In any case, even limiting global warming to below 2°C will result in significant differences in sea surface height, up to 10 cm: the coasts of southern Italy could be largely inundated by 2100; the coastlines of the Mediterranean Sea, more generally, could undergo substantial changes (Al Sayah et al., 2021).

The impacts on the infrastructures and economies of cities that have lived off the resources offered by the sea for centuries could be further compromised, if we consider that these changes will affect the territories of the basin together with other environmental phenomena, which are not negligible. It is necessary to consider that the population of Middle Eastern and North African nations quadrupled between 1960 and 2015. During the same period, the degree of urbanisation increased from 35% to 65% (Myers, 2021). The implementation of new irrigation techniques has allowed the intensification of agricultural activity, but the management of land use could change further, leading to consequences especially for water resources. In addition, air and water pollution, unless local improvements in wastewater treatment are made, have increased as a result of increasing urbanisation, private transport and other factors. Political conflicts also have inevitable and dramatic impacts on the environment, as do continuing migration flows, which plague already poor economies and deplete their ability to adapt to climate change. The combination of natural and anthropogenic hazards, identified in this paragraph, represents the main challenge for urban systems living on the Mediterranean Sea for the coming decades. Some research, including that of Guiot et al. (2018), states that the impacts of climate change on the Mediterranean basin are not only accentuated, compared to global trends, as shown above, but have been strongly underestimated. Each individual problem has indeed been examined independently, but the truth is that they are closely interconnected and, above all, interact with social and economic problems that further amplify their impact.

Health, Wellbeing and Sustainability in the Mediterranean City. Interdisciplinary Perspectives

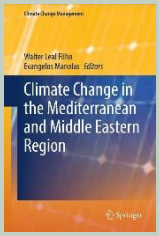


Authors/Editors: Antonio Jiménez-Delgado, Jaime Lloret
Publisher: Routledge
Publication year: 2019
ISBN code: 978-0-42940-157-2

This book provides a model for the creation of sustainable and healthy cities in the Mediterranean region. It uses the coastal city of L'Alfàs del Pi in Spain as an example for designing renewable and innovative urban models that offer high standards of living, wellbeing and eco-friendly advantages. Quantitative and qualitative analyses are presented by scholars in a wide variety of fields to provide a thorough understanding of the social, cultural, economic, political, physical, environmental and public health influences, through the case study of L'Alfàs del Pi. L'Alfàs del Pi has a geographically unique population made of a mixture of local inhabitants and Northern European residents attracted by the weather

conditions and the sea. The chapters in this book explore a series of innovative proposals for addressing concerns in the area, including historic preservation, sustainable transportation, promoting health and physical activity and water conservation. The methodology establishes a strategic approach that serves as a useful reference point for coastal cities, particularly in Mediterranean countries, in the creation of sustainable and healthy cities.
The book addresses the topic of Mediterranean climate adaptation through the lens of different perspectives which range from urban planning to tourism, from health geography to architecture. Moreover, it tries to give an interesting and holistic gateway to the Mediterranean city.

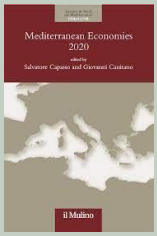
Climate Change in the Mediterranean and Middle Eastern Region



Authors/Editors: Walter Leal Filho and Evangelos Manolas
Publisher: Springer
Publication year: 2022
ISBN code: 978-3-030-78565-9

Climate change is having a much greater impact in the Mediterranean than the global average. In the Paris Climate Agreement, the UN member states pledged to stop global warming at well below two degrees, if possible, at 1.5 degrees. This mark, which is expected elsewhere only for 2030 to 2050, has already been reached in the region. The situation could worsen in the coming years if the global community does not limit its emissions. The above state of affairs illustrates the need for a better and more holistic understanding of how climate change affects countries in the Mediterranean region on the one hand, but also on the many problems it faces on the other, which prevent adaptation efforts. There is also a perceived need to showcase successful examples of how to duly address and manage the many social, economic and political problems posed by climate change in the region, in order to replicate and even upscale the successful approaches used. It is against this background that the book Climate Change in the Mediterranean and Middle Eastern Region has been produced. It contains papers prepared by scholars, practitioners and members of governmental agencies, undertaking research and/or executing climate change projects, and working across the region. It serves the purpose of showcasing some of the works in respect of applied research, field projects and best practice to foster climate change adaptation across the region. This book is structured in two main parts. The first one is dedicated to climate change models and impacts; the second concerns climate change adaptation and resilience initiatives.

Mediterranean Economies 2020



Editor: Salvatore Capasso and Giovanni Canitano
Publisher: Il Mulino
Publication year: 2020
ISBN code: 978-88-35-29082-3

The annual report published by ISMed-CNR (Mediterranean Studies Institute) focuses on mobility as a source of prosperity for all Mediterranean countries. Mobility is the deep soul of the market and is the engine that enables any economic system to grow and prosper. Driven by endogenous forces, when free to move, factors of production flow towards higher-yielding investments with the result of stimulating productivity and growth. Moreover, the greater the output gaps, the greater their impact in terms of productivity.
The report recognises that the Mediterranean region is an area of great inequalities and economic and demographic differences, not only between the north and south shores, but also within countries and between regions. Here, more than elsewhere, the lack of mobility factors compromises the growth and development of the entire area.
Mediterannean Economies 2020 is a collection of essays analysing the nature and effects of mobility factors in the Mediterranean. In particular, the collection focuses on the socio-economic impact of human capital mobility in the labour market and on the specific characteristics of migration in the Mediterranean. In addition, the book also offers new analyses on some important aspects of goods mobility: the relevance of logistics and port infrastructures in the Mediterranean and the dynamics of traffic in the basin in recent years.
The Report on Mediterranean Economies 2020 is the follow-up to the long-standing Report on Mediterranean Economies, and as such intends to provide an annual overview of the political and economic conditions in the area. This year, while focusing on mobility, this collection of studies also offers an account of the impact of the coronavirus pandemic on the basin's economies and outlines possible recovery scenarios.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 149-156
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/9044
Received 18th March 2022, Available online 30th April 2021

www.tema.unina.it

REVIEW NOTES – Town Planning International Rules and Legislation

Accelerating sustainable urban transition: European climate action

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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. Section aims at presenting the latest updates in the territorial and urban legislative sphere. Accelerating the sustainable urban transition requires functional and structural changes in urban systems through which challenges such as the climate crisis are addressed. Researchers, professionals, policy makers in their various roles are trying to provide concrete proposals and actions to the challenge of climate change in cities from a sustainability perspective. The European Commission has also played a crucial role in providing forms of funding on the issue. In this direction, the paper examines precisely the European regulatory excursus starting from the climate law up to the EU Adaptation Strategy to increase the resilience of cities.

Keywords
Urban sustainability transitions; Climate change; European climate policy; Urban climate action.

How to cite item in APA format
Gaglione, F. (2022). Accelerating sustainable urban transition: European Climate Action. *Tema. Journal of Land Use, Mobility and Environment*, *15* (1), 149-156. http://dx.doi.org/10.6092/1970-9870/9044

1. Sustainable urban transition

The latest reports issued by the UN show that 70% of people globally will live in cities by 2050. This will mean that the global urban population will be far much higher than the rural population (Seto et al., 2010). The consequence of this is an increased demand in and around cities for energy, food, water, buildings, waste management, health care, education and other basic services. The growing demand, in turn, involves the creation of socio-technological systems necessary to "manage cities" with a view to sustainability. Unfortunately, cities are the terrains where most of the (in) sustainability problems originate. This is confirmed by the latest reports issued by the IPCC which show that cities are responsible for almost 75% of total resource consumption (Madlener and Sunak 2011) and the primary source of greenhouse gas (GHG) emissions (Hurlimann et al., 2021). Conversely, cities are also the terrains concentrated efforts towards actions aimed at innovation, sustainability and social progress (Thornbush & Golubchikov, 2021). The different territorial realities are called to play a dual role, first as actors "for the (re) development of socio-technological systems and as facilitators of" places "for sustainable innovations (Geels et al. 2011). This intuition according to which cities are "actors and places" of the transition to sustainability is not a completely new concept. Many ambitious sustainability initiatives have already emerged at the level of cities and metropolitan regions, such as the Covenant of Mayors and the C40 climate coalition. There are the policy gaps in defining a sustainable city model is in the lack of "development" policies that so far seem insufficient to guide and accelerate a deeper systemic change. The transition to urban sustainability is an ever-changing political process, permeated by conflicts and contradictions. Surely the concept of sustainability entered the world scene with the introduction of the notion of sustainable development by the so-called Brundtland commission in the 1980s; they defined it as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). After almost three decades, there is still an extreme difficulty in making operational and implementing sustainable development in the scientific and political debate. Unfortunately, urban policies and related governance systems still focus on “direct” economic development and standard technological solutions, instead of aiming for adaptive and transformative sustainability strategies. Sustainability is too often seen as an element of secondary policy interest, mainly because it is dominantly perceived in the short-term economic balance sheet. Since its advancement is perceived as costly and often uncertain. Clearly, in order to (re) structure cities, large investments are required which often require large initial investments, the benefits of which can occur in the period (Fuenfschilling et al., 2019). The primacy of short-term economic concerns in the decision-making process is short-sighted in the face of the current realities of different territorial contexts and their relative functioning of economic systems that depend on the sustainable functioning of socio-technological systems and their social and environmental context. At the same time, user needs vary and depend among other things on historical, political, economic and social events (Raven et al., 2019). The many forms of unsustainability are visible in the form of what we call persistent problems. Just think about our current energy systems and how it affects urban life. In most modern cities that once had their energy supply now their energy infrastructures depend on nationwide grids and power plants running fossil fuels in a liberalized market. The interests, investments, and stakes in the current fossil-based regime are high and would require structural change. Many cities today are concentrating their efforts on developing new urban energy solutions, which range from stimulating energy efficiency, to the spread of renewable technologies on the one hand to improve the energy efficiency of urban areas and on the other to counter the climate crisis (Frantzeskaki et al., 2018) thanks also to the issue of documents in the framework of the United Nations conventions. Cities have opened up the possibility of providing space for radical alternatives to the dominant centralized and fossil fuel-based energy system, thus becoming important agents of change in transitions. However, there is still a lack of coordination in which cities explore different strategies, solutions and technologies, depending on the context and the potential and characteristics of the different local contexts. Faced with this scenario, the need to focus on and accelerate the sustainable urban transition emerges today.

While the potential does indeed exist to accelerate sustainability, cities are not automatically able to proactively anticipate and adapt to such possibilities.
A transition consists of a number of system changes, which are innovations that fundamentally alter the relationships between organizations, institutions and individuals in a given field or domain (a subsystem). To orient the transition towards sustainability, new governance methods are needed that take into account the long time horizon, the uncertainties and complexities, and the multitude of people and interests involved (Raven et al., 2019). Transition studies in science in recent years have been developed on the basis of different perspectives useful for analysing the transition of sustainability in the urban area. A first approach aimed at innovations on different urban scales useful to be able to radically change the urban fabric and social practices towards sustainability even if these changes involve high costs. A second approach, instead multiphase, which aims at a holistic and dynamic knowledge of the multiple phases (pre-development, take-off and lock-in) and the associated dynamics that a transition process involves. A third approach based on the definition of conceptual tools to understand the evolutionary interactions between environment and social transformations that occur in a long and short period. A fourth perspective based on the analysis of the different models of processes in which transitions can proceed when considering policies, institutions, technology (Gells, 2002). The different perspectives provide concepts for innovation, but also the "stepping stones" to overcome theoretical gaps for proactive management of the transition of specific sustainability problems in a given urban area. Surely today the scientific debate on how to accelerate the sustainable urban transition by filling its hitherto existing gaps and management difficulties remains open. What are the steps that have so far been made by science, technicians of the territory and local communities in countering the climate crisis by indirectly promoting sustainable urban transition also by reason of the European directives?

2. The role of science and policy in accelerating climate action

In recent years, the community made up of researchers, professionals, policymakers have tried to give answers to the challenge of climate change in cities. Urban systems are globally recognized as sites of climate vulnerability. The fight to combat the phenomena of climate change has been conducted according to two strategies: mitigation, which focuses on the drivers of climate change, and adaptation, which focuses on the impacts of climate change (Sharif, 2021). Today there is an urgent need to fully mobilize climate action at different urban scales where cities play a central role as stated in the United Nations Framework Convention on Climate Change (UNFCCC). A first moment of confrontation between the scientific, political and practical communities on the issue of science and cities on climate change took place at the science conference held in 2018. This conference, for the first time, constituted a meeting focused on the projection of impacts between the scientific community and institutions. Furthermore, it recognized the importance that if a partnership between science, politics and practice is not established, only in this way will we be able to enhance climate action and aim for sustainable development. Within the same conference, a solid program of tailor-made research and action was also defined that are sensitive to the level of resources available in the different cities (for example, large, medium and small; high, medium and low income; cities in shrinking and expanding, etc.). The high level of knowledge developed today by scientists, the European directives issued on the climate must not remain closed and are within decisive consensus, but must constitute the starting point for actively involving local inhabitants to better respond to specificities, local needs and priorities. The scientific community lately feels more and more the need for a cutting-edge analysis of the climate, vulnerability, impact, adaptation and mitigation, identifying critical areas linked to the priorities of the operators and associated methodologies to investigate them (Giri et al., 2021; Khan et al., 2021). Scientific research on the topic of climate change and sustainability is moving through the creation of multidisciplinary, interdisciplinary frameworks that allow investigation in new ways that identify innovative approaches to the analysis of the urban climate with the aim of increasing the resilience of the city and to promote environmental sustainability (de Falco et al., 2018; Tira

et al., 2020). On the contrary, the technicians of the territory require a practicable science, centered on consensus and based on the concreteness of being able to implement mitigation and adaptation actions, with a careful evaluation of the synergies and compromises of particular actions on the basis of the knowledge of the " worst case "that their city is facing, as developed for the Climate Ready Boston report. Instead, city policymakers demand concrete examples of what other cities are doing and how they have been and have not been effective. They need context and guidance to define the general guidelines that their cities must follow, not only in the context of climate change, but also with its likely interactions with the different components of an urban system (Yeganeh et al., 2020; Bastin et al., 2019). Valid examples developed so far are action networks such as C40 and the Coalition for Urban Transitions which play an important role in providing guidance to cities, for both professionals and policy makers. An additional professional network of climate specialists on an international, national, regional and urban scale is UN-HABITAT Planners for Climate Action (www.plannersclimate.org) which seeks to support the role of climate action and sustainability in practices. Urban and regional planning, capacity building and research. The knowledge demands of the scientific, political and practitioner communities may differ, but it is important to recognize that their knowledge needs overlap and diverge. Issues related to climate and sustainability have received a major boost and acceleration as these issues have been included in post-Covid-19 recovery and resilience plans (Gaglione & Ayiine-Etigo 2021). Investment choices will define the future of the climate-environmental agenda in the post-Covid-19 era and for a sustainable, low-carbon economic recovery that is supported by renewed democratic governance mechanisms and social participation frameworks (Hepburn et al., 2020). Cities, as nodes of multifaceted interdependencies, can therefore benefit from development that starts at the local level to reach the subnational and national level and finally to reach the regional and international one (UCLG, 2020). The European Commission has played a crucial role not only in promoting ambitious climate goals that enhance the credibility of EU leadership efforts internationally, but at the same time in more strategic behaviour that reflects the preferences of Member States and in offering substantial forms of financing useful for combining different interests based on a single objective. In light of these considerations, the following is the European regulatory excursus starting from the climate law up to the EU Adaptation Strategy with the aim of examining the actions defined so far and how they can positively influence in favouring urban sustainability and the climate crisis.

EU Climate Law

The climate law enacted on 30 June 2021 continues with the objectives set by the European Green Deal. The law sets a legally binding target to achieve zero net greenhouse gas (GHG) emissions by 2050. Climate action will provide an opportunity for all sectors of the economy in the Union to contribute to ensure industrial leadership in the field of global innovation. The law is articulated in its 17 articles. The highly ambitious objective governed by Article 1 also aims to increase the competitiveness of European industry and ensure a just transition for the regions and workers concerned. The additional objectives governed within the document are aimed on the one hand at integrating the policy framework by defining short and long-term projections, providing predictability for investors and businesses and ensuring transparency and accountability. In the document, precisely in article 3, an intermediate goal is set that in 2030 it will be necessary to reduce greenhouse gas emissions by at least 55% compared to 1990 levels. Account of an indicative greenhouse gas balance for the period 2030-2050 to be published by the Commission. In detail, the Union's climate target for 2040 will have to take into account some key elements: (i) the best and most recent scientific evidence available, including the latest IPCC reports; (ii) the social, economic and environmental impact, including the costs of inaction; (iii) the need to ensure a just and socially equitable transition for all; (iv) cost efficiency and economic efficiency; (v) the competitiveness of the Union economy, in particular of small and medium-sized enterprises and sectors most exposed to carbon leakage; (vi) the best cost-efficient, safe and modular techniques available; (vii) energy efficiency and the principle of energy efficiency in the first place, affordability of energy and security of energy supply; (vii) the need to ensure environmental effectiveness and progression over time; (viii) the need to maintain, manage and enhance natural wells over the long term and to protect and restore biodiversity; (ix) investment

needs and opportunities; (x) international developments and efforts undertaken to achieve the long-term objectives of the Paris Agreement and the ultimate goal of the UNFCCC Framework Convention.
Furthermore, the law places its emphasis on tackling the fight against climate change according to an adaptation strategy as regulated in article 5, highlighting that constant progress is necessary in improving the adaptability of urban systems which in turn involves strengthening resilience and reducing vulnerability to climate change. In addition, Member States will have to implement national adaptation strategies and plans, taking into account the European Union strategy on adaptation to climate change based on rigorous analyzes on climate change and vulnerability, on assessments of progress made on the basis of indicators able to define the concept of vulnerability and based on the best and most recent scientific evidence available. In Articles 6 and 7 it takes into account both the evaluation of the progress made and the Union measures and the evaluation of national measures. In assessing the progress made and the Union's measures, the collective progress of all Member States in achieving the goal of climate neutrality is measured and in turn the collective progress made by all Member States in adaptation actions. By 30 September 2023, and every five years thereafter, the Commission will review the consistency of the Union's measures with respect to the goal of climate neutrality and progress on adaptation. On the other hand, in the assessment of national measures the significant aspects are in the assessment of the coherence of the national measures considered, on the basis of the integrated national energy and climate plans, of the national long-term strategies and of the biennial interim reports submitted under the regulation. (EU) 2018/1999, relevant for the achievement of the climate neutrality objective referred to in Article 2 (1) of this Regulation. Then, in the consistency of the relevant national measures in ensuring progress on the adaptation referred to in the article. Finally, the law highlights a further determined aspect, namely participation in involving different communities. Citizens and communities play a decisive role in advancing the transition to climate neutrality, therefore strong public and social commitment to climate action at all levels, including national, regional and local, should be encouraged and facilitated in an inclusive and accessible process. The European Union aims to create a network capable of involving all the components of society, including interested parties representing the various sectors of the economy, to offer them the possibility and invest them with the responsibility to commit themselves to a society. Climate neutral and climate resilient, including through the European Climate Pact. An increasing number of countries have adopted climate laws with a long-term perspective others in the process of being adopted. The UK was one of the first countries to adopt the Climate Change Act. By February 2020, ten EU Member States had adopted climate laws, seven of them aiming for a long-term transition. Seven other Member States are preparing or considering adopting a climate law. A study carried out by Duwe et al., 2020 called "Climate Laws in Europe: Good Practices in Net-Zero" carried out an analysis of the legal text of climate laws and how there are differences in the way and forms in which climate policy elaborations are expressed in each country. While no equal climate laws exist, it emerges that most of them are based on a number of common design elements: (i) clear quantitative and long-term goals; (ii) mandatory climate planning to align short-term policies with long-term planning; (iii) periodic (annual) reports and progress checks to implement corrective actions, if necessary; (iv) attribution of responsibilities to the competent institutions (ministries and parliaments); (v) an independent scientific advisory body; (vi) public participation, for example city assemblies.

European Climate Pact

To give greater impetus so that the laws and policies put in place by the European Union so far can bear fruit, the European climate pact was issued. The main objective of this pact is to invite people, communities and organizations to participate in climate action and build a greener Europe. In turn, the pact aims to invite on the one hand to connect and share knowledge on climate change and on the other to develop, implement and scale solutions. The Pact will have the possibility to evolve through creativity, to the needs and ideas of those who will be part of it. In the initial phase, the Pact will give priority to actions focused on four areas that offer immediate benefits not only for the climate, but also for the environment. The four areas of interest are: (i) green areas; (ii) green transport; (iii) Green buildings; (iv) Green skills. For each of these four areas. As regards green areas, the Pact has the task on the one hand of offering local authorities solutions to restore, protect and expand green urban areas and on the other hand of supporting new initiatives for planting and caring for trees, for example through information and visibility. The benefit of creating green areas is both to absorb greenhouse gas emissions and to reduce excessive temperature rise. Several European initiatives have been developed in this area. A prime example is the European Green Capital Award. The (European) Green Capital Award values the efforts of local authorities to improve the environment, and thus the economy and the quality of life in cities. The prize is awarded annually to a city that is at the forefront of environmentally friendly urban life. The award encourages cities to commit to ambitious goals for further environmental improvement. A second example is Green City tool. Cities can use the tool anonymously or, if they wish, officially register and enter the Green City map. The tool is based on a yes / no assessment of your city in sustainable urban planning governed by criteria. It covers 12 key environmental thematic areas such as mobility; power; adaptation and mitigation to climate change. Finally, the tool also provides guidelines of the best practices so far implemented on the various issues. A third example The Green City Accord is a movement of European mayors committed to making cities cleaner and healthier. It aims to improve the quality of life for all Europeans and to speed up the implementation of relevant EU environmental laws. By signing the Agreement, cities are committed to addressing five areas of environmental management: air, water, nature and biodiversity, circular economy and waste

and noise. Regarding green transport, the pact aims to support numerous initiatives how to move efficiently and in healthier and less polluting ways. Many European cities are implementing simpler, safer, healthier and cheaper solutions for fossil combustion vehicles, such as sharing electric vehicles, bicycles and e-bikes, eco-friendly buses and trains while also favouring ways of moving from rural areas to cities. . Two significant European initiatives developed in this area are illustrated below. A first initiative is the CIVITAS (sustainable and smart mobility for all) project. The CIVITAS initiative works to make sustainable and smart urban mobility a reality for everyone in Europe and beyond. The thematic areas in which the whole project moves goes on how to favour moving mode based on a type of soft mode to favour a type of collective transport such as local public transport in order to create a multimodal city in which people can complete your travels in a comfortable and sustainable way, without the need for your own car. In addition, the project aims to improve the demand for urban space management through an integrated planning between the built environment and the sustainable displacement modality in order to have an integrated and inclusive planning. A second initiative is the European Platform on Sustainable Urban Mobility Plans. The European SIA platform supports the development of the Sustainable Urban Mobility Plan (SUMP) concept and the tools necessary for its successful application by local planning authorities and facilitates coordination and cooperation between the different actions. The Mobility Plans portal provides a wealth of information on how to develop and implement a SUMP, including information on the elements of a SUMP, guidelines on the process of developing and implementing a SUMP and selected tools, guides, manuals and reports to support health professionals. Urban mobility in their work. As for green buildings, the goal is to make our buildings more climate-friendly by building better structures and at the same time renovating existing ones. The pact aims both to share information and raise awareness on the multiple benefits of building renovation and to share guidelines and technical assistance for local authorities and citizens. A significant example of urban evaluation of our building stock is the European initiative EU Building Stock Observatory (BSO). BSO was established aiming to provide a better understanding of energy performance in the construction sector through reliable, consistent and comparable data. The BSO contains a database divided into 250 indicators. The indicators are organized into thematic areas ranging from the characteristics of the building stock, building renovations, energy consumption, and certification. Each dataset can be viewed by subject, year and country or for the EU as a whole. Once the indicators have been selected, the data is presented in summary tables and graphs, with references to each data source. The results obtained can also be mapped and allows users to compare information between EU countries. To promote and publish the database results, the BSO produces thematic and country-specific factsheets that address the most relevant issues. Finally, as regards green skills, climate action is already providing the jobs and opportunities of the future. The transition to a climate-neutral economy will trigger a fundamental transformation in a wide range of sectors. New jobs will be created, while some will be replaced and others redefined. The pact aims to: (i) encourage companies and organizations to participate in the Skills Pact to help workers qualify and retrain; (ii) disseminating good practices and success stories collected in European programs; (iii) help navigate the European Social Fund, which will train five million people in green jobs and green recovery; (iv) building links with Erasmus + in support of education and training and other programs that offer opportunities to develop forward-looking skills and partnership projects; (v) Encourage stakeholders, local authorities and communities to use the Just Transition Mechanism to promote the retraining and active inclusion of workers and job seekers and help create new local jobs in regions concerned; (vi) support programs for higher education institutions seeking to develop and teach courses on environmental and climate impacts.

EU Adaptation Strategy

In February 2021 the new strategy for adaptation to changes was issued by the European Union. The new strategy establishes how the European Union can adapt to the inevitable impacts of climate change and become climate resilient by 2050. The cornerstones on which this strategy is based make adaptation (i) smarter; (ii) faster; (iii) more systematic and finally intensify international action on adaptation to climate change.

The strategy primarily aims to foster smarter adaptation aimed at improving knowledge and managing uncertainty. Climate change manifests itself in many threats, with impacts in almost all sectors. Therefore, the knowledge base required to inform effective action is broad. It includes uncertainty about how it will change and affect natural and human systems and the effectiveness of policies and measures put in place. This involves feeling the need to push the frontiers of adaptation knowledge and acquire more and better data relating to the climate. Faced with these knowledge gaps, in the document, the European Commission proposes to strengthen knowledge on climate impact and resilience through support tools such as Horizon Europe, Digital Europe, Copernicus and EMODnet. Also, to improve the state of the art on adaptation modelling, risk assessment and management tools - towards "activity level modelling". However, decision support tools such as the Climate-ADAPT platform are already well established, which in turn is gradually being expanded, for example with access to Copernicus data. The European Union aims to update and expand Climate-ADAPT as a source of knowledge on climate impacts and adaptation, also by federating various sources of information, and as a monitoring and reporting mechanism. In recent years the effects of climate change have manifested so frequently causing impacts so pervasive that our response to them must be systemic. Therefore, on the one hand, adaptation must aim at improving adaptation

strategies and plans at all levels must be effective and based on the latest science. Improvement can take place both by stimulating cooperation at regional and cross-border level and by improving guidance on national adaptation strategies in cooperation with Member States by updating monitoring, reporting and assessment of adaptation using a harmonized framework of standards and indicators. In turn, the document aims to promote local, individual and just resilience, step up support for planning and implementation of local adaptation and launch an adaptation support structure under the EU Covenant of Mayors. Finally, promote nature-based adaptation solutions to propose nature-based solutions for carbon removal, including accounting and certification in upcoming carbon cultivation initiatives. Progress in adaptation planning remains slow and implementation and monitoring even slower. Current measures mainly focus on awareness raising, institutional organization or policy development, but in reality the implementation of physical solutions, such as creating more green spaces to reduce the impact of heatwaves or adapting sewer systems to better cope with storms, is overdue. The goal of this strategy is therefore to shift the focus on the development and implementation of solutions, to help reduce climate risk, increase climate protection. To do this, the European Union places as strategies: (i) supporting the development of further adaptation solutions, including tools to support rapid response decisions to enrich the toolbox for adaptation professionals; (ii) develop an EU-wide climate risk assessment and strengthen climate considerations in EU disaster risk prevention and management; (iii) increase cooperation with standardization organizations for climate-proof standards and to develop new ones for climate adaptation solutions. Finally, to strengthen international action for climate resilience, the EU will increase support for resilience and international climate preparedness through the provision of resources, prioritizing action and increasing effectiveness, through increasing of international finance and through greater engagement and global exchanges on adaptation.

Conclusions

The concept of sustainability has burst into the scientific and political landscape. Today there is a strong need to encourage and accelerate the sustainable urban transition thanks to the multitude of funding established by the European Union, but also in the recovery and resilience plans. Although there are still strong theoretical and managerial gaps in favouring it as described in the first paragraph of this work. Fostering sustainable urban transition indirectly means addressing some challenges that cities are called upon to respond to such as climate change given the multitude of effects that occur in urban areas. Today the community made up of researchers, technicians of the territory and local administrations are asking for different answers in addressing the climate crisis. Their joint work could give satisfactory results if there was coordination and sharing of needs and knowledge in order to improve the quality of urban systems.

Europe is playing a frontline role on the issue as can be seen from the fact data-sheet of this work. First, it is setting legally binding targets such as zeroing emissions by 2050 for member states to focus their efforts on favouring climate-neutral cities, trying not to make it become a utopia. Secondly, the climate pact aims to promote initiatives at different national, regional and local scales to reduce organizational difficulties at different national, regional and local territorial scales. Thirdly, Europe is pushing to fight the climate crisis according to adaptation strategies and measures at the local scale and the implementation of national plans for adaptation to change through knowledge of the risk and vulnerability of urban systems to the effects of climate change. It is necessary to accept that the territorial dynamics are in continuous evolution as their changes and therefore it is necessary to accelerate the ways in which to govern them.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 157-161
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/9033
Received 7th March 2022, Available online 30th April 2022

www.tema.unina.it

REVIEW NOTES – Urban practices

European cities embracing digital nomads

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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 two European cities to attract and retain digital nomads and remote workers: Venice (IT) and Madeira (PT). The contribution discusses the effectiveness of such initiatives and the benefits to designing specific programs and facilities to welcome digital nomads.

Keywords
Digital nomads; Remote workers; Urban policies; Venice; Madeira.

How to cite item in APA format
Angiello G. (2022). European cities embracing digital nomads. *Tema. Journal of Land Use, Mobility and Environment*, *15* (1), 157-161. http://dx.doi.org/10.6092/1970-9870/9033

1. Introduction

The term 'digital nomad' refers to professionals who perform work digitally over the Internet to enable a lifestyle of constant traveling and expat living (Schlagwein, 2018). Compared to traditional workers, digital nomads are not geographically bounded to the constraints imposed by organizations and have the possibility to choose where to work and live. Digital nomadism is a modern phenomenon of the network information-communication society that has emerged due to mobility and digitalization (Kuzheleva-Sagan & Nosova, 2016). The practices of location independence and remote work that characterize their lifestyle were growing already before the Covid-19 pandemic, but the pandemic itself has further amplified this phenomenon by normalizing remote-working, fostering the adoption of technologies to support virtual collaboration, communication, and work from a distance (Herman et al., 2020).

2. Digital nomads and the city

As a large population of highly skilled people has embraced this modern lifestyle, scholars have started analysing the impacts of digital nomadism on cities, communities and the urban environment. For instance, according to Lee et al., 2019, the exponential growth of digital and creative workers in the late 2000s has contributed to spread of co-working and co-living spaces, as well as related shared spaces such as makerspaces and hackerspaces. The latter have had a profound impact on the contemporary process of urban regeneration and urban economic growth, in particular in terms of community building (not just within the workspaces), improvement of surrounding public spaces, and ultimately urban revitalization (Mariotti et al., 2017). Other researches have started analysing the positive impacts that digital nomads may make on the local economy of the cities where they tend to cluster. Digital nomads indeed tend to be - on average - young, well-educated and globally connected people (MBO Partners, 2021), with one out of five digital nomads earning more than 100.000 USD per year (Flexjobs, 2020) and spend more than 35% of their income locally in their destinations (MBO Partners, 2021), thus stimulating travel, restaurants, shopping, consumption, and services in general, resulting in a greater reactivation of local jobs (Cotella & Bovarone, 2020). Finally, recent studies have analysed the leading factors in choosing a location for digital nomads. While the cost of living, the presence of a large expat community or a temperate climate are the most valued elements, other "urban" factors also play an important role in digital nomad's location choices. These include the presence of co-working and co-living space, high-quality public transport, excellent internet infrastructures, good air quality and abundance and quality of public spaces (Orel, 2020; Nash et al., 2021; Chevtaeva, 2021).

Since: (i) attracting digital nomads might have positive impacts on the local economy and (ii) most of the factors that influence digital nomads' location choices can be – within a certain extent - worked out by local authorities, some cities around the Word have started developing specific plans or initiatives aimed at attracting remote workers on their territories. This contribution provides an overview of the initiatives taken in two EU cities: Venice (IT) and Madeira (PT).

3.1 Venice

Venice is a city in northeastern Italy and the capital of the Veneto region. It is built on a group of 118 small islands that are separated by canals and linked by over 400 bridges. Although the city is facing some challenges (including problems caused by pollution, tide peaks and cruise ships sailing too close to buildings), it remains a very popular tourist destination and a major cultural center. Tourism in Venice has become one of the main driver of the city's economy; at the same time tourism represents today one on the main source of gentrification (Transaco Gonzales, 2018). As a consequence, the city population has dwindled by two-thirds over the past 50 years to fewer than 60,000 people.

As part of the city's plans to address this issue, local authorities have partnered with private companies, academics and non-profit organizations to explore new ways of attracting and fostering a thriving ecosystem of remote workers. In particular, in December 2021 the city has launched an ambitious initiative named "*Veniwhere*". The initiative is designed to entice people who can work from anywhere, like freelancers or remote office workers.

However, it is also looking to get companies to send entire workforces to Venice for short periods. Beside addressing the issue of shrinking population, the initiative also aims to: (i) enrich the city of Venice with new and bright talents; (ii) integrate remote workers with the local community and (iii) contribute transforming Venice into a city of contemporary work.
The focal point of the initiative is a web portal (https://www.venywhere.it/), a sort of "one stop shop" where individuals and companies interested in settle their home or headquarter in Venice can find relevant information and access a number of specific services such as:

- *Soft Landing*. This service is aimed at making digital nomads landing in the city of Venice as smooth and frictionless as possible. To this aim the platform provides support on different issues that might arise when a foreigner-born person takes the decision to life and work in the city. In particular, support is provided for visa and tax compliance, for setting up a health insurance, for creating an Italian banking account or for getting familiar with city's logistics and transportation options.
- *Workspaces*. This service is about providing digital nomads with historical and unique spaces in the Venetian landscape adapted as modern workspaces. Thanks to the partnership between the municipality of Venice, no-profit foundations and private actors, the city has managed to secure eight main work environments that provide different types of facilities including Wi-Fi, desks, meeting rooms, private offices, auditoriums, bars and refreshment areas. The portal provides a dedicated service to book such places in advance for both short and long term booking.
- *Becoming Venetian*. This service offers the opportunity to participate in unique activities of local artisans, associations and small entrepreneurs that will open the doors of their shops and activities to digital nomads. The overall idea behind this service is not only to offer alternatives for nomads' free time, but also give them the possibility of experiencing the real Venice and to connect them with local residents and local business.
- *Accommodation*. This service helps digital nomads finding a home in Venice that satisfies their needs of work from anywhere. Finding a home in Venice is indeed not an easy task with prices that can greatly vary according to seasons and location. In order to making Venice an attractive place for remote workers, the city has established partnership with private home owners that can provide transitional contracts of 3 or 6 months at a price compatible with a long-term rent for local inhabitants.

3.2 Madeira

Madeira – officially the Autonomous Region of Madeira - is a group of Portuguese islands located in the Atlantic Ocean just under 400 kilometres north of the Canary Islands. Madeira sits in the region known as Macaronesia and is just 520 kilometres (320 miles) west of Morocco. Although Madeira is technically located on the African Tectonic Plate, it is widely considered European as it is part of Portugal and shares similar cultural aspects to Europe. The archipelago has been a top remote workers' destination for years thanks to the near perfect climate and abundance of outdoor activities, culture, and more. The arrival of many EU and US young, well-educated and affluent remote workers has greatly contributed to the archipelago's economy and it is seen by local authorities as an important asset to diversify the island rural economies, where tourism and rural/agricultural activities are the main sources of income for the local population.
In 2021, the Regional Government of Madeira created a tester project called "*Digital Nomads Madeira Islands"*, with the main concept being to attract digital nomads to Madeira by providing a unique experience in the form of what is titled the "*Digital Nomad Village"*. The concept is to provide living, co-working, and community for digital nomads on the island. The project began in February 2021 and was on trial until June 30th, 2021, to see if it was appealing to the digital nomad community. Following the success, more digital nomad villages are opening across the island and, as of January 2022, three new villages have opened their doors to remote workers. The experiment is considered a success by the Regional Government that is investing further resources in it. The main lines of public interventions cover the following aspcets:

- *Free working spaces.* As a digital nomad hub, Madeira offers several community co-working spaces, equipped with offices, conference rooms, and other resources for small businesses. These facilities are provided at no cost for digital entrepreneurs who can demonstrate to set their business on the island for a month or more.
- *Reduced taxation.* Taxation also play an important role in attracting business and firms. For this reason, the Regional Authority established the "*Madeira Free Zone"* scheme, a regional aid scheme providing operating aid in the form of corporate income tax reduction on profits resulting from activities performed in Madeira.
- *Adequate internet infrastructures*. Having a fast and secure internet connection is a must in a digital nomad way of life. For this reason, the Regional Government has recently developed a submarine cable station, hosted in the Madeira Datacentre, operating several international optical submarine cables, allowing interconnectivity with national and international SDH networks and providing, as such, significant advantages in terms of quality, cost, bandwidth and scalability. Thanks to this investments, Madeira has nearly 100% broadband Internet coverage on the island, and a fairly high and consistent download speed. Furthermore, the entire historical area of Funchal offers free Wi-Fi access.

According to the EU Interreg Europe Project (2021), the approach adopted by the Madeira's public authorities can be considered a good practice that – taking into account local conditions – can also be transferable to other European cities. According to the same report, the project can be considered successful for the following reasons:

- Since November 2020, the project received over 7.570 registrations from 105 countries;
- The popularity of the project is expanding at an exponential rate. In the past 10 months over 2.600 new digital nomads registrations have been received;
- The project has been been covered in multiple international-news outlets for more than 80 times (Cable TV, newspapers, magazines, online news sites).

4. Discussion and conclusions

The enthusiasm around remote and independent working has rapidly gained momentum in the last few years. However, only recently EU cities have started developing specific plans or initiatives aimed at attracting remote workers on their territories. These efforts have become more common since the benefits of attracting remote workers have become more evident. Indeed, there are many benefits to designing specific programs and facilities to welcome digital nomads. Remote workers tend to have diverse work portfolios having worked across several countries, cultures and industries. They tend to be young, motivated and affluent individuals that spend a large portion of their annual income in the city where they decide to settle. Attracting them, can thus be an effective way to bolster local economy, especially if reduced tourism revenue has led to a loss of income. The present contribution analyzed the policies and initiative undertaken by two EU cities to embrace digital nomads. The case study of Madeira represents one of the most consolidated experience in this direction. The popularity of the Madeira's project and the high number of registrations occurred since its inception can be both considered signs of a successful initiative. The project elaborated by the Municipality of Venice is still in its early stage and the impacts of this project on the city's economy can only be assessed in the long term. In both cases however, the initiatives have developed actions targeting important factors that can influence the location choices of digital workers as identified in the scientific literature. Interventions in particular have focused both on the "physical" infrastructure of the city, as well as on the "immaterial" infrastructure. Interventions following under the first domain have been focused on providing places for digital nomads that are suited for their expectations and needs, such as co-working and co-living spaces equipped with all the facilities required to sustain a nomadic life style. Again on the "physical" infrastructure of the city, actions have been also taken to secure a fast and convenient internet connection. Other initiatives, on the contrary, have been developed with the aim of facilitating the landing of digital nomads, such as support on visa and tax compliance, support on setting up a health insurance or creating a banking account. Finally financial incentives also represent an important ingredient of a strategy aimed at attracting remote workers. Another common trait that seems to be an indispensable asset for this type of initiative is the partnership between local authorities, private firms, the academia and NGOs. Indeed, only a strong cooperation between these actors can leverage the benefits of embracing digital nomads in EU cities.

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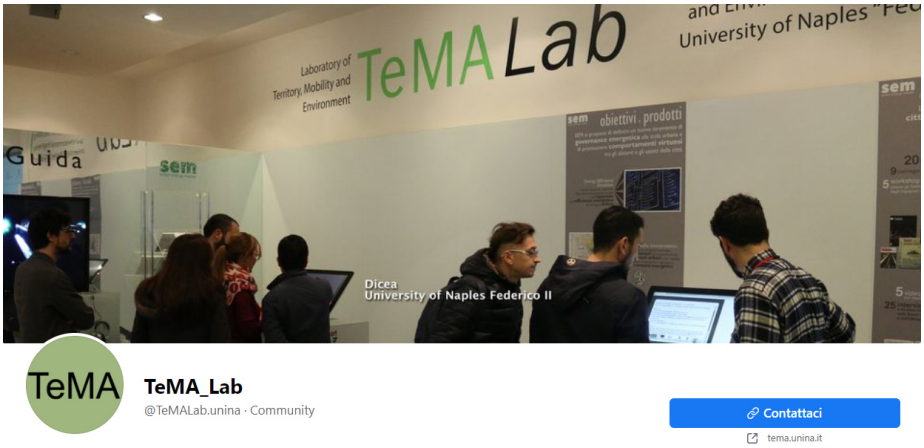

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 163-166
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/9047
Received 20th March 2022, Available online 30th April 2022

www.tema.unina.it

REVIEW NOTES – Economy, business and land use

Towards the achievement of SDGs: Evidence from European cities

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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 deals with the topic of the United Nations Sustainable Development Goals and on how European cities are performing in the achievement of such a differentiated set of targets.

Keywords
Sustainable Development Goals; Cities; Climate change.

How to cite item in APA format
Franco, S. (2022). Towards the achievement of SDGs: evidence from European cities. *Tema. Journal of Land Use, Mobility and Environment*, *15*(1), 163-166. http://dx.doi.org/10.6092/1970-9870/9047

1. Introduction

Sustainable Development Goals (SDGs) represent the most widespread framework to trace the road towards the achievement of sustainable development by the civil society. Developed by the United Nations in 2015, they are a set of 17 goals that push organizations, both public and private, towards sustainability. Each of these goals then group several specific targets, for a total number of 169. Public administrations and cities also have to make their efforts to achieve ambitious goals aimed at reducing carbon emissions and social inequalities, while adapting their environments to the climate change challenges (Kolesnichenko et al., 2021; Tira, 2020). The social and environmental impacts of cities is going to rapidly grow as a consequence of the increased attractiveness of cities as places where people decide to live and where companies decide to locate (United Nations, 2019). For example, cities water footprints account for 41% of the Earth surface, their GHG emissions account for 70% of the global emissions, while there is the possibility that breathable air will decrease as a consequence of such issues (United Nations, 2019). Such challenges present cities with very ambitious commitments and opportunities (Sanchez Rodriguez et al., 2018). In fact, the path to achieve sustainability goals drives the future of cities and, in turn, their future investments that are needed for cities adaptation to their continuous growth and its relative drawbacks both for citizens and environment (Lai et al., 2021). This is true mostly for the developed economies. On the other hand, phenomena like air and water pollution are linked with industrialization that is, especially in emerging economies, the actual path towards economic development. Shifting from an industrialized economy to a sustainable economy – aimed at achieving SDGs – is thus a cost that requires cities reviewing their development models, priorities, and policies. However, it also shows positive economic impact. A recent study (Pisani et al., 2019) investigates if a city's environmental performance is linked to its economic performance. Focusing on a sample of 185 Chinese cities, Pisani and colleagues (2019) find that cities that show positive performance in air pollution and water waste management are more attractive for foreign direct investments (FDIs). The authors state that environmental sustainability has become a location choice factor for multinational companies. Another study based on Italian cities showed that environmental sustainability has a positive impact on their competitiveness, and that this relationship is stronger for larger cities, i.e. those that present higher risks in terms of sustainability issues (Papa et al., 2017). This evidence is important for policymakers, as they show that the investment on environmentally sustainable goals is worth the cost because cities are repaid by economic performance. Literature so far has analyzed issues like cities adaptation to climate change or SDGs (Krayenhoff et al., 2018; Sanchez Rodriguez et al., 2018), but few have devoted the attention towards how cities perform on the different goals set by United Nations. The understanding of this aspect is determinant to understand whether the sustainable transition is proceeding in a linear and coherent manner, or it is an unbalanced path. In this note, I try to show how European cities are proceeding in their path towards the achievement of SDGs. Evidence from the SDG Index shows that while they are performing well in some areas – and even meeting the targets in some cases – they still need to do a lot on other important topics such as climate change adaptation.

2. Cities performance in the achievement of SDGs

The path of European cities towards the achievements of SDGs is very differentiated. Table 1 shows the ranking of some of the most committed European cities in pursuing SDGs (the full report is available at https://euro-cities.sdgindex.org/#/). Indeed, not all the cities are aligned towards reaching the ambitious targets. Moreover, they achieve different performance for different SDGs. Yet, most of them fail in achieving some of the goals that really matter for cities. For example, most of the cities analyzed by the SDG index, a project developed by a team of independent researchers in collaboration with the Sustainable Development Solution Network and the Brabant Center for Sustainable Development, shows that all European cities, even

the more sustainable ones, show unsatisfactory results on SDG 9 (industry, innovation and infrastructure), SDG 11 (sustainable cities and communities), and SDG 13 (climate action).

SDGs Ranking	City
1	Oslo
2	Stockholm
3	Helsinki
4	Copenhagen
5	Zurich
6	Lyon
7	Paris
8	Munich
9	The Hague
10	Eindhoven
11	Amsterdam
12	Rotterdam
13	Luxemburg
14	Hamburg
15	Bordeaux
…	…
34	Milan
35	Turin
…	…
40	Rome

Tab.1 The ranking of European cities in the achievement of Sustainable Development Goals (Source: https://euro-cities.sdgindex.org/#/)

This result is quite worrying considering that: 1. these performances are very poor according to the results shown by the index, and 2. that such goals are supposed to be met by 2030. This suggests deep reflections on government bodies in driving those investments that urban areas need in order to pursue SDGs. Such reflections are even more urgent because the worst performances are met in some of the key areas in which cities should make a difference. Thinking about the importance of dealing with climate change (Pilogallo et al., 2019) by reducing emissions or building infrastructures that adapt cities to its connected risks (SDGs 9 and 13), there is still too much to do considering that also the top performers in Europe shows that most of the challenges still remain to be solved. The same is true for SDG 11 about sustainable cities and communities. On the other hand, better results are achieved when considering SDGs 3, 6 and 7 (good health and well-being; clean water and sanitation; affordable and clean energy). Thus, while in the areas of infrastructures, innovation and climate change major challenges still remain, in the areas of green energy and good health European cities are on the right track, even though some of them are still laggard on several aspects.

Milan, Turin and Rome

This box highlights the situation of the only three Italian cities that perform among the top 50 according to the SDG Index (respectively 34th, 35th, and 40th).
Milan shows fair results in SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 7 (affordable and clean energy) and SDG 10 (reduced inequalities). However, it still needs major improvements for SDG 13 (climate action) and SDG 15 (life on land). As far as these two SDGs are concerned, Milan shows very low performance on all the single

indicators that measure the performance.

Turin shows a different situation. It has already achieved top performances on SDGs 2 and 6 (zero hunger; clean water and sanitation), while it shows the worst results on SDG 4 (quality education), SDG 13 (climate action), SDG 15 (Life on Land) and SDG 16 (peace, justice and strong institutions).

Finally, Rome shows the worst performance on 6 SDGs (4, 5, 11, 12, 13, 16) with good results only on SDG 2 (zero hunger) and average results on the others. These results are worrying if one looks at the different indicators that show problems both on the social and on the environmental side of sustainability. For example, Rome shows low results in the quality of local government, the perceived safety, and the gender equality, but also on waste treatment and CO2 emissions.

3. Discussion and conclusions

This note has focused on the topic of SDGs and the performance that European cities are achieving in contributing civil society to the achievement of the goals set by United Nations, to be met by 2030. As shown by the SDG index, reported in Table 1, Northern European cities are those that meet SDGs more than others European cities. Overall, results are very much differentiated and, while most of the cities achieve satisfying results about green energy and good health, the greatest difficulties regard innovation and infrastructure issues, mostly related to climate change. This calls for urgent interventions from those institutions that are in charge of driving investments in urban areas. As previously underlined, the issue of sustainability represents great opportunities in terms of economic development because it is connected the attraction of investments. With this note, I suggest that these interventions should now be mostly devoted to the achievement of those SDGs (in particular 9, 11, and 13) that are very important for cities, but in which major challenges still remains.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2022) 167-173
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/8982
Received 18th February 2022, Available online 30th April 2022

www.tema.unina.it

REVIEW NOTES – NextGenerationEU and urban development

The interventions of the Italian Recovery and Resilience Plan: Urban regeneration of the Italian cities

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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 five parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal.

This section of the Review Notes explores a specific topic, related to cities, within the framework of the European program NextGenerationEU.

This contribution deepens the topic of urban regeneration, providing an overview of the urban regeneration measures in the Italian Recovery and Resilience Plan and deepening how these measures are intended to make Italian cities more sustainable and inclusive. Furthermore, it highlights the main strategies, reforms, and interventions for urban regeneration, which have been activated in Italian cities, thanks to the NRRP investments.

Keywords

NextGenerationEU; Urban regeneration; Sustainability; Inclusion.

How to cite item in APA format

Sgambati, S. (2022). The interventions of the Italian Recovery and Resilience Plan: Urban regeneration of the Italian cities. *Tema. Journal of Land Use, Mobility and Environment*, *15(1),* 167-173. http://dx.doi.org/10.6093/1970-9870/8982

1. Introduction

On March 11, 2020, The World Health Organization declared the novel coronavirus (COVID-19) outbreak a global pandemic. The limits imposed by the national governments in the whole world, along with the changes in travel, commerce, work, and social distances, placed the global economy in front of an epochal challenge, determining different reactions of countries. In 2021, the European Union launched the program NextGenerationEU, a more than €800 billion temporary recovery instrument to help repair the economic and social damage brought about by the coronavirus pandemic, by operating in different fields (EC, 2021). Each Member State has been invited to develop its recovery and resilience plan to access the funds under the Recovery and Resilience Facility. In this context, Italy proposed its program of investments "Italia domani", which was approved by the European Commission on July 31, 2021 (Governo Italiano, 2021). The document outlines how the country will invest €191.5 billion to overcome the effects of the COVID-19 pandemic by describing which projects Italy intends to implement with the European funds. It defines how these resources will be managed and presents a timetable of the reforms necessary to implement the plan and modernize the country. In addition to the COVID-19 crisis, the plan is intended to face other present and future challenges, such as digital and green transitions, economic and social resilience, and territorial cohesion. These topics are key aspects for ensuring better levels of resilience for the country and Italian cities.

The Italian NRRP provides for both regulatory measures (reforms) and the implementation of public works (investments). Reforms and investments are structured into 16 sectors, which are divided into six missions: (i) Digitization, Innovation, Competitiveness, Culture and Tourism; (ii) Green revolution and Ecological transition; (iii) Infrastructures for Sustainable Mobility; (iv) Education and Research; (v) Inclusion and Cohesion; (vi) Health (Governo Italiano, 2021).

The investments are organized in horizontal reforms (horizontal to all the objectives of the plan), enabling reforms (actions to ensure the implementation of the Plan) sectoral reforms (contained within the individual missions of the plan), and reforms of implementation (which define the modalities of implementation). The targets of the plan must be achieved by 2026. The Italian government assesses the impact associated with the achievement of these targets as a growth of 0.8%, bringing the potential growth rate in the final year of the plan to 1.4%.

This contribution is framed within a more extended study that aims at exploring some of the most significant topics afforded in the Italian National Recovery and Resilience Plan (NRRP) from an urban perspective. Cities play, in fact, an important role on the road to recovery, hence it is interesting analyzing the future of Italian cities in the light of the contents of the plan. Firstly, in Italy cities constitute the main implementing bodies of the strategies and interventions proposed, given that a large part of the European resources has been assigned to the direct management of metropolitan cities and municipalities. While the central government will function as a control room, the Municipalities and Metropolitan Cities will play a role in the implementation of most of the territorial projects, participation in initiatives financed by the Central Administration and management of resources and interventions already programmed by the plan. Secondly, they represent a piece of strength for recovery and improvement of resilience of the country since they are a vast pool of resources, services and facilities, skills, and people. And, for this reason, the NRRP constitutes a great opportunity for the recovery and growth of Italian cities.

2. Urban regeneration in the Italian NRRP

Among the emerging topics of the Italian NRRP relating to cities, it is worth deepening urban regeneration.

Since the 1990s', urban regeneration has gradually become the key to problems of marginalization and abandonment of urban areas (Roberts et al., 2016). It can be seen as a combination of integrated measures, initiatives and interventions aimed at taking action in an area characterized by social and economic problems

but also opportunities of improvement (Gargiulo & Sgambati, 2021). Urban regeneration strategies can regard different urban dimensions such as settlement, economy, environment, society and culture (Mecca & Lami, 2020). Objectives of urban regeneration can be achieved by implementing both hard and soft measures. The former concern the urban settlement and physical infrastructures (e.g. the redevelopment of built heritage). The latter includes governance, participation of citizens and other integrated actions. Regeneration is often considered an efficient tool for the transformation of urban areas to tackle social, environmental, cultural, and economic issues and enhance the level of resilience of territories and communities (Mazzeo, 2018). Other horizontal benefits regard the improvement of urban quality, the quality of life for citizens and the level of attractiveness of urban areas (Bianconi et al., 2018; Degen & Garcìa, 2012; Ng, 2005; Güzey, 2009).
Contextualizing the topic of urban regeneration in the Italian NRRP, one of the transversal priorities of the plan is the reduction of territorial gaps between the north and the south of the country and between the major centers and the suburban and inner areas (Openpolis, 2021). The mission of the plan that is most related to urban regeneration is Mission M5 "Inclusion and cohesion" - which can rely on €19.85 billion - and, in particular, the component M5C2. This component includes the interventions shown in the table below.

ID of the investment	Investment	Implementing bodies	Resources (€ billion)
M5C2.2.1	Urban Regeneration to reduce marginalisation and social degradation	Municipalities	3.3
M5C2.2.2	Integrated Urban Plan	Municipalities and Metropolitan Cties	2.49
M5C2.2.2a	Integrated Urban Plans overcoming unauthorized settlements	Municipalities	0.2
M5C2.2.2b	Integrated Urban Plans Fondo dei Fondi	Private subjects	0.272
M5C2.2.3	Social housing – Piano innovativo per la qualità dell'abitare (PinQua)	Regions, Provinces, Metropolitan Cities, Municipalities	2.8
M5C2.3.1	Sport and social inclusion	Municipalities	0.7
M5C3.1.1.1	National strategies for inner zones	Municipalities	0.725
M5C3.1.2	Valorization of goods confiscated from mafia	Provinces, Metropolitan Cities, Municipalities	0.3

Tab.1 the investments for urban regeneration in the Italian Plan for Recovery and Resilience (Source: Openpolis https://www.openpolis.it/i-nostri-open-data-per-il-monitoraggio-del-pnrr/)

M5C2.2 involves Metropolitan Cities and municipalities in the drafting and implementation of Integrated Urban Plans (Piani Urbani Integrati) aimed at the maintenance/reuse of public areas and buildings, the regeneration/valorization of unutilized, under-utilized or mis-utilized urban areas, and the development of cultural, social, sport and safety services (IlSole24ore, 2021). In addition, the plan allocates €0.2 billion for Integrated Urban Plans for unauthorized settlements and 0.272 for the "Fondo dei Fondi". €2.8 billion are for social housing and in particular for the Innovative plan for housing quality (Piano Innovativo per la qualità dell'Abitare PinQua), some of which are reserved for existing projects and others for future projects. €0.7 billion are allocated to improve sports facilities and increase social inclusion among urban communities. Other investments aim at the redevelopment, the enhancement of attractiveness in inner zones and the reduction of the processes of abandonment in small villages (€0.725 billion). There is also a quote destined for the re-functionalization of properties confiscated from the mafia (€0.3 billion), in order to redefine their role in urban settlements and cities 'communities. On the whole, the plan has assigned € 3.3 billion for urban regeneration projects whose beneficiaries will be 483 municipalities. 53% of the fund for urban regeneration has been

assigned to Southern regions. Campania is the region that benefits from the largest amount of resources (€486.60 billion).

To summarize, the topic of urban regeneration in the plan includes measures that deal with the strengthening of proximity services and accessibility, the re-functionalization or redevelopment of buildings and public spaces, the promotion of social inclusion and the reduction of marginalization and degradation. It is intended to enhance livability in urban areas, especially those affected by marginality and social and economic inequalities, and increase the safety of neighborhoods. Urban regeneration measures must be accompanied, according to the NRRP, by the construction or renovation of existing buildings to support housing of the most vulnerable people such as the elderly, lower-income citizens or people with disabilities. The promotion of culture and sport in urban environments contributes to the improvement of public welfare and sustainable economic development, as well. The subject of the redevelopment will be municipalities and metropolitan areas affected by problems of degradation and widespread vulnerability, in order to overcome inequalities, threats and weaknesses, while, at the same time increasing their competitiveness. Once completed, the interventions will provide substantial benefits in terms of quality of life, sustainability and attractiveness of territories since they will be able to reduce social disparities and create new opportunities for citizens.

Subsequently, there is a selection of the strategies, reforms and individual projects concerning urban regeneration financed by the plan.

Integrated Urban Plans (Piani Urbani Integrati)

The Integrated Urban Plans relate to the investment M5C2.2.2 and concern urban regeneration interventions with a value lower than €50 million for Metropolitan Cities, which will identify the eligible projects. The investment has been proposed to support general projects for the realization and implementation of integrated urban plans aimed at the maintenance and reuse of public areas and buildings along with the regeneration and enhancement of underused or unused urban areas. The interventions concern the recovery of public areas and structures, the improvement of urban decorum, the social and environmental urban fabric, and the development of cultural, educational, sports, and security services for residents. In particular, the investment regards the suburbs of Metropolitan Cities and involves participatory urban planning, with the aim of transforming vulnerable territories into smart and sustainable cities, limiting land consumption. The Integrated Urban Plans will allow planning synergies between the main municipality of the metropolitan area and the smaller municipalities. The plans will have the objective of repairing urban fabric, reinforcing connectivity between territories, filling infrastructure and mobility deficits, as well as promoting social and entrepreneurial participation processes. The projects will have to give back to the communities an identity through the promotion of social, cultural, and economic activities with particular attention to the environmental aspects. This investment has been thought to make Italian cities more sustainable and inclusive. Financed projects must lead to the improvement of degraded urban areas through the creation of new services and the requalification of accessibility and infrastructure, accompanied by the improvement of urban decorum and renovation of public buildings. As regards the development and enhancement of social and cultural services, the promotion of cultural and sporting activities in the areas of intervention is fundamental. Finally, for what concerns projects related to smart cities, which is one of the objectives of Integrated Urban Plans, the focus will be on transport and energy consumption, with the vision of improving the environmental and digital quality of urban areas. For the selection of the projects, priority must be given to areas with high values of social and material vulnerability index and to projects aimed at guaranteeing the autonomy of vulnerable groups. Moreover, the interventions must ensure feasibility as well as an increase in energy performance. Some of the funds (25% of the interventions' total budget) are allocated for private subjects. The NRRP allow also for the participation of public services start-ups and the co-planning with the third sector.

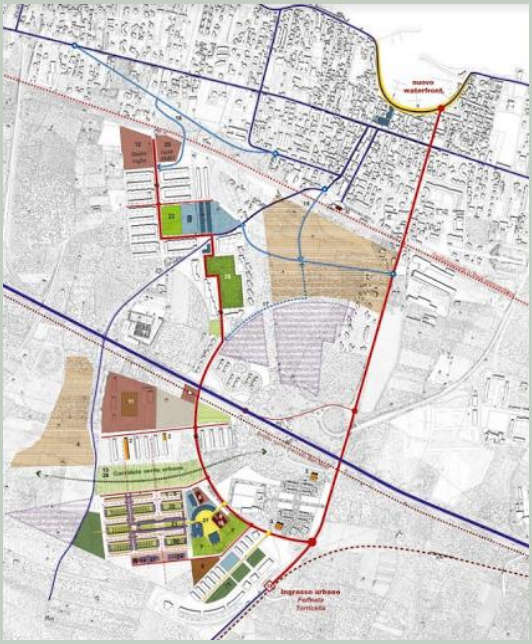
PinQua - Piano Innovativo Nazionale per la qualità dell'abitare

The Innovative Plan for housing quality was at first introduced by the Ministry of Infrastructure and Sustainable Mobility (MIMS) with the 2020 Italian budget law which set transformation targets for 2033. Then the law targets have been adopted by the NRRP although with a briefer schedule (2026). This national strategy refers to the component M5C2 and, specifically, to the investment 2.3. The interventions linked to this investment aim to increase and improve the public housing stock and regenerate urban centers and suburban areas. This investment has the objective of improving the accessibility, functionality, and security of Italian cities and neighborhoods.

A special commission has the task of selecting the projects which deserve to be financed, according to selection criteria defined by art.8 D.M. 395/2020. In particular, priority has been given to interventions in areas with greater housing

problems, to the recovery and valorization of cultural heritage, and to interventions with lower impacts on land consumption. The implementers of the strategy will be Regions, Metropolitan Cities, and Municipalities with more than 60,000 inhabitants. The implementing bodies present a project proposal for a maximum budget of €15 million. There is also the possibility to present a pilot project – considered strategic for the entire country – with a maximum budget of €100 million. The investment consists of two actions: (i) the redevelopment and increase of social housing and the regeneration of urban society, through the improvement of accessibility and urban safety, mitigation of housing shortage and increase of environmental quality, inclusion and well-being, use of innovative models and tools for urban management; (ii) interventions with a high strategic impact on the national territory.
According to these criteria, 40.07% of the funds have been assigned to Southern regions, including Sicily and Sardinia, 32.27% to Northern regions, and 27.66% to Central regions. Puglia is the region with the higher number of financed projects (21). Lombardia is the second (17), followed by Lazio (15). A total of € 655 million has been allocated for pilot projects of urban regeneration. They deal with the reorganization of public spaces having strategic importance (such as Bari's Central Station), the redevelopment of social housing buildings, the recovery of suburban areas, and interventions of valorization of cultural and historic heritage. For what concerns the benefits of the plan, it is estimated that its implementation will result in a 38% reduction in primary energy consumption and a 31% reduction in annual CO_2 emissions per square meter, with a significant effect on the fight against the climate crisis, which is critical above all for marginal areas.

Bari – the regeneration of San Pio, Santa Rita and the pilot project "Green Node"



Puglia is the most involved region in urban regeneration projects, having obtained the highest number of financed projects for urban regeneration. 3 projects regard the Metropolitan City of Bari, which received €45 million allocated to individual interventions. In addition, €75 million of the "Costa Sud" project, a six kilometers long coastal park that will redesign the south coast of the city, are allocated for the valorization of cultural attractors, in order to expand the tourist and cultural offer of the city of Bari.
The two projects of San Pio and Santa Maria are part of the Innovative Plan for housing quality (PinQua) since they have been selected as worthy projects. Both the urban regeneration programs contain 320 urban regeneration interventions (160 per district), developed within a defined strategy, in which social housing plays a priority role and aims to provide coherent responses to the needs expressed by citizens and by the local stakeholders.
In detail, €15 million were assigned to the regeneration of the district San Pio (ex Enziteto), characterized by low levels of social inclusion, marginality and a high criminality rate. The approved and financed project is called "Made in San Pio". It includes 160 strategies and interventions to enhance the territory's productivity and at the same time defeat social problems, empower energy redevelopment, renew public spaces, and create new opportunities for young people and families, such as music and sports facilities, cinema, mechanical crafts and public art. Specifically, the strategy of transformation includes: the redesign of Piazzetta Eleonora; the demolition of the structure of the old market; the improvement of the level of accessibility and permeability with the district of Torricella; and the creation of new cultural and sporting facilities, such as a rock academy, a guest house for artistic residences, a social screen printing, a sports centre, a bike workshop, between the second floor of the Accademia del Cinema and the public building ex CNIPA currently unused. Participation is one of the main characteristics of the project since different stakeholders, institutions and associations have been involved in the drafting phase of the project proposal.
The second investment concerns the regeneration of the Santa Rita's district ("Santa Rita, il quartiere che abbraccia la cava"). €15 million have been allocated to mend and repair the territory. The objectives are the energetic redevelopment of the urban fabric, the empowerment of soft mobility - cycling and walking -, the reconversion of the market are in via Cascia into an equipped public park, and the provision of new cultural facilities such as schools, a public library, and an auditorium. The project vision aims to emphasize the naturalistic value and valorize the agricultural landscape of the district, at the same time overcoming the separation from the rest of the city.
The goal is to transform Santa Rita into a green neighborhood, with good air quality and a high level of wellbeing for its inhabitants. This is possible through the reorganization of the districts on the basis of sustainability principles, architectural quality, and social equity as well.

The third project has been included in the group of the eight high-performance "pilot projects". €100 million will support the reorganization of the area of the central railway station of Bari that, in this way, will become a hinge between the existing two parts of the city, currently divided by the rails. The project, by Fuksas, is called "Green node" and involves an area of about 160 thousand square meters. The area includes Piazza Moro and the railway between Corso Italia and Via Capruzzi, to Via Eritrea.
The financed project aims to reconfigure this part of the city by increasing green spaces, redeveloping existing public areas such as Piazza Umberto, increasing pedestrian and cycling flows and offering new services and facilities. Furthermore, 2 public parks have been included in the financing. The first will extend from the new metro station to via Quintino Sella, while the second will develop from via Quintino Sella to via Eritrea.
On the one hand, these interventions are intended to solve social and economic problems affecting the suburban and inner areas of the city of Bari (in particular the two residential districts and the area of the central station). On the other hand, the investments will provide horizontal benefits that will not only regard the social and economic sphere, but also environmental sustainability, citizens' quality of life and resilience of local communities.
(Image Source Quotidiano di Bari, 2021. Retrieved from: https://quotidianodibari.it/via-alla-rigenerazione-dei-rioni-san-pio-e-santa-rita/)

Brescia – Torre Tintoretto

One of the symbolic projects of the PinQua program regards the Tintoretto Tower of San Polo in Brescia. The tower – which has been recently demolished according to the project -was one of the results of the '70s urban planning vision and presented problems connected to the limits of social housing projects of the last century. That is why the project contains a lot of issues related to the general objectives of the NRRP and urban regeneration such as building replacement, improvement of urban quality in the suburbs, and empowerment of social housing. The project was defined in 2020 and includes the demolition of the tower and its replacement with about 300 new apartments destined for social housing.
The project also provides 2,000 square meters of services and retail. The demolition of the tower is one of the premises to open the spaces to the neighborhood and citizens. The success of the project will depend on the synergic actions on the environment, architecture, technology, and community since citizens deserve not only decent housing structures but also pleasant living spaces and adequate services.
The objective is to create a neighborhood in connection with the local community to overcome disparities and socio-economic problems affecting the area.
(Image Source Bresciaoggi, 2021. Retrieved from: https://www.bresciaoggi.it/territori/brescia/iniziata-la-demolizione-della-torre-tintoretto-di-san-polo-1.9045456)

Vercelli – Redevelopment of the Sesia riverfront

Vercelli obtained the financing from the Ministry of Sustainable Mobility for three projects of urban redevelopment regarding the historic center and the suburbs along with the modernization of squares, streets, and neighborhoods. The financing is included in the national program PinQua. The resources are €41 million, divided into three expenditure items of, respectively, €15, €15 and €11 million.
The programs of regeneration concern the Sesia riverfront or "Lungosesia", the agricultural territory and the historic center of the city. They are all intended at redeveloping portions of degraded territory through coherent and interrelated measures in order to enhance the quality of life and increase citizens' opportunities. At the same time, they aim at reducing housing deprivation and fostering social inclusion. The Vercelli Sesia riverfront is one of the financed interventions. Andreas Kipar designed the project for the redevelopment of the waterfront, proposing the creation of equipped spaces for retail, spare time, sport, and leisure. Some of the main objectives of the project are to improve the accessibility of the riverfront, valorize biodiversity, and favor the sustainable development of activities and communities located in the area close to the river.
At the same time, the new riverfront is intended to become a new model of mobility for citizens that will travel mainly by walking and cycling, having the opportunity to reach different destinations and activities. In the Kipar project, there is also a general redesign of green urban areas and the proposal for the construction of 5 new parks. For what concerns the historic settlement and the urban center, the project promotes the creation of new pedestrian areas and the encouragement of sustainable mobility, along with the re-functionalizing of the historical-industrial building. The proposed interventions include also the reconversion of the abandoned railway and the transformation of neglected areas into urban parks, as well as landscape connections with the agricultural territory.

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