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

Vol.13 n.3 December 2020

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

3 (2020)

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

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The cover image is a photo of the 1966 flood of the Arno in Florence (Italy).

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TeMA Journal of Land Use, Mobility and Environment

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EDITORIAL PREFACE: TEMA JOURNAL OF LAND USE MOBILITY AND ENVIRONMENT 3(2020)

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

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The Times They Are a-Changin' and cities have to face challenges which cannot be further postponed. In particular, six of these challenges may modify and/or adapt the physical shape, the distribution of facilities and organisation as complex systems of cities: climate change effects, population ageing, reduction of fossil-fuel energy consumptions, immigration flows from disadvantaged regions, technological innovation, and optimisation of land use. The three issues of the 13th volume will collect articles concerning the challenges that cities are going to face in the immediate future, providing readings and interpretations of these phenomena and, mostly, methods, tools, technics and innovative practices (defiantly defined as Climate proof cities, Zero consumption cities, Car Free cities, …) oriented to gain and keep a new equilibrium between cities and new external agents.

For this Issue, the section "Focus" contains five contributes. The first article of the section is titled "Logistic models explaining the determinants of biking for commute and non- commute trips in Lahore, Pakistan" by Houshmand E. Masoumi (TU Berlin, Germany), Muhammad Asim, Izza Anwer, S. Atif Bilal Aslam (University of Lahore, Pakistan). This study takes Lahore, Pakistan, as a case-study city to explore the factors defining commute and non-commute bike trips as well as commuting by bike. These issues were analysed by collecting data from 379 subjects accommodating in three socio-economic statuses (lower, medium, and higher) in Lahore in spring 2018.

The second article, titled "A GIS-based automated procedure to assess disused areas" by Mauro Francini, Nicole Margiotta, Annunziata Palermo, Maria Francesca Viapiana (University of Calabria, Italy) deals with the issue of the regeneration of disused sites. It provides an overview of the main definitions in the scientific literature, and it proposes a parametric definition of functionally disused areas. Subsequently, the paper introduces a GIS-based operational tool able to map disused areas through an advanced screening of the local territory.

The next article, titled "Land surface temperature and land cover dynamics" by Federica Leone, Sabrina Lai, Corrado Zoppi (University of Cagliari, Italy). This study aims at analysing analogies and differences between the spatial relations regarding land surface temperature (LST) and land covers in May and August 2019. The Sardinian region is taken as a case study because its climate homogeneity and its self-containment allow for pretty straightforward identification of the regional boundaries.

The fourth article, titled "Fostering the climate-energy transition with an integrated approach" by Anna Codemo, Sara Favargiotti, Rossano Albatici (University of Trento, Italy). This study provides an overview of the interrelations and to present the gaps in current processes, with the aim of fostering a more integrated approach at the local level and of implementing more efficient low carbon and adaptive solutions.

The last article of this section, titled "Project role for climate change in the urban regeneration" by Veronica Strippoli (University of Tor Vergata, Italy) deepens the topic of the urban regeneration as an opportunity to operate on the city's "wounds" through an accurate plan. Starting from the effects of climate change on the city and on the inhabitants, the paper analyses the urban regeneration as a "multidisciplinary container" that can efficaciously face the needs of the territory. Case studies are the Reinventing Cities projects (C40 Cities Climate Leadership Group) for Milan and Rome.

Four papers address the section "LUME" (Land Use, Mobility and Environment). The first, titled "Covid-19 pandemic from the elderly perspective in urban areas. An evaluation of urban green areas in ten European capitals", by Gerardo Carpentieri, Carmen Guida, Ottavia Fevola, Sabrina Sgambati (University of Naples Federico II, Italy). This paper is a part of the Covid-19 research conducted to study the topic of spread for the pandemic in the European countries during the first phase of emergency and the importance to safe access and uniform distribution of urban services. The study focuses on urban green areas as a means of achieving a better quality of life, especially for the vulnerable groups of the population as the elderly.
The second article, titled "Transit oriented development: theory and implementation challenges in Ghana" by Kwabena Koforobour Agyemang, Regina Obilie Amoako-Sakyi, Kwabena Barima Antwi, Collins Adjei Mensah, Albert Machi Abane (University of Cape Coast, Ghana). The paper identifies possible benefits of TOD in Accra, Ghana, to include a reduction in motorisation and congestion, promotion of walkability and other forms of non-motorised transport. The paper highlights its consequent opportunities, as public transit ridership and improvement in the liveability of neighbourhoods.
The third article of this section, titled "Spatial policy in cities during the Covid-19 pandemic in Poland", by Przemysław Śleszyński, Maciej Nowak, Małgorzata Blaszke (West Pomeranian University of Technology, Poland). The 'geographic' aim of the study is to find the regularity of the increase in the number of infections in larger cities and their surroundings. The goal related to the science of public policy is to determine the implemented and potential effects related to spatial policy in Polish cities.
The last article of this section, titled "The contribution of a tramway to pedestrian vitality", by John Zacharias (Peking University, China). This research investigates the contribution of a tramway to local pedestrian movement, using the Hong Kong Tramways (HKT) as a case. The contributing factors of local physical planning and land use are also examined for their contribution to pedestrian flow.
The new Review Notes section propose four insights on the themes of TeMA Journal.
The first research "After recovery: new urban emergencies" is by Carmen Guida. The contribution discusses, reviewing scientific works, the impacts of Covid-19 pandemic on our lives and urban systems. Infections due to Sars-Cov-2 had and still have serious social, economic and health consequences, that each country around the world is currently experiencing. Moreover, myriad other challenges – especially climate change – are on the horizon and cities have to pivot to resilience, focus on their most vulnerable citizens and adopt a zero-tolerance for inequality.
The second research "Strategies and guidelines for urban sustainability: The explosion of soft mobility from Covid-19" is by Federica Gaglione. The contribution highlights how the rise of infections from Coronavirus has led users towards "soft" and at the same time, sustainable forms of mobility for cities. It also highlights how the fear of getting infected, the limitations imposed only for proven work needs and for the achievement of essential services has indirectly induced a cultural reversal of users of how to move around the city. In detail, the review examines the regulatory documents on electric scooters and precisely where they can circulate and how they can be used in Italian territorial contexts.
The third research "Toward greener and pandemic-proof cities? Italian cities policy responses to Covid-19 pandemic" is by Gennaro Angiello. The section provides an overview of the policies and initiatives undertaken by four EU cities in response to the Covid-19 pandemic. Based on this overview, a cross-city analysis is employed to derive a taxonomy of urban policy measures. The article concludes with a discussion on the effectiveness of such measures in providing answers to epidemic threats in urban areas while, at the same time, improving the sustainability and resilience of urban communities.
The last research "Entrepreneurship in the city: sustainability and green entrepreneurs" is by Stefano Franco. The work aims at shedding lights on late advancements about sustainability in the city. In doing so, the article discusses the role that green and sustainable entrepreneurs have on making the city more sustainable, also providing some practical cases.

TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 291-308
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/6983
Received 15th June 2020, Accepted 10th October 2020, Available online 31th December 2020

www.tema.unina.it

Logistic models explaining the determinants of biking for commute and non-commute trips in Lahore, Pakistan

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Abstract
The determinants of biking behavior are less studied in a wide range of developing countries including South Asia. This study takes Lahore, Pakistan as a case-study city to explore the factors defining commute and non-commute bike trips as well as commuting by bike. These issues were analyzed by collecting data from 379 subjects accommodating in three socio-economic statuses (lower, medium, and higher) in Lahore in spring 2018. The data were analyzed by applying multinomial logistic regression for investigating biking frequency and binomial logistic regression for examining commuting by bike. The results show that gender, age, education, income, purpose of majority of trips, preferred distance to travel using cycle, preferred time to travel using cycle, and preferred bike trip purpose are significantly correlated with biking frequency. The significant determinants of bicycle commuting included categories of education, the purpose of the majority of trips, using bike in combination with other modes, preferred distance to bike, preferred biking time, and preferred bike trip purpose are associated with bicycle commuting. Commuting by bike is a more popular in socio-economically weaker neighborhoods. The discussion of this study shows that the determinants of biking in the sample in Lahore are different from those that have already been addressed by studies undertaken in high-income countries.

Keywords
Cycling; Active transportation; Sustainable mobility; Human perceptions; Pakistan.

How to cite item in APA format
Masoumi, H. E., Asim, M., Anwer, I., & Aslam, S.A.B. (2020). Logistic models explaining the determinants of biking for commute and non-commute trips in Lahore, Pakistan. *TeMA. Journal of Land Use, Mobility and Environment*, *13* (3), 291-308. http://dx.doi.org/10.6092/1970-9870/6983

1 Introduction

The topic of biking determinants has widely been investigated across the highincome countries. In the recent past, the topic has also got the attention of the researchers from emerging economies and literature findings on the topic are also being surfaced from the developing world. However, the share of such studies in the overall volume is quite less. Also, the variation in the results of such limited studies is high as compared to the findings of the studies conducted in the developed world. This study focuses on exploring the biking determinants in Pakistan primarily to enrich our understanding of the dynamics associated with the biking in the context of a developing country and to find out the similarities and differences of the results in comparison with the literature findings relevant to the developed world.

As of many developing countries, there are not sufficient studies available for cycling in Pakistan. JICA's study included bicycle's trips stated that 45% trips counted for non-motorized in Lahore (JICA, 2012). This study included both pedestrian and cycling as non-motorized modes of transport and data were analyzed with respect to number of trips without stating their purpose. Such primary data is not available for the biking in Pakistan for commuting and non-commuting trips. This data gap provides a rationale to conduct study on this subject i.e. determinants and cycling use in Pakistani society.

The World Bank Technical paper on non-motorized Vehicles (NMVs) in Asian cities categorized bicycle, cycle rickshaw and carts as non-motorized vehicles. It concluded that NMVs were more efficient on shorter distance of travel while for larger distances, motorized transport modes were more efficient (Replogle & Mundial, 1992). But, the research findings on the aspect of short distance travelling with non-motorized seems inapplicable with the increase in travel distances in large cities such as Lahore, due to rapid urbanization and lack of infrastructure or safety measures for bicycle users in Pakistan. The value of time, speed and price of mode is also important factor for promoting the NMVs in Asian cities (ibid). This study revealed that choice of non-motorized mode is based on distance and cost of travelling. Bicycle's trips share is higher in urban places of Asian countries with low per capita income in comparison to Chinese and Indian cities, where the use of bicycles is declining due to non-availability of bicycle road infrastructure i.e. dedicated lanes (Tiwar et al., 2008). This study revealed that bicycle infrastructure and income level are the determinants of biking in Asian cities. Another study in the Indian city of New Delhi stated that most cycle users were male and belong to low income class (Arora 2013). Based on the findings, Arora (2013) also concluded about the effective role of gender as an important determinant of cycling in the Asian cities.

In other neighbouring country i.e. Bangladesh, research identified four factors of bicycle promotion in Sylhet city; those were health, convenience, weather and a deterrent factor of cycling due to more hazard as compared to motorized vehicles (Nawaz, 2015). However, studies on biking determinants within the context of Pakistan are very hard to find. The JICA study (2012) included biking as a mode of transport and provided trip count data only. In another study, (Aslam et al., 2018) looked into the potential of cycling in Lahore based on a descriptive analysis of the available opportunities and constraints. While looking into the relevant literature emerging from other neighbouring countries such as China, India and Bangladesh, various studies mainly identify biking infrastructure, weather, gender, travel distance and income level as determinants of biking. This research mainly focuses on investigating biking determinants in Pakistan.

The objective of this study is to find the correlates of biking frequency including commute and non-commute trips as well as the determinants of commuting by bike using the primary data collected in Lahore, Pakistan. It is also intended to descriptively show the differentiation of biking in different socio-economic levels in the city. A marginal task taken in this study is finding the differences between biking determinants in Lahore, compared to those of high-income societies mostly located in Europe, North America, and Australia.

The first section provides an overview of the topic and rationale behind conducting this study. It also highlights the main objective of the study. The second section offers a review of the literature and presents the results of the past studies on the topic of biking determinants. It also covers the methodological considerations of

similar past studies to report on the methodological consistencies and variations which leads to the methodology section of this study. The next section presents the study findings based on the inferential analyses which is followed up by the discussion section where the results of this study have been compared with the literature findings, particularly those emerging from the developed world. The last section concludes this study on the basis of findings and discussion.

1.1 Biking Determinants

The bicycle is a greener mode of transport and it needs to be promoted for better air quality management, health benefits and reduction of carbon emissions and also improve accessibility of the poor segment of community. In some countries, promoting bicycling is on the agenda of policy of the respective governments while in others effort at the individual level is the main cause of its promotion (Nawaz 2015). Policy makers are keen to identify the biking determinants while looking into the theory and available evidence to formulate policies for behavioural change to attract more cycle users (Chatterjee et al., 2013). In a comparative study of Germany and the USA, (Buehler, 2011) found that despite having been among the highest motorization rates in the world, Germans make about four times more share of trips by active transportation modes including cycling as compared to Americans. On investigating deeper, he concluded that the main determinant causing the difference in the person's mode choice behaviour is transport policy making the car travel slow, expensive and thus discouraging. Another study conducted by (Douglas, 2014) pooled the possible determinants like biking infrastructure, traffic safety, attitude by other mode users toward bicyclists, travel distance, income level, knowing how to cycle, health benefits and its integration with other modes of transport. The policy making cannot be effective unless it is derived from strong evidence of biking determinants. Such informed policy making can help in transforming the behaviour either through providing incentives or restricting any activity for bringing change in the society. (Caulfield et al., 2012) specifically investigated the determinants of biking infrastructure in Dublin and found that exclusive biking infrastructure segregated from motorized traffic is the leading preference of the cyclists.

In many studies, biking as a commuting mode has not been studied in isolation; rather it has been investigated as a part of overall transport system where bike sharing system is integrated with other modes of traffic to cover longer travel distances in large cities. In a similar such study conducted in Ningbo, China, (Guo et al., 2017) investigated the factors affecting bike-sharing usage and found gender, bike ownership, travel time, location of bike-sharing station, trip model and perception of bike-sharing as important determinants of bike use. Some researchers aimed at school-based commuting trips to identify the determinants of travel behaviour with respect to active travel modes including bike. (Irawan & Sumi, 2011) conducted such a study in Yogyakarta, Indonesia and found the travel distance from home to school is the main determinant of active travel mode choice. They also identify other significant determinants of age, gender and student's household characteristics. In a trans-national study, (Masoumi, 2019) investigated travel mode choices of the residents of Tehran, Istanbul and Cairo and identified the lack of biking infrastructure, socio-cultural issues exerting a pressure on biking and personal preferences as important determinants of biking. In another study conducted in Abu Dhabi, United Arab Emirates, (Badri et al., 2012) found gender, educational level of children, number of cars owned, nationality and number of children as important determinants of biking or walking decisions made by the parents for the children commuting to schools.

In South Asian region, there are some studies on biking promotion conducted within the Indian context. Tiwari et al. (2008) conducted a study in some Asian cities from Sri Lanka, India and China. They investigated about trends, potentials and association of biking with poverty and concluded that cycling is a transport mode of low-income people. They also shed light on the role of biking friendly policies of respective governments in each case and found out that most of cities' residents switched to motorized modes due to non-friendly government policies towards biking infrastructure. While in comparison, Chinese cities of Beijing and Shanghai observed 20 to 30% biking trips due to biking-friendly policies of governments; mainly a decent biking

infrastructure. (Majumdar & Mitra, 2015) conducted a study to identify factors affecting bicycling in small sized cities of India and found physical factors, safety concerns and topographic features as the main determinants of biking.

Reviewing the similar past studies on the topic, it has been found that a variety of approaches have been used to find out the determinants of the biking in urban settings. The topic has sufficiently been addressed within the developed countries context; however, it is still a matter of deeper inquiry for the developing world. There are lesser studies available which took the biking mode exclusively for investigation (Rietveld & Daniel,2004; Buehler,2012; Fuller & Winters, 2017; Aslam et al.,2018; de Geurs et al.,2019), while many studies explored the topic either through merging it in a wider group of active travel modes including walking (Yu, 2014) and public transit (Frank, 2004; Norwood et al., 2014; Mueller et al., 2015; Brown et al., 2016; Rojas-Rueda, 2019) or studied it in an overall sharing system (Park, Kang et al., 2014; Guo, Zhou et al., 2017; Hosford & Winters, 2018) where biking mode is integrated with other modes of traffic to facilitate riders to cover longer travel distances in large urban areas. Some researchers focused on educational based commuting trips and examined the travel behaviour of students (Irawan & Sumi, 2011; Badri et al., 2012) while others focused on job based commuting patterns (Panter et al., 2013). There are studies which also target the non-commuting trips through biking mode. The data collection method has mainly been the survey of the target population (de Souza et al., 2014; Fernández-Heredia et al., 2014), while some studies also relied on investigating the matter qualitatively through theoretical research (Koglin & Rye 2014), case study research (Zayed, 2016) or expert interviews; however such studies mainly focused on biking infrastructure (Caulfield et al., 2012). Inferential analyses, mainly the binomial and multinomial regression model analyses (Cole-Hunter et al., 2015; Muñoz et al., 2016) have been found the leading data analysis technique in the majority of the papers. Some papers also opted for discrete choice modelling (Masoumi, 2018; Masoumi, 2019) depending upon the objectives of their studies while some also employed simple descriptive analyses (Aslam et al., 2018) for presenting their results.

2. Methodology

The main questions that this manuscript seeks to answer are (1) which individual, household, and perceived factors determine biking frequency in Lahore? (2) which traits of different types define commuting by bike in the case city? In this study, it is hypothesized that the socio-economic, household, and individual factors as well as personal preferences and perceptions of biking are the most important determinants of biking in Lahore as an example of large cities in Pakistan. In the meantime, it is meant to prove that biking is a commute mode mainly for lower socio-economic statuses, namely for people accommodating in more deprived or more traditional neighbourhoods.

The data was collected in different districts of Lahore, Pakistan by interviewing people based on a standard questionnaire in spring 2018. The sample included 379 subjects accommodated in three different socio-economic statuses (lower, medium, and higher) accessing to traditional and older bazaars, uptown bazaars, and pedestrian malls (Fig.1).

The questionnaire consisted of 19 questions leading to development of 17 categorical/dummy variables, two open-ended variables, and two continuous variables targeting on socioeconomics, bike trip characteristics, biking barriers, and preferred travel specifications.

The descriptive findings of this exploratory survey were already published in detail in a previous publication of the authors i.e. (Aslam, Masoumi et al., 2018).

The two main dependent variables that are examined in this paper are biking frequency and commuting by bike. The former variable refers to the frequency of all bike trips for commute and non-commute purposes.

The question that was asked from interviewees was "what is the frequency of you cycling routine?" and the options were daily, weekly, monthly, occasionally, and need based.

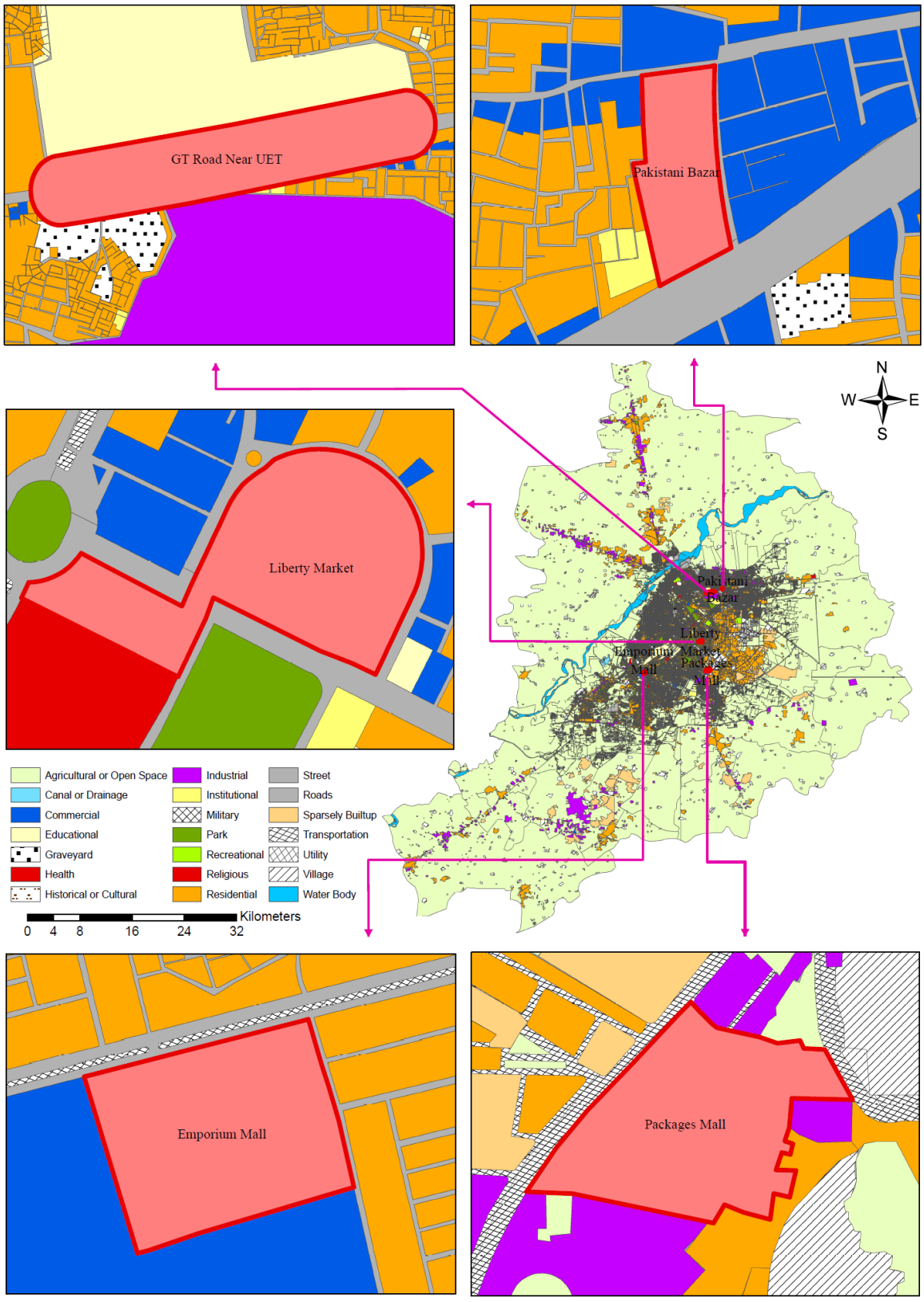

Fig.1 Location of case study districts in Lahore City (Source: Aslam et al., 2018)

The second variable was a binary one developed by the question "do you use cycle for commuting?" and two options of yes and no were given to the respondents.

In order to analyze the commute and non-commute biking frequency and biking as a commute mode in the sample, multinomial logistic regression (MNL) and binary logistic (BL) modelling were applied respectively. The MNL technique is generally explained by formula 1 and 2 respectively.

$$P = \frac{\exp(V_{in})}{\sum_{j=1}^{k} \exp(V_{jn})} \quad (1)$$

Whereas:
$P_n(i)$ is the probability that cycling has a frequency of i,
V_{jn} is the utility derived by individual n having frequency j,
K is the number of possible frequencies of cycling by the respondents.

For exploring the probability of commuting by bike the general formulation of binary logistic model is applied (Formula 2).

$$P = \frac{\exp(\alpha + \sum_{i=1}^{k} \beta_i x_i}{1 + \exp\ (\alpha + \sum_{i=1}^{k} \beta_i x_i)'} \quad (2)$$

Whereas:
P is the probability that respondents commute by cycle (commute by cycle=1),
x_i is each explanatory variable,
α is a constant term,
β_i is the regression coefficient of the model.

Thirteen explanatory variables were selected for both models: gender, age, income, education, know how to ride bicycle, no of cycle user in house, no of cycle owned in house, purpose of majority trips, use cycle in addition or split of other mode, preferred distance to travel using cycle, preferred time to travel using cycle, preferred bike trip purpose, and the most important aspect of biking. The MNL model (biking frequency), need-based biking was taken as the reference category, so the results were relevant to this option. For the purpose of interpretation of results, P-values less than 0.05 were taken as significant and values between 0.05 and 0.10 were accepted as marginally significant.

3. Findings

Tab.1 summarizes the frequencies of the responses including dependent and independent variables. The question regarding biking frequency was answered by 115 respondents, more than 31% of whom bike in a daily manner and 32% bike occasionally. More than 70% of the respondents have declared that they may use bike as a commuting method. Although biking is not a serious transportation mode choice in Pakistan according to the literature, but the descriptive findings show that it is used, more or less, for almost frequently (daily or weekly) especially for commuting.
Moreover, number of bikers in the household is a marginally significant variable (P=0.056). Interestingly, bike ownership, using bike combined with other modes, the most important motive behind cycling are not correlated with biking frequency. Whether they bike because of affordability, reliability, or accessibility is not associated with the number of their bike trips.
The results of the MNL model shows that eight variables of gender, age, education, income, purpose of majority of trips (not only biking), preferred distance to travel using cycle, preferred time to travel using cycle, and preferred bike trip purpose are significantly correlated with biking frequency (Tab.2).
The most significant explanatory variable is the dominant purpose of the majority of trips including recreation (16.5%), educational (27%), work (7%), health, fitness, and wellbeing (49.6%). This indicates that biking frequency is highly significantly related with who the person is and what his/her main daily overall travel

purpose is. Another highly significant variable is education. This variable consists of five educational levels: under matric (13.9%), matriculation (27.8%), undergraduate (28.7%), graduate (22.6%), and post-graduation (7%).

Variables	Category	n	Share of Sample	Variables	Category	n	Share of Sample
Cycling Frequency	Daily	36	31.3%	Purpose of majority Trips	Recreation	19	16.5%
	Weekly	21	18.3%		Education	31	27.0%
	Monthly	7	6.1%		Work	8	7.0%
	Occasionally	37	32.2%		Health, Fitness, Wellbeing	57	49.6%
	Need Based	14	12.2%	Use cycle in addition or split of other mode	Yes	92	80.0%
Gender	Male	99	86.1%		No	23	20.0%
	Female	16	13.9%	Preferred distance to travel using cycle	<1	4	3.5%
Age	15-24	46	40.0%		0.25 Km	28	24.3%
	25-54	69	60.0%		up to 5 Km	43	37.4%
Income	0-15000	29	25.2%		1-2	1	0.9%
	15000-50000	70	60.9%		5-10 Km	26	22.6%
	50,000 - 100,000	15	13.0%		10-15 Km	13	11.3%
	>100,000	1	0.9%	Preferred time to travel using cycle	under 15 min	64	55.7%
Education	Under matric	16	13.9%		15-30 Min	41	35.7%
	matriculation	32	27.8%		up to an hour	10	8.7%
	Under-graduate	33	28.7%	Preferred bike trip purpose	Recreation	18	15.7%
	Graduate	26	22.6%		Education	34	29.6%
	Post-graduation	8	7.0%		Shopping	4	3.5%
Know how to ride bicycle	Yes	115	100.0%		Work	52	45.2%
No. of cycle users in household	0	8	7.0%		Health, Fitness, Wellbeing	7	6.1%
	1	50	43.5%	Commuting by bike	Yes	84	70.5%
	2	29	25.2%		No	35	29.4%
	3	13	11.3%	Important motive behind cycling	Affordability	47	40.9%
	4	14	12.2%		Reliability	35	30.4%
	5	1	0.9%		Accessibility	33	28.7%
No. of cycles owned in household	0	9	7.8%	Valid		115	100.0%
	1	77	6.0%	Missing		264	
	2	25	21.7%	Total		379	
	3	1	0.9%				
	4	3	2.6%				

Tab.1 The frequencies of responses of dependent variables

Effect	-2 Log Likelihood of Reduced Model [a]	Chi-Square	df	P-Value
Gender	131.249	9.811	4	0.044
Age	131.451	10.013	4	0.040
Income	138.465	17.027	8	0.030
Education	157.044	35.606	16	0.003
Know how to ride bicycle	121.438	0	0	-
No of cycle users in household	152.365	30.927	20	0.056
No of cycles owned in household	135.722	14.284	16	0.578
Purpose of Majority Trips	162.333	40.895	12	<0.001
Use Cycle in addition or split of other mode	127.009	5.571	4	0.234
Preferred distance to travel using cycle	151.502	30.064	16	0.018
Preferred time to travel using cycle	139.196	17.758	8	0.023
Preferred bike trip purpose	153.189	31.751	16	0.011
Important Aspect behind cycling	127.063	5.625	8	0.689

The reference category is: Need-Based

Tab.2 Results of multinomial logistic regression for cycling frequency

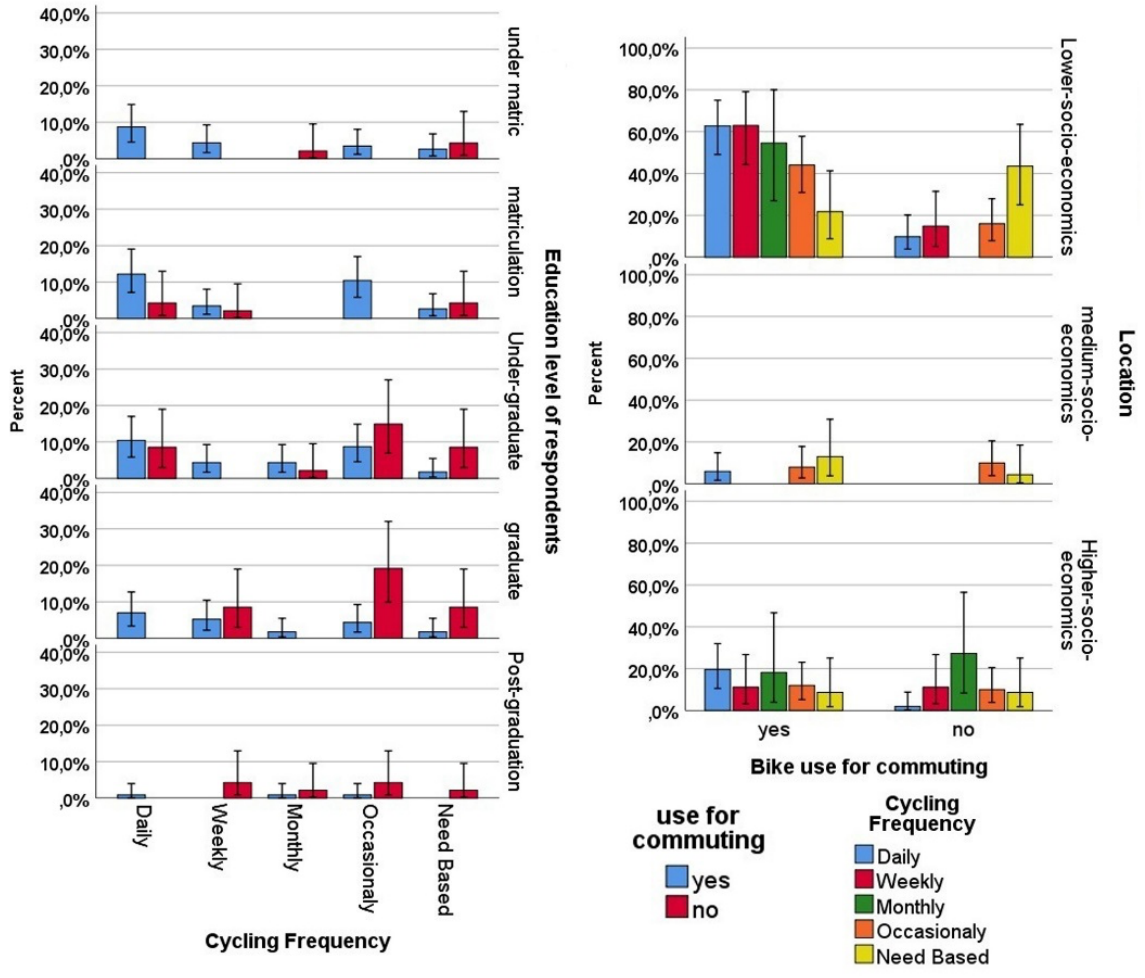

Fig.2 Left: Frequencies of bike commuting based on education level. Right: Cycling frequency in different socio-economic statuses in Lahore city

Fig.2 shows how cycling frequency varies by different education levels (right). Nevertheless, to have a more precise understanding of the direction of the significant variables, more information is needed about the coefficients.

Tab.3 provides this information about the significant categories (P<0.05) and marginally significant categories (0.05<P<0.10). According to these results, young people aged 15 to 24 years are more probable to bike daily instead of need-based compared to those respondents with 25-54 years of age.

	Cycling Frequency	B	Std. Error	Wald	df	P-Value
Daily	Age of Respondents=15-24	11.492	6.864	2.803	1	0.094
	Age of Respondents=25-54			Reference		
	No. of cycle users in household=1	75.686	31.639	5.723	1	0.017
	No. of cycle users in household=2	75.869	32.015	5.616	1	0.018
	No. of cycle users in household=3	69.639	31.340	4.937	1	0.026
	No. of cycle users in household=5			Reference		
	Purpose of Majority Trips=Education	7.595	4.039	3.535	1	0.060
	Purpose of Majority Trips=Health, Fitness, Wellbeing			Reference		
	Use cycle in addition or split of other modes=Yes	7.593	3.632	4.370	1	0.037
	Use cycle in addition or split of other modes=No			Reference		
Weekly	Age of Respondents=15-24	13.595	6.990	3.783	1	0.052
	Age of Respondents=25-54			Reference		
	No. of cycle users in household=1	73.141	31.654	5.339	1	0.021
	No. of cycle users in household=2	80.534	32.087	6.300	1	0.012
	No. of cycle users in household=3	70.450	31.385	5.039	1	0.025
	No. of cycle users in household=5			Reference		
	Preferred travel distance using cycle=up to 5Km	-13.947	6.971	4.003	1	0.045
	Preferred travel distance using cycle =1-2Km			Reference		
	Preferred bike trip purpose=Work	-12.338	6.268	3.875	1	0.049
	Preferred bike trip purpose= Health, Fitness, Wellbeing			Reference		
Occasion	Age of Respondents=15-24	12.529	6.864	3.332	1	0.068
	Age of Respondents=25-54			Reference		

Tab.3 Parameter Estimates for the MNL model (dependent variable: cycling frequency. Reference category: Need-Based)

Households with between 1 and 3 bike users are much more likely to bike daily relative to need-based compared to those household that have 5 bike users.

Respondents whose main travel activity is with the purpose of education are more probable to bike daily instead of need-based compared to those who cycle because of health, fitness, and wellbeing.

Perhaps these people are students who do not own or access a car or motorbike and do not use public transport, or those who cycle for health, fitness, and wellbeing usually bike whenever there is a need rather than continuously. As expected, those people who bike as a completion of other modes are more likely to do it daily rather than need-based compared to those who do not combine biking with other travel modes.

Like biking in a daily manner, it is more probable for people ages 15-24 to bike weekly instead of need-based compared to people ages 25-54. Moreover, households with fewer bike users are more likely to cycle weekly rather than need-based compared to those households that have 5 bike users.

The respondents who prefer to bicycle less than five Km are less likely to do it weekly instead of need-based compared to people who prefer to bike one to two Km. People whose main biking purpose is commuting are less probable to cycle weekly instead of need-based compared to people who bike for health, fitness, and wellbeing. Finally, respondents of this sample that were aged 15 to 24 years are more probable to bike occasionally instead of need-based compared to those respondents with 25-54 years of age.

Table 4 summarizes the model validity tests. The Pseudo R-Square results show very high amounts, i.e. the Nagelkerke value is 0.92, indicating that the model explains 92% of the variances. The Chi-square and the goodness-of-fit test also confirm the validity of the model.

	Model	**-2 Log Likelihood**	**Chi-Square**	**df**	**P-Value**
Model information	Null	368.784	-	-	-
	Final	121.438	247.346	140	<0.001
Goodness-of-Fit	Pearson	-	481.928	288	<0.001
	Deviance	-	120.052	288	1.000
Pseudo R-Square	Cox and Snell		Nagelkerke		McFadden
	0.884		0.920		0.668

Tab.4 Model Fitting Information of the binary logit model for commuting by bike

The results of the binomial logit model show that education, the purpose of the majority of trips (all modes), using bike in combination with other modes, preferred distance to bike, preferred biking time, and preferred bike trip purpose are the variables that are generally correlated with commuting by bike or at least one of their categories are associated with bike commuting (Tab.5).

Three categories in the education variable are significantly correlated with bike commuting, indicating that if people have studied up to under matric, matriculation, and undergraduate levels, then they are more likely not to commute by bike.

If the purpose of most trips is working, then people are less probable not to commute by bike, or in other words, they are more probable to commute by bike. Of course, this finding is logical and expectable. In very near commuting distances like 0.25 Km, it will be more likely not to bike.

The reason is probably that in such distances, people in Lahore prefer to walk rather than bike. Surprisingly, in short or middle commuting distances of less than 15 minutes and between 15 and 30 minutes, the respondents prefer not to cycle. Finally, for those who bike motivated by recreational purposes are less likely to commute to work.

The results of the model validity test are illustrated in Tab.6. The omnibus tests result indicated validity of the model (P=<0.001). the Nagelkerke R-square is more than 75%, indicating that 75% of the variation can be predicted by the model.

Category	B	P-Value	Exp(B)	Category	B	P-Value	Exp(B)
Gender=Male	-0.953	0.351	0.386	Preferred distance to travel using cycle	-	0.056	-
Age=15-24	-0.810	0.345	0.445	Preferred distance to travel using cycle=0.25 Km	8.789	0.014	6561.218
Income	-	0.637	-	Preferred Distance to travel using cycle=up to 5 Km	1.679	0.338	5.361
Income=0-15000 PKR	2.445	0.313	11.525				
Income=15000-50000 PKR	1.313	0.574	3.717	Preferred Distance to travel using cycle=5-10 Km	-0.631	0.707	0.532
Income=50000-100000 PKR	0.974	0.637	2.650	Preferred Distance to travel using cycle=10-15 Km	-20.131	1.000	≈0
Education	-	0.094	-	Preferred Distance to travel using cycle=more Than 15 Km	-0.906	0.587	0.404
Education=under matric	-4.395	0.024	0.012	Preferred Time to travel using cycle	-	0.131	-
Education=Matriculation	-4.532	0.021	0.011	Preferred Time to travel using cycle=under 15 minutes	5.528	0.073	251.605
Education=Undergraduate	-3.828	0.028	0.022	Preferred Time to travel using cycle=15-30 minutes	6.009	0.048	407.279
Education=Graduate	-1.628	0.284	0.196	Preferred bike trip purpose	-	0.192	-
No. of cycle user in household	-0.616	0.223	0.540	Preferred bike trip purpose=Recreation	-4.146	0.038	0.016
No. of cycle owned in household	-0.146	0.822	0.864	Preferred bike trip purpose=Education	-1.824	0.240	0.161
Purpose of majority trips	-	0.082	-	Preferred bike trip purpose=Shopping	1.413	0.595	4.108
Purpose of majority trips=Recreation	2.001	0.184	7.396	Preferred bike trip purpose=Work	-2.205	0.163	0.110
Purpose of majority trips=Education	0.079	0.947	1.082	Aspect driving using cycle	-	0.340	
Purpose of majority trips=Work	-5.225	0.037	0.005	Aspect driving using cycle=Affordability	1.125	0.331	3.081
Use cycle in addition or split of other mode=Yes	-3.120	0.002	0.044	Aspect driving using cycle=Reliability	1.643	0.144	5.170

Tab.5 Binomial logistic model for commuting by bike (Yes coded as 1, and No coded as 2)

	Category	Chi-square	df	P-Value
Omnibus Tests of Model Coefficients	Model	99.479	28	<0.001
	-2 Log likelihood	Cox & Snell R-Square		Nagelkerke R-Square
Model Summary	65.490	0.567		0.755

Tab.6 Binomial logit model validity test results

The above two models reveal some of the predictors of cycling frequency and bike commuting in Lahore city. Due to limitation of work force and time, urban form characteristics were not modeled in form of variables in this study. According to the literature, such factors including land use, density, street configuration and connectivity can be influential on biking behaviours. As mentioned in the methodology section, in this study, the urban forms were classified in three groups of lower, medium, and higher socio-economic statuses, based on the accessibilities to different types of bazaars and malls.

Fig.2 integrates commuting by bike in these three socio-economic statuses. This figure relates cycling frequency, bike commuting, socio-economic status, and education level.

As observed, those respondents who have undergraduate and graduate university degrees and bike occasionally, are less likely to commute by bike. On the other hand, if people commute by bike, they do it in a daily routine. This is seen among almost all education levels. Those who commute daily are very probable to live in lower socio-economic neighborhoods (Fig.2-right).

As the MNL and BL models showed, the number of cycle users per household was a significant or marginally significant variables for cycling frequency and commuting by cycle, while household bike ownership was not significant in either of the models.

Fig.3 depicts the relationship between the number of cycling household members and household bike ownership with biking frequency and bike commuting. The mean of the number of cycling household members is higher than the mean of cycles per household.

This might be justified by shared use of bikes by household members. This result indicates that bike ownership may not be treated as car ownership that indirectly indicates car use according to the literature.

The purpose of the majority of trips is a significant predictor of both biking frequency and commuting. The purpose of bike trips is significantly associated with bike commuting.

Fig.4 illustrates the breakdown of these purposes broken down on commuting by bike. As expected, the largest share of commuting is related to "work" purpose, be it for all the modes or only for biking.

The next important purpose is education that makes more than one-third of the commute trips. Interestingly, the largest percentage of bikers who do not commute by bike is related to people who cycle for health, fitness, and wellbeing, and in general for physical activity, sport, and entertainment (10%).

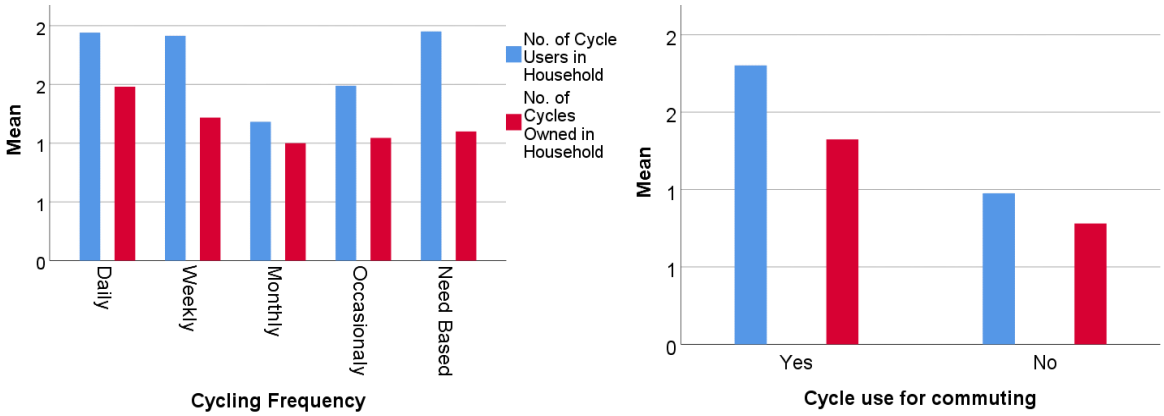

Fig.3 Breakdown of the means of household cycle users and bike ownership on cycling frequency and commuting by bike in the sample

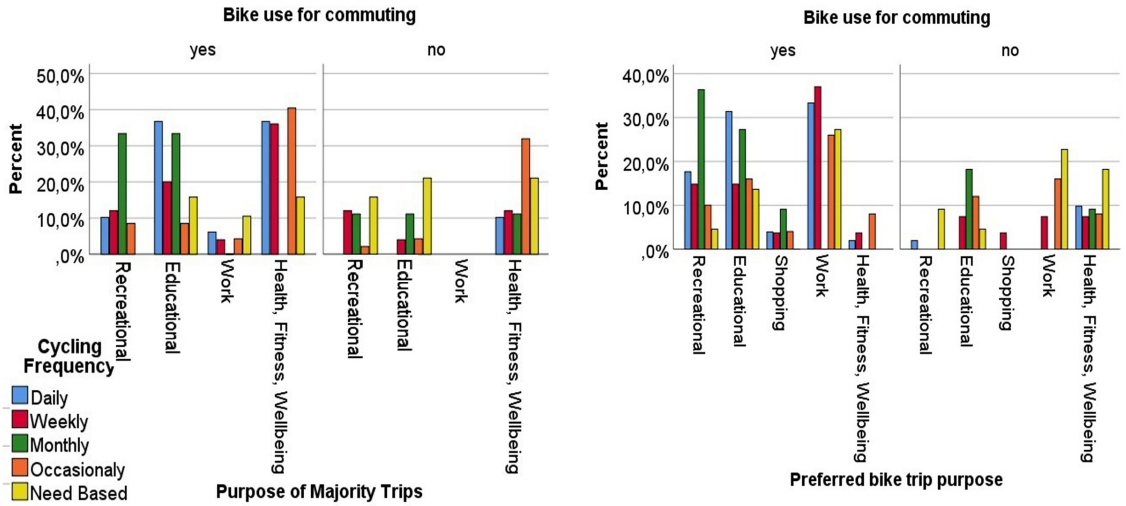

Fig.4 Purposes of all modes of travel and also bike trips based separated based on commuting by bike

4. Discussion

This section discusses the results with reference to latest work from other developed countries. The modelling of this study has been undertaken for producing correlations for the purpose of comparing the travel behaviors in Pakistan and South Asia with other contexts. However, it is also possible to use the results of the modelling for more applied purposes like transportation planning and policy making in South Asia or similar contexts like the Middle East and North Africa (MENA) or Asian countries. However, in an optimal case, the results of the models explaining the cycling frequency and commuting by cycle in Lahore can be generalized and transferred to other medium and large cities of South Asia region.

Applying the findings to other contexts will need strict and careful calibration before transferring. The reason is that the above two behaviours (frequency of general cycling and cycling to work) are heavily related to culture and climate, which may be very different in several regions compared to South Asia.

As mentioned above, the main interest of this study is to find contextual differences between biking behaviors in Pakistan and South Asia with other contexts.

Below some of these differences have been highlighted.

A quantitative study from China (Li & Zhao, 2015) shows that students who commute for education purposes and reside on the suburbs belong to different socio-economic backgrounds and prefer to cycle within 3 km of distance from their home to school whilst in Lahore people did not want to travel through bicycle for shorter distances. The reason is education and population policy designed by the country which is not given a due attention in case of Lahore. One step ahead of that, bicycle friendly cities (e.g. Ireland) are introducing and improving bicycle sharing schemes which is getting popular among people especially in higher-income groups and due to the increasing awareness among drivers (Murphy & Usher, 2015) but are not significantly considered in case of Lahore.

A study from America shows that different institutions at national level come across to take into account of people's choices to travel through healthier, safer and low-carbon travel modes such as walking and biking, and define policies for neighbourhood by encouraging them adopt through the provision of necessary facilities and infrastructure (Abel et al., 2019). Similar is the case with other high income countries such as Britain, European countries and Australia (Docker & Johnson, 2018; Cervero et al., 2019).

This shows a gap between residents of Lahore who are willing to bicycle if are given enough opportunities and biking friendly infrastructure and the policy makers and implementers at national/subnational level in Pakistan.

Results showed that people who have obtained education up to matriculation used bicycle either on daily basis or occasionally and similar was the case with undergraduate students too, whilst it is already established that frequency of bicycling reduces with the increasing levels of education, especially, in the context of commuting (da Silva Bandeira et al., 2017).

In Lahore, lower socio-economic groups frequently commute on daily or weekly basis whilst the trend is not considerable in medium and higher socio-economic groups. This shows that the difference in socio-economic characteristics of a community effects the choice and frequency of bicycling to commute. In contrast, trends towards cycling in all three socio-economic groups towards bicycling have been closed in developed countries such as Sweden (Bastian & Börjesson, 2018) and all socio-economic groups are inclined to bicycle.

This paper contributes that there seems a strong inter-related effect of education, socio-economic characteristics and the need of commuting to cycle (based on the distance between residence and workplace) which previously has not been explored significantly in case of Lahore and can be achieved even with very limited available data on socio-economic conditions of Lahore as presented by (Jain & Tiwari, 2019).

Results showed that considerable number of people of Lahore bicycled for health, fitness and wellbeing purposes following educational purposes whilst the least number of users cycled for sake of work purpose. Also, participants from Lahore showed different preferences that they would like to cycle more for work trips

compared to recreational trips and as is happening in other high-income and well developed countries such as Australia (Heesch et al., 2015).

However, it is yet to be investigated that what could be the possible factors that may influence people's preferences to bike for a specific purpose-oriented trip and how bicycling could be promoted for various trips. Biking to work may add additional advantage of health and wellbeing as is also practiced in countries like Singapore (Raustorp & Koglin, 2019).

There seem other factors linked with this situation, for example, distance to travel or/and time constraints and other health issues. For example, as if health and wellbeing policies are implemented at national/subnational levels then at least in public sectors biking to work can be encouraged with the provision of necessary facilities and required support as done in South-Western Norway (Jahre et al., 2019) and can be further extended to private sectors.

In countries such as China, bicycling is well integrated mode with other public transit modes which allow travelers to use partial modes of travel as per their own convenience (Zhao & Li, 2017). A similar bicycle-bus integrated system may support bicycling more in Lahore. In this study, around 80% of participants were willing to use bicycle in split or addition to other modes of traffic which is already an ongoing practice in developed countries and a well-accepted solution to urban traffic problems (Frade & Ribeiro, 2014).

Results also showed that people want to travel to work using bicycle and this might help them in saving costs of commuting. Therefore, it is need of the hour to take up willingness of people of Lahore towards cycling and design policies accordingly at least for smaller travel distances (say up to 5 km).

Even bike sharing policies as practiced in many countries based on various travelling activities could be good starting point (Midgley, 2009; Vogel et al., 2011).

Results showed that more than half of people of Lahore preferred to travel for shorter time span (less than 15 min) compared to longer travel time spans for which the possible reasons need to be well explained.

For example, in a detailed study from China, structural modelling equation is used to investigate the various factors effecting the shared use of bicycle, it was found that those bicycle users who travel for shorter distances are influenced by the effect of perceived behavioural control and certain habits especially on shared bicycle whilst in contrast to that for long distance users the prominent factors are subjective norms and attitudes (and behavioural intentions) (Xin et al., 2019).

In a contemplation based study from Australia, it is found that the closer proximity of residential area in relation to shared bicycle stations (or availability of bicycling) and destined places of trips may not are of any significance which is another indication that there might be other factors involved in deciding the travel time through bicycling (Heinen et al., 2018). However, in the same study it is also indicated that other factors may be are more supportive of bicycling by sharing bicycle friendly schemes (Haider et al., 2018).

Results showed that people of Lahore were willing to commute by bicycle, if like other countries such as China, government supports such policies and give subsidies and facilities on bicycle sharing schemes then it might facilitate people who are already willing to commute by bicycling (Cai et al., 2019). Such schemes can facilitate other aspects of urban mobility e.g. low carbon solutions through bicycling rather than motorization whilst making bicycle as more user-friendly and environmental-friendly mode (Aladin et al., 2019).

Results showed that affordability could be the main motivation behind bicycling compared to reliability and accessibility for the people of Lahore.

This is a clear indication and as discussed above as well that if people of Lahore are given opportunities and facilities by the government (or private sector) where they can cut the cost of travelling, they would certainly go for bicycling rather than spending on other modes of transport e.g. preference of cycles over cars (Pirlone & Candia, 2015). In addition, reliability and accessibility were also given weightage by the people of Lahore. This means that there are multiple-determinants that might target various groups of people with different needs, priorities and incentives (Majumdar et al., 2015).

There is not a single factor responsible to persuade people to bicycle or commute for any (specific) purpose (Cervero et al., 2019). There is involvement of complexity due to many factors involved in knowing the needs of people who can potentially bicycle whilst declining other modes of travel.

From the discussion so far, it is quite clear that people of Lahore are willing to (commute through) bicycle (solely or in split with other modes of transport) if are given suitable incentives and facilities as in other high income and developed countries. There are many governing factors that influence the choice of mode to travel particularly bicycle as studied by (Masoumi, 2013) that the sustainable modes like walking and bicycling are promoted when facilities/amenities are accessible.

It is required that a detailed study that involves multiple factors and determinants such as land use densities, people's preferences, incentives offered by government etc. should be carried out along with more advanced data collection and analysis methods.

Like all other studies, this study too has some limitations such as there is need to get more data (bigger sample size) and (complex analysis method to do) core analysis in the context of versatile relationships of time, travel distances and purpose of trip, health and publics' willingness and prevailing constraints (such as infrastructure).

5. Conclusion

This study analyzed the commute and non-commute biking frequency and also biking as commute mode in the sample using multinomial regression and binary logistic model. In this regard, thirteen explanatory variables used for both models i.e. gender, income, education, know how to ride bicycle, no. of cycle user in house, no. of cycle owned in house, purpose of majority of trips, use of bicycle in addition or split of other mode, preferred distance to travel using cycle, preferred time to travel using cycle, preferred bike trip purpose and important aspect of biking.

The result of analysis identified important biking determinants i.e. age, education level, purpose of trip and income level. While factors like bike ownership is not important as less bike ownership in house still has more bike user. People are willing to use bike in combination with other mode.

Surprisingly, people those bikes for health and well-being do not use bike for commuting whereas mostly people prefer to bike for shorter distance (15 min or less).

The study has identified that there is willingness to bike for shorter distance and also in connection with other modes e.g. bus or metro train etc. There is potential to promote biking as greener mode of transport if it is part of transport policies at provincial and local level.

This study identified determinants of biking i.e. age, education, income, purpose of trip, length of trip using bike, no. of bicycle users and no. of bicycle owned with respect to urban forms and socio-economic groups. Due to limitations, factors like land use, density, street configuration and connectivity could not be analysed and these factors can greatly influence biking pattern.

There is need to conduct studies on factors i.e. land use, density, street configuration and connectivity in connection with this study. This subject of bicycle remained ignored from researchers' side and from government in transport policy formulation in Pakistan too. More studies should be conducted in other cities of Pakistan with bigger data set using more factors to guide the policy makers for promoting biking in big cities of Pakistan.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 309-328
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/7039
Received 6th July 2020, Accepted 4th November 2020, Available online 31st December 2020

www.tema.unina.it

A GIS-based automated procedure to assess disused areas

Identification methods and regeneration opportunities

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Abstract
Regeneration of disused sites represents a significant opportunity. The scientific interest in their redevelopment possibilities has grown considerably in recent years. Despite this, a shared definition of disused sites which goes beyond that of brownfields and allows recognition the size of the problem on a transnational scale is still lacking. This study provides an overview of the main definitions provided by scientific literature and on this basis, it proposes a parametric definition of *functionally disused areas*. Subsequently, a GIS-based operational tool able to map functionally disused areas through a progressive screening of the local territory is introduced. The proposed methodology is tested on two Italian municipalities. It is the first step of a research aimed at defining a wider process able to assess the possibility of converting disused areas into multifunctional or monofunctional "smart" districts. They could be, indeed, characterized by a mixed use – contributing to soil consumption reduction – or by a single use – "social infrastructures" – linked to the needs that emerged as result of Covid-19 pandemic. This assessment process, hence, could support urban planning both at ordinary and emergency phase, allowing to identify in very short time areas where temporary facilities could be installed.

Keywords
Soil consumption; Sustainable development; Urban regeneration; Disused areas; GIS.

How to cite item in APA format
Francini, M., Margiotta, N., Palermo, A. & Viapiana, M.F. (2020). A GIS-based automated procedure to assess disused areas. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 309-328. http://dx.doi.org/10.6092/1970-9870/7039

1. Introduction

Due to the rapid environmental emergency progress, policy makers have made considerable efforts to agree international climate targets in the last few years (Bauer & Menrad, 2019). One of the most important programmatic initiatives is the Paris Agreement (2015), through which the United Nations agreed to limit global warming below 2 °C compared to pre-industrial levels, to reduce greenhouse gas emissions by 40% by 2030 and to improve energy efficiency, as well as to use 27% of energy from renewable sources (Amanatidis, 2020). In summary, the EU's climate change adaptation strategy aims to make Europe more resilient to climate change by promoting coordinated and shared measures between member States (Zucaro & Morosini, 2018). Globally, cities have emerged as leading climate change adaptation and mitigation actors (Grafakos et al., 2020). Indeed, today about 55% of the world's population lives in urban areas and it is expected that the population rate will increase to 68% by 2050 (ONU, 2018). Due to the high concentration of human activities, contemporary cities are (and will be) highly energy-intensive organisms, responsible for most of the consumption of non-renewable resources (Gargiulo & Russo, 2017). One of these is soil; to protect uncontaminated habitats and ensure sustainability we must ensure that it is used as efficiently as possible (Bartke, 2013). The EU aims to achieve zero soil consumption by 2050, avoiding the new sealing of natural areas (European Commission, 2016). Among the short-term strategies outlined by the member States of the European Commission, the highest potentialities concern the recovery of disused areas, which identify a wide range of urban properties that include areas, individual artifacts or entire compendiums, characterized by different dimensions, intended uses and intensity of degradation (Morano & Tajani, 2018). These are spaces and containers which are no longer used for the activities for which they were originally designed and built; they are in need of urgent intervention plans whose purpose should be the re-definition of spatial, social and economic functions (Krzysztofik et al., 2013). Their regeneration can take very different forms, providing a wide variety of land uses – residential, commercial, productive, open spaces (Loures et al., 2016) – without involving further consumption of greenfields. Disused areas recovery, indeed, can be for hard reuse (buildings and infrastructures), soft reuse (e.g. green space or biomass production), or a combined approach. The soft reuse such as recreation and amenity has become increasingly common due to the demand for the potential environmental, social and economic benefits that it can deliver (Bardos et al., 2015; Li et al., 2019). On the other hand, hard or – better – combined use would contribute to achieve the goals for urban development agreed-upon at the global level: compactness, polycentrism, mixed use, and prioritization of urban renewal (UN General Assembly, 2016).

In addition, the need for additional social urban services emerged as result of Covid 19 pandemic has amplified potential of disused areas, which could be converted into permanent or temporary "social infrastructures".

Regardless of the end-use chosen, therefore, disused areas regeneration entails benefits for both present and future populations.

The district scale of interventions would allow innovative solutions, regarding the saving and the intelligent use of resources, to be tested. The district size, indeed, is intermediate between that of the single building (understood as an autonomous entity) and that of the entire city (of which the district is a subsystem). This territorial level overcomes the individualistic approach of the single building and facilitates the experimentation and optimization of practices that could then be replicated on an urban scale. While the potential offered by the recovery and the conversion of disused spaces are many, there is currently no methodology for the systematic mapping of these areas. They are often erroneously assumed as coincident with the so-called brownfields for which intervention possibilities are often limited by the problems related to their reclamation.

The disused area concept is wider, also including areas that were not previously connected to industrial functions (greyfields).

The aim of this paper, which corresponds to the first phase of our research, is to propose a parametric definition of this type of area, introducing the "disuse function". The theoretical proposal is translated into an

operational tool through the building of an automated GIS-based process, able to perform a first discretization of the territories, identifying potentially disused areas within them. With the goal of developing a census of these areas, the results obtained would constitute a useful starting point for local technicians, who would then just have to conduct a subsequent verification and refinement procedure. The proposed methodology uses only open-source data, and it has been developed in the operational environment of the QGIS desktop application, freely available to any user category. The assessment process, in addition to supporting urban planning at ordinary phase, could be used at emergency phase such as that of Covid 19 pandemic, allowing to identify in very short time areas where temporary facilities could be installed.
Model validity has been tested through two case studies, the municipalities of Rende (Calabria, Southern Italy) and of Voghera (Lombardy, Northern Italy).

2. Background and theoretical model development

2.1 Definition of the research application field

Disused areas constitute a substantial portion of the land area in post-industrial cities (Martinat et al., 2018). The *European Environmental Agency* (EEA) estimates the presence of over three million disused sites in Europe (EC, 2013) and this figure is, however, related only to areas with a previous industrial use (brownfields). The continuous activities of degradation, abandonment and dismantlement require rethinking the city, focusing on renewal, regeneration and recycle (Punziano & Terracciano, 2018). In the last decade, the number of literature studies concerning the effective reuse of disused and underused sites has grown exponentially. These areas, indeed, represent an enormous capital of stored grey energy (Paolella, 2013) and giving priority to their redevelopment can contribute to more sustainable land regeneration and management (Bartke, 2016). Nevertheless, less attention has been paid to the correct way of identifying them. Knowledge about the quantitative and qualitative dimensions of the "disuse phenomenon" are still fragmentary. The few local-scale inventories refer to criteria that are not comparable and they often have little influence on subsequent planning choices and, therefore, on the reduction of land consumption (Filpa et al., 2013).
In addition, despite the universally recognised generic definition of disused area as including all sites that have lost their original functional characteristics, the literature almost always focuses exclusively on the analysis of *vacant lands* with previous productive use. The definitions of British *derelict lands*[1] and of the French *frinche industrielle*[2], as well as that of the most recent *brownfields*[3], all refer to sites whose degrade condition is consequential to the processes of de-industrialization and for which contamination (presumed or confirmed) is the decisive indicator in most European countries (Poland, Belgium – Flanders, Italy, Bulgaria, Spain, etc.). Hence, these expressions exclude from the assessment all the interurban voids consisting of abandoned residential, commercial and tertiary areas, in state of neglect, underused or never completed, resulting from urban processes such as decentralisation linked to demographic change, urban expansion or citizens' preference for new types of residential choices (Johnson et al., 2014). The British *National Planning Policy Framework* refers to these areas with the expression *previously developed lands*, which includes "*lands which are or were occupied by a permanent structure, including the curtilage of the developed lands (although it should not be assumed that the whole of the curtilage should be developed) and any associated fixed surface infrastructure. This excludes: lands that are or were last occupied by agricultural or forestry buildings; lands*

1 The expression *derelict lands* was introduced by the British Department of Environment in 1979 and indicates "degraded areas so damaged by its industrial or other productive uses that it is unsuitable for any use without prior treatment" (DoE, 1979).
2 The expression *frinche industrielle* is used to describe all those spaces, built and not, previously occupied by industrial activities and then abandoned or underused (Iaurif, 1988).
3 The term *brownfield* refers to "sites and immovable property the upgrading and re-use of which may be complicated by the presence of a dangerous substance, pollutant or contaminant" (Davis & Sherman, 2010).

that have been developed for minerals extraction or waste disposal by landfill, where provision for restoration has been made through development management procedures; lands in built-up areas such as residential gardens, parks, recreation grounds and allotments; and lands that were previously developed but where the remains of the permanent structure or fixed surface structure have blended into the landscape" (NPPF, 2019). There are still a small number of studies extending the concept of disused area beyond that of brownfield sites. Indeed, while recent attention has largely focused on contaminated industrial sites, relatively little research or political work has considered the vast potential represented by the different types of *vacant urban lands* present in the most economically depressed urban districts (Goldstein et al., 2001). Few examples can be mentioned in this regard. The CABERNET (*Concerted Action on Brownfields and Economic Regneration*) Network Report (2006) defines different types of *previously developed lands*, according to the current site conditions (Fig.1). Kim et al. (2017) catalogue the vacant urban sites distinguishing between *post-industrial*, *abandoned*, *unattended land with vegetation*, *natural* and *transport related*. Loures & Vaz (2018) classify brownfields into five different types: *abandoned lands*, *contaminated lands*, *derelict lands*, *underutilized lands and vacant lands* (Fig.2). Krzysztofik et al. (2013) define the *functionally derelict areas*, divided into *derelict greenfields*, *greyfields*, *brownfields* and *blackfields*.

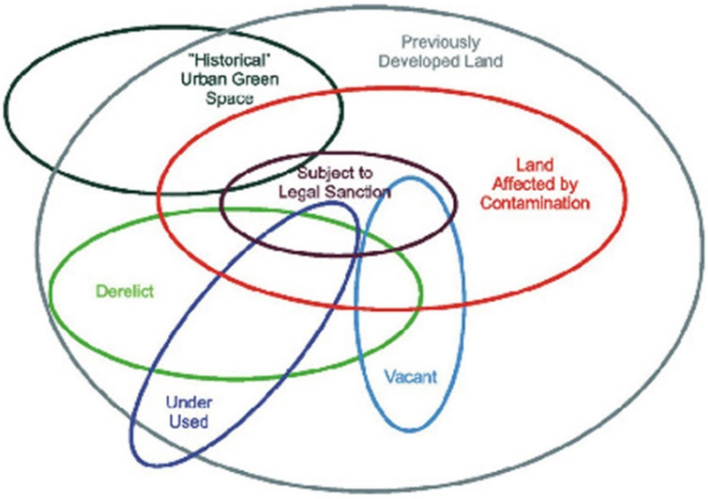

Fig.1 Previously developed lands types

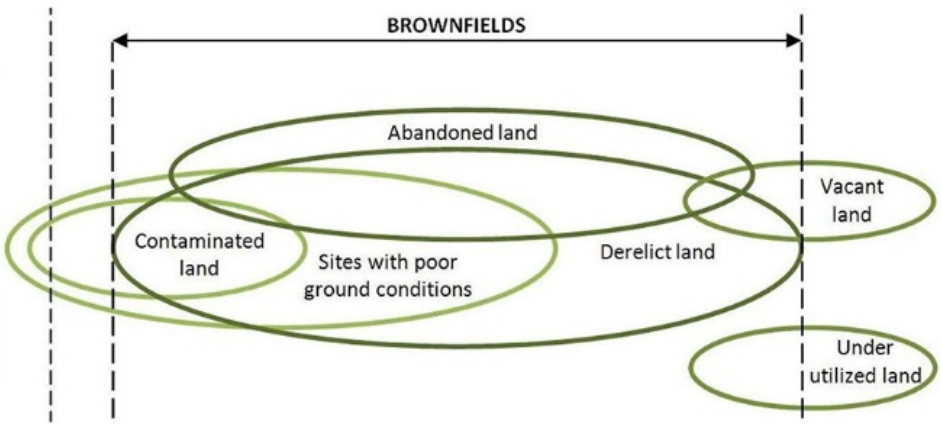

Fig.2 Brownfields types

Referring to the literature review (Tab.1), in the present study it was decided to consider the sites within the greyfields and brownfields categories (grey in the Tab.1) as "disused areas".

Types and references		Greenfields	References	Greenfields	References	Greenfields	References	Greenfields	References
Former use	No one	X	European Commission, 2013; Gallagher et al., 2019; Krzysztofik et al., 2013; Municipality of Rende, 1971; Regione Lombardia, 2014	-	-	-	-	X	Tang et al., 2020
	Farming	X	European Commission, 2013; Krzysztofik et al., 2013; Municipality of Rende, 1971	-	-	-	-	X	European Commission, 2013; Hou et al., 2016; Song et al., 2019; Tang et al., 2020
	Residential	-	-	X	Krzysztofik et al., 2013; NICOLE, 2002; Newton, 2010; Newton, 2011	-	-	X	Tang et al., 2020
	Industrial	-				X	Note 4; European Commission, 2013; Krzysztofik et al., 2013; Loures, 2016; NICOLE, 2002	X	Alker, 2000; European Commission, 2013; Krzysztofik et al., 2013; Munafo & Tombolini, 2014; Salvati et al., 2016; Tang et al., 2020
	Tertiary	-	-	X	Clarinet Project, 2002; Krzysztofik et al., 2013; Sobel et al., 2002	-	-	X	Krzysztofik et al., 2013; Tang et al., 2020
Relevant sealing[5]	No	X	Bartke, 2016; European Commission, 2013; Gallagher, 2019; Li, 2019; Municipality of Rende, 1971; Regione Lombardia, 2014	-	-	-	-	X	Hou et al., 2016; Song et al., 2019, Tang et al., 2020; UN General Assembly, 2016
	Yes	X	Krzysztofik et al., 2013	X	Krzysztofik et al., 2013; Newton, 2010; Sobel, 2002	X	Notes 4; 6; 7; 8; 9; 10; Bauer & Menrad, 2019; European Commission, 2013; Ferber, 2006; Krzysztofik et al., 2013; NICOLE, 2002	X	Alker et al., 2002; Krzysztofik et al., 2013; Munafo & Tombolini, 2014; Salvati et al., 2016; Tang et al., 2020
Contamination (presumed or confirmed)[11]	No	X	European Commission, 2013; Hou et al., 2018; Krzysztofik et al., 2013; Municipality of Rende, 1971; Regione Lombardia, 2014	X	NICOLE, 2002; Newton, 2010; Newton, 2011	X	Notes 6; 7; 10; Coutinho Guimaraes, 2019; European Commission, 2013; Ferber et al., 2006; Krzysztofik et al., 2013; loures et al., 2020; Paolella, 2020	-	-
	Yes	-	-	-	-	X	Notes 4; 8; 9; Bauer & Menrad, 2019; NICOLE, 2002	X	Alker et al., 2002; European Commission, 2013; Hou et al., 2016; Krzysztofik et al., 2013; Loures, 2016; Munafo & Tombolini, 2014; Salvati et al., 2016; Song et al., 2019; Tang et al., 2020; UN General Assembly, 2016

Tab.1 Main characteristics of the different types of disused site according to the literature

Fig.3 summarizes the disused site typologies characteristics and outlines the application field of the present work.

[4] Brownfield definition provided by French Ministry of Environment.

[5] In this study soil sealing resulting from the building of agricultural structures and/or infrastructure is considered as *not relevant*.

[6] Brownfield definition provided by Danish Environmental Protection Agency.

[7] Brownfield definition provided by Direction Generale des Ressources Naturelles et de l'Environment (DGRNE).

[8] Brownfield definition provided by Openbare Afvalstoffenmaatschappij voor het Vlaamse Gewest (OVAM).

[9] Brownfield definition provided by Polish Ministry of Environment.

[10] Brownfield definition provided by Romanian Ministry of Waters and Environment.

[11] With regards to the brownifields sites, the distinction of literature references is made between definitions that indicate contamination – presumed or confirmed – as a necessary characteristic in order to identify a site as brownfield, and definitions for which it is a probable but not a discriminating feature.

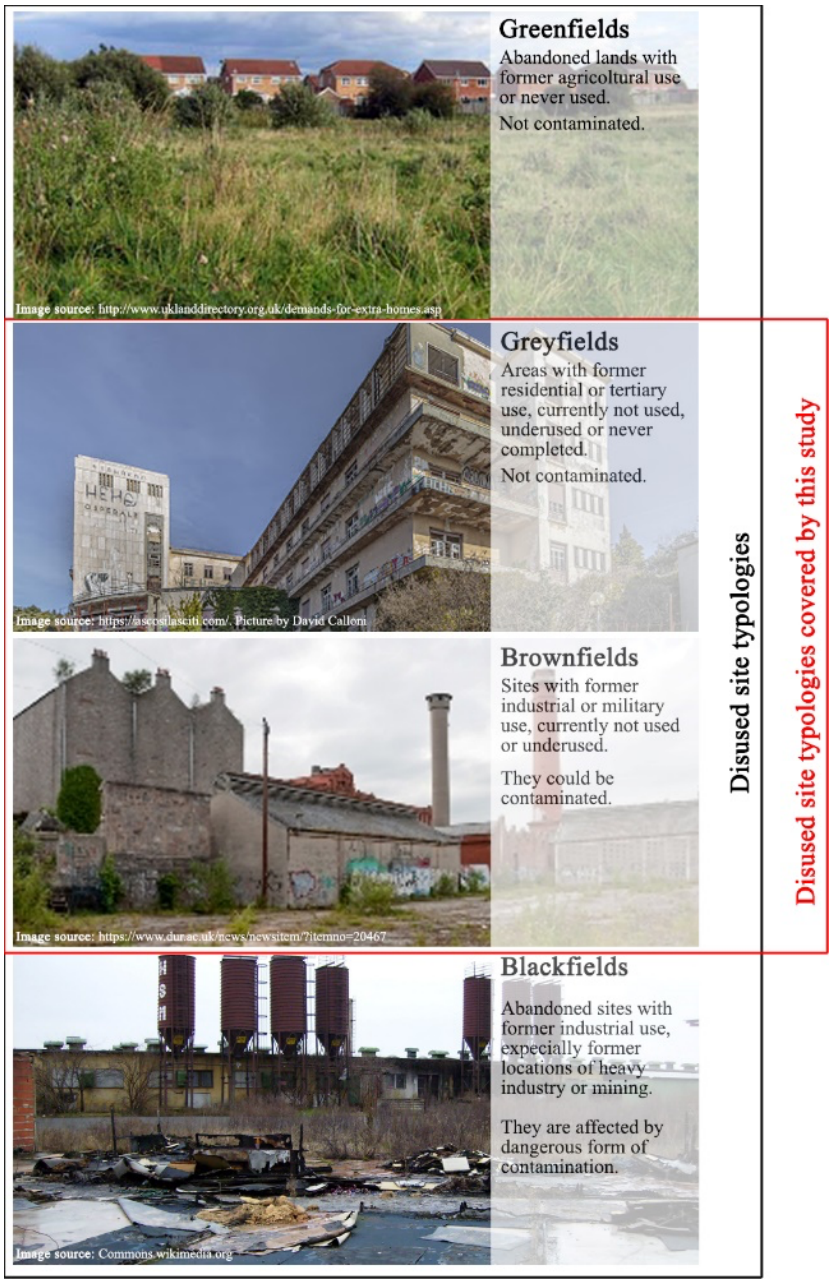

Fig.3 Schematic representation of disused site typologies and research application field identification

2.2 Theoretical model development

After the application field definition, the research focus shifted to determining parameters useful to identify disused areas. Providing objective criteria is necessary not only to avoid misunderstandings, but also to create a common language between the different people involved in regeneration processes (Loures & Vaz, 2018). Regarding the subject of this work, the definition of quantitative metrics is essential for a threefold purpose:

- to facilitate the disused areas census by the technical offices of the different municipalities, providing a unified identification code free from the various local specificities;
- to allow the development of a GIS-based automated process for the detection of potential disused areas;
- to make the results of the two detection methodologies comparable.

The critical literature review has allowed identification of the most influential parameters in the characterization of a disused area and their threshold values (Tab.2).

Parameter	Symbology *(Italian parameters acronyms)*	Description	References	Included in the "functionally disused area" definition	Used for the GIS-based process development
Soil sealing	Ss	Sites with a soil sealing percentage ≥ 30% (discontinuous medium density urban fabric)	European Commission, 2016	-	X
Zoning	Du	Consolidated or consolidation areas for residential, productive or service use. New expansion areas are excluded	Note 12	X	X
Population density	Dp	Census areas with population density ≤ 1,500 ab/m^2 (urban clusters)	Department of the Environment; 1979	-	X
Not used buldings	Ev	Census areas in which the presence of at least one unused building is recorded	Note 13	-	X
Total surface area	S	Disused areas with a total surface ≥ 10,000 m^2 (1 ha)	Grassi, 1989; POST, 1988; Taylor & Lewin, 1966	X	X
Covered surface area	Sc	For industrial areas the covered surface must be ≥ 1,000 m^2; for areas with a different use covered surface must be ≥ 3,000 m^2	European Commission, 2016; POST, 1988; Taylor & Lewin, 1966	X	X
Decommission year	Ad	Areas not used for at least one year with regards to brownfields and for at least three years with regards to greyfields	CzechInvest 2008; Grassi, 1989; Krzysztofik et al., 2013; Loures et al., 2016; POST, 1988	X	-
Buildings rated life (linked to degradation)	Vn	If more accurate information is not available, the potential building degradation is estimated referring to the ordinary structures rated life, which is equal to 50 years[14]. The parameter is not discriminatory	MIT, 2018; Regione Lombardia, 2010	-	X

Tab.2 Key disuse parameters in accord with the definition proposed by authors

It is possible, hence, to define the "disuse phenomenon" as a function of Eq.1:

$$Disuse = f(Ss, Du, Dp, Ev, S, Sc, Ad, Vn) \quad (1)$$

Some parameters have been included in the proposed definition of "functionally disused area" (explained below) reported in the census form sent to the municipal offices. Other ones have been used to develop the GIS-based detection process, allowing a progressive discretization of the analysed territories. The criteria relating to the zoning, the minimum total surface area and the minimum covered surface area have been used in both cases.

The brief definition of functionally disused area proposed in this research work, as result of the analyses and reworkings carried out, is the following:

"*The "functionally disused areas" are sites and building complexes which are no longer used to carry out the activities for which they were designed and built. They are artificially shaped spaces, totally or partially abandoned, already provided with at least primary urbanization works (roads, power grid and sewage, etc.),*

[12] Any disused or underused area definition provided by the literature assumes that this falls into previously developed areas.
[13] Any brownfield and/or greyfield definition provided by the literature assumes that the site is disused or underused, that is at least one of the buildings in the area is not currently in use (or, at most, abusively occupied).
[14] The NTC2018 (Technical Standards for Construction, which are the equivalent of the Eurocode in the Italian national legislation) define the rated life as the number of years in which it is expected that the buildings, subjected to necessary maintenance, maintain specific performance levels. Due to the uncertainty of the parameter in absence of documentation relating to the individual building, it is not considered discriminatory.

but characterized by building, urban and/or socio-economic degradation. The disuse condition must have been for at least one year with regards to brownfields (disused industrial areas) and for at least three years with regards to greyfields (disused residential and/or commercial areas). The total surface area must have a minimum size of 10,000 m² (1 ha); the covered surface area must have a minimum size of 1,000 m² with regards to industrial sites and of 3,000 m² with regards to sites with a different use".

3. Methods

3.1 A GIS-based automated process for the detection of functionally disused areas

The purpose of the development of a GIS-based automated process is to provide a tool to support municipalities during the early stages of the functionally disused areas census and mapping. Briefly, the tool develops a progressive discretization of the territory identifying the areas which, respecting the conditions described in Tab.2, are potential disused sites. A subsequent verification procedure by local authorities is however necessary, due to two main reasons:

- data used in the process are not constantly updated by the relevant sources[15], so any territorial changes may not have been recorded and need to be checked;
- some disuse parameters (e.g. the decommission year) cannot be found from open source data, so it is essential to integrate the data.

3.2 Input data homogenization

QGIS is an open source, cross-platform desktop GIS application written in C++ and Python and used by a wide variety of users (Meyer & Riechert, 2019). The wide range of functionalities that it provides makes it a valid alternative to the most popular commercial GIS software, while maintaining its free character. Linking with this feature, which greatly simplifies its use, we have developed a code that uses exclusively open source and easily available input data. To standardize all the input data, a regular grid of 100x100 meters was used as the only cartographic base. Each cell has an area of 1 ha, that is the defined minimum size for the total surface of a disused area (Tab.2).

QGIS plugins are tools for the execution of all the spatial operations necessary to translate the data from the various relative bases to the regular grid, whose use involves several advantages (Istat, 2018):

- cells have the same size so that they can be easily compared to each other;
- grids are stable over time and the data within them integrate very easily;
- a grid-based system can be subdivided and aggregated regardless of hierarchical subdivisions into administrative units.

The reference system used for the data-processing is that used by Eurostat for the GEOSTAT population grid ((EPSG: 3035) ETRS89/LAEA). This simplifies the use of the proposed tool and the comparison of the results provided by different European countries.

3.3 The workflow in QGIS

As mentioned, the proposed methodology operates a progressive screening of the territory, analysing data on an increasingly smaller scale as the process progresses.

Figure 4 outlines the discretization process workflow. The methods for calculating the parameters and the sources of necessary dataset are provided in Tab.3.

[15] For instance, Istat (the Italian National Institute of Statistics) carries out regular censuses every 10 years.

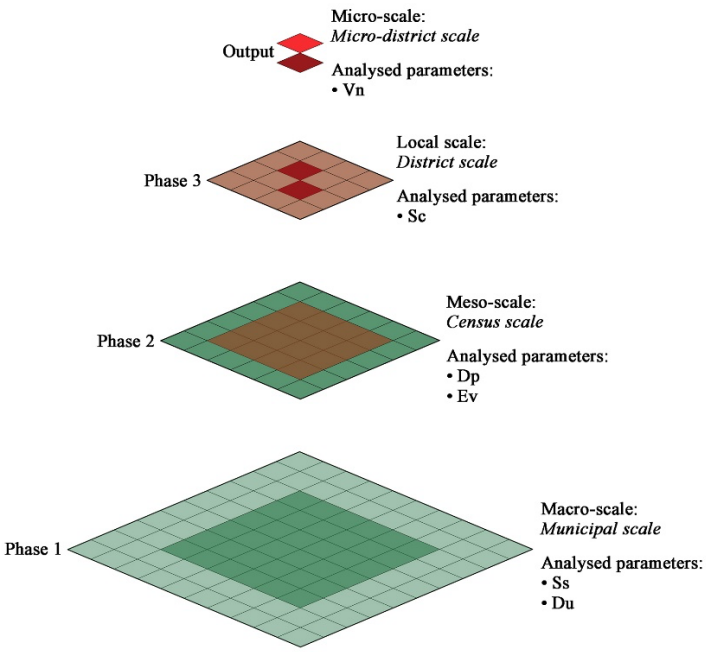

Fig.4 Schematic representation of the workflow in QGIS

Scale of analysis	Parameter	Method for calculating	Source
Macro-scale	Ss	-	Copernicus Degree of Imperviousness HR Layer
	Du	Zonal statistics algorithm	Municipal urban planning reference tool
Meso-scale	Dp	Zonal statistics algorithm	Istat – GEOSTAT population grid
	Ev	Zonal statistics algorithm; calculation code by using "aggregate","sum" and "contains" or "intersects" function	Istat census data; OpenDemanio georeferenced data
Local scale	Sc	Contiguous cells aggregation; calculation code by using "aggregate", "sum" and "intersects" functions	Updated municipal cartography
Micro-scale	Vn	Calculation code by using "aggregate", "sum" and "intersects" functions	Buildings conservation status map / Municipal historical maps
		Zonal statistics algorithm (on not industrial cells aggregations only)	Istat census data (regarding residential buildings)

Tab.3 Methods for calculating parameters used in QGIS process and sources of related dataset

3.3.1 Phase 1: macro-scale analysis

In this study the macro-scale is equivalent to the municipal scale.

The first parameter to be examined is the percentage of soil sealing (Ss) within municipal administrative boundaries. The sealing percentage is indeed indicative of the irreparable degradation of the soil resulting from human activities (Munafo & Tombolini, 2014). For this analysis the *Copernicus Degree of Imperviousness HR Layer* was used, which has been developed by the *European Environmental Agency* (EEA) under the Copernicus project to monitor land cover at the continental level and at a high level of detail (Istat, 2017). The cell layer with a soil sealing percentage of less than 30% are hidden. Following literature studies and a comparison of the Layer with the cartographic results of the European project *Corine Land Cover*, it has been verified that above this threshold the soil can reasonably be considered *artificially shaped*.

Subsequently, the zoning (Du) of the municipal territory is examined. Using the urban planning reference tool, cells totally falling into agricultural or newly expanding areas are hidden.

3.3.2 Phase 2: meso-scale analysis

The reference meso-scale is that of the census areas used for the processing of statistical data.
In this phase data concerning population density (Dp) and the presence of not used buildings (Ev) are analysed. Istat makes the data concerning the population distribution available using the Eurostat grid with cells size of 1 km^2 (GEOSTAT population grid), aligning with the European trend. The non-demographic data, on the other hand, still refer to the census areas[16].
Referring to the procedure used by Istat, the proposed methodology resamples all input datasets on the regular grid with cells size of 100x100 meters, using the QGIS algorithm *Zonal statistics* iteratively. For each cell, the algorithm returns a single output value concerning the Dp parameter and a single output value concerning the Ev parameter. Ev values are increased if one or more not used public real estate are located into the analysed aggregation cells. In Italy, georeferenced data regarding not used public real estate are freely downloadable by the State Property Agency website (OpenDemanio).
These values are compared with the relevant threshold values (Tab.2); cells that do not comply the disuse criteria examined are hidden.

3.3.3 Phase 3: local scale analysis

In phase 3, district scale (local scale) parameters are examined.
Contiguous surviving cells are aggregated using a specific algorithm. The definition of *contiguous cells* refers to that provided by Eurostat for *moderate-density urban clusters* (Eurostat, 2019). For this reason, cells connected only along a diagonal are also aggregated.
The parameter concerning the minimum total surface area (S) is theoretically already verified, because each cell has size equal to 1 ha. This parameter will have to be checked subsequently by municipal technicians, when the real boundaries of the disused areas have been precisely defined (disused areas can be included in the single cells, but not occupy them totally).
The covered surface area (Sc) falling in each aggregation of contiguous cells is determined by the software, setting a special calculation code. It is necessary to provide a polygonal *Shapefile* containing all the buildings falling within the municipal territory, referring to an updated cartography, as input. The value of Sc contained in each cell aggregation is compared with its threshold value, depending on whether the aggregation falls in an industrial area or in an area with a different use (Tab.2). Aggregations in which the Sc value is inferior to the relative threshold value are hidden.

3.3.4 Phase 4: micro-scale analysis

The cell aggregations resulting from the discretization operated in phase 3 constitute the set of potential functionally disused areas within the municipal territory.
A subsequent refinement of the results can be carried out on a micro-district scale (micro-scale), using an algorithm to identify the aggregations in which buildings whose construction period is before 1970 (Vn ≥ 50 years) fall. The necessary input data is the same polygonal *Shapefile* used in phase 3, in which buildings have been classified according to the age of construction. This data can be obtained by comparing the updated cartography with the municipal historical maps. Regarding residential buildings, Istat provides census data concerning with their conservation status and construction period. Since these data refer to dwellings, they are resampled only on the *not industrial* cells aggregations by using the QGIS *Zonal statistics* algorithm.
The Vn parameter is definitely more uncertain than the others for three main reasons:

- historical maps of periods of interest are not always available;

[16] The census areas constitute the minimum survey unit of the municipal territory. A census area is a homogeneous part of the territory in which the environmental and socio-economic characteristics are similar.

- although the building was built before 1970, it may have undergone restoration works which have improved its conservation status;
- buildings built after 1970 could also be in a poor conservation status.

For these reasons the Vn parameter is not considered as discriminatory. The presence of buildings with Vn ≥ 50 years is indicative of a *higher* probability that the area is currently in a disuse condition.

4. Cases studies – methodology test on the municipalities of Rende (Southern Italy) and Voghera (Northern Italy)

The validation process of the proposed methodology provides for the comparison of output data obtained in the GIS environment with the data collected through appropriate census forms send to the staff of local authorities and filled out by them. The general procedure is described in Fig.5.

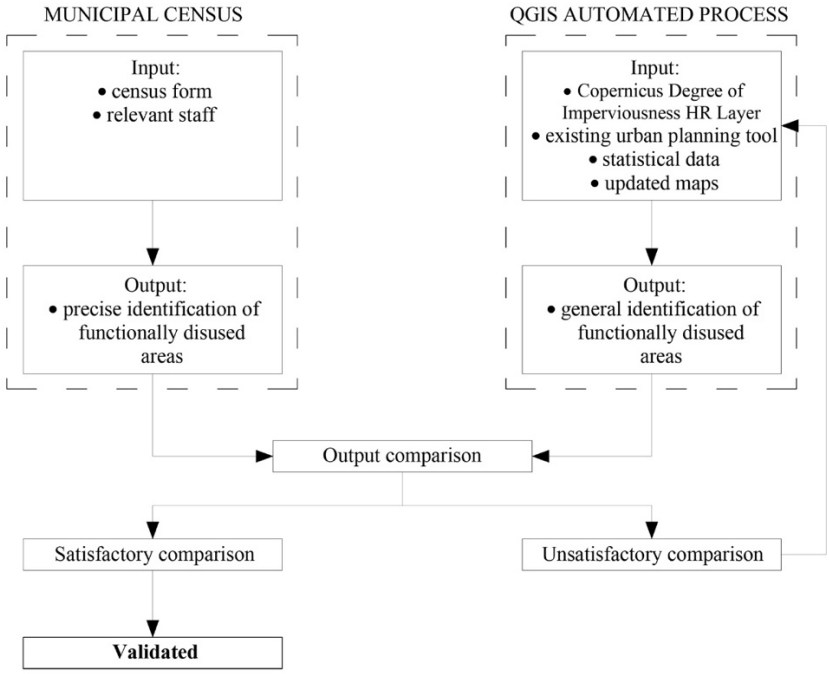

Fig.5 General description of the model validation procedure

Validation has been carried out on two sample municipalities which have been selected according to the criteria that will be described in paragraph 4.1.

4.1 Case studies selection

For the selection of the two municipalities, three criteria were adopted:

1. significance of the comparison;
2. data availability;
3. comparability of the two case studies.

The Italian municipalities of Rende (Calabria, Southern Italy) and Voghera (Lombardy, Northern Italy) (Fig.6) were chosen due to the following reasons:

1. the choice of two case studies, one located in the extreme South and the other in the extreme North of the Italian peninsula makes the comparison particularly relevant, because of the numerous differences and disparities existing between northern and southern Italy[17];

[17] For istance, the strong industrial vocation of Northern Italy, compared with the widespread tendency to abandon small villages or unfinished buildings in Southern Italy, would suggest a preponderance of brownfields in the first case and of greyfields in the second one.

2. in order to validate the methodology results it was necessary to compare them with data obtained by a municipal census. The choice of a Lombard municipality was, in this regard, prompted by the fact that Lombardy is the only Italian region to have carried out a census of the disused areas in its territory[18]. The choice of the municipality of Rende is linked to the authors' possibility to have a direct discussion with municipal technicians;
3. Voghera has been selected among the various Lombard municipalities because: (i) it belongs to the same size class as Rende according to Istat classification[19]; (ii) the municipal censuses have detected a comparable total surface of the functionally disused areas.

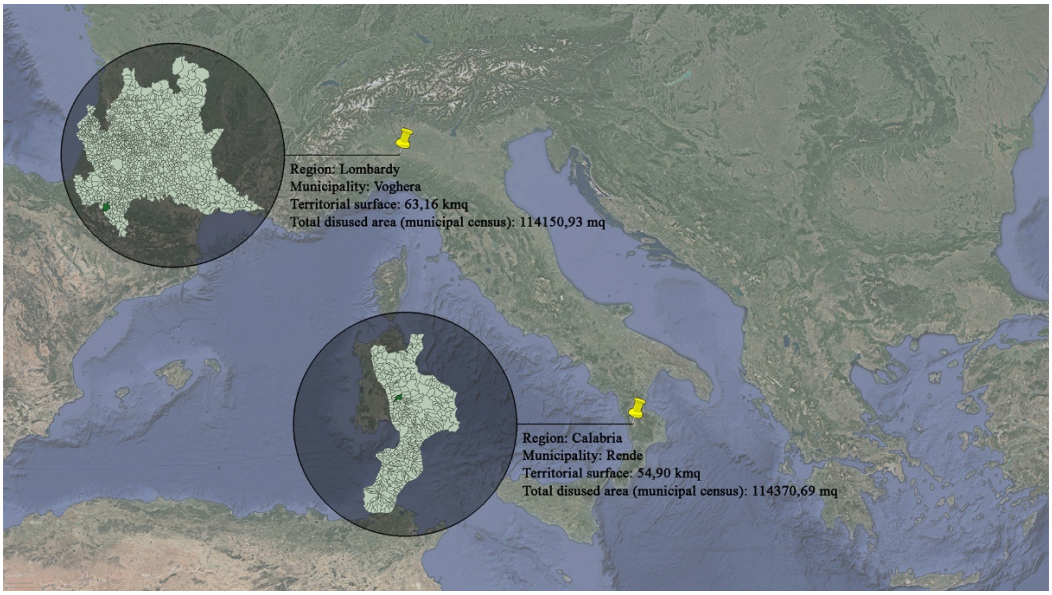

Fig.6 Cases study localization and their main features

4.2 Comparison data retrieval: the municipal census

In order to assess the validity of the experimental results, it is necessary to compare them with those provided by "certified sources". In this study, the output data obtained by the GIS-based automated process are compared with the data acquired following the censuses of functionally disused areas carried out in the two municipalities analysed. Regarding to the municipality of Voghera, the useful information was taken from the website of the Lombardy Region. In Voghera there are nine functionally disused areas, for a total surface area of 114,150.93 m^2. Seven of these sites were characterized by a former industrial use and two of these by a former commercial use.

Regarding the municipality of Rende, the lack of data has been remedied by transmitting the format of a census form of the functionally disused areas to municipal technicians.

The format has been structured by referring to the form that was used by the Lombardy Region and to the indicators proposed by the CABERNET European project for the brownfields classification[20] (CABERNET Network Report, 2006) with particular reference to those relating to the location characteristics (position

[18] The census was carried out between 2008 and 2010. The format of a survey form made by the Region was sent to the various Lombard Provinces, which in turn forwarded the document to all municipalities falling within their jurisdiction. The Lombardy Region makes available the results of the survey on the site: https://www.regione.lombardia.it/wps/portal/istituzionale/HP/DettaglioPubblicazione/servizi-e-informazioni/Enti-e-Operatori/territorio/sistema-informativo-territoriale-sit/aree-dismesse/aree-dismesse.

[19] Istat divides Italian communes into 5 classes, according to their territorial extension. The data from the last census (2011) highlight that communes with a territorial surface between 50 km^2 and 250 km^2 cover more than half of Italian territory (50.7%) (Istat, 2013).

[20] The classification recommended by the European project CABERNET, similar to that used by the United Kingdom National Brownfield Regeneration Strategy, divides brownfields into three categories A-B-C according to their development potential (Doleïelová et al, 2014). Some of the indicators proposed by the CABERNET project have been included in the census form because they will be useful in the second phase of research (under development).

relative to the city center, distance from the highway) and the potential for redevelopment (properties, risk of contamination).

The format is organized as following:

- *Functionally disused area* definition (according to authors)
- *Section 1: area description*
  - location (address)
  - disuse characteristics of the area
  - urban and disuse parameters
- *Section 2: physical feauteres*
  - building typological features
  - building conservation status
- *Section 3: location characteristics*
  - position and accesibility
  - area connectivity
- *Section 4: regeneration potential*
  - urban data
  - cadastral data
  - restrictions

The census forms completed by the municipal technicians initially highlighted the presence of eight functionally disused areas in the territory of Rende.

From the forms received, the territory of Rende was initially found to present eight functionally abandoned areas. Following verification, it was noted that of these areas: (i) one is currently used; (ii) one does not meet the minimum total surface area requirement (S); (iii) two do not meet the minimum covered surface area requirement (Sc); (iv) the remaining four can be classified as functionally disused areas, for a total surface area of 114,370.69 m^2.

Fig. 7 summarizes the relevant data of phase 4.

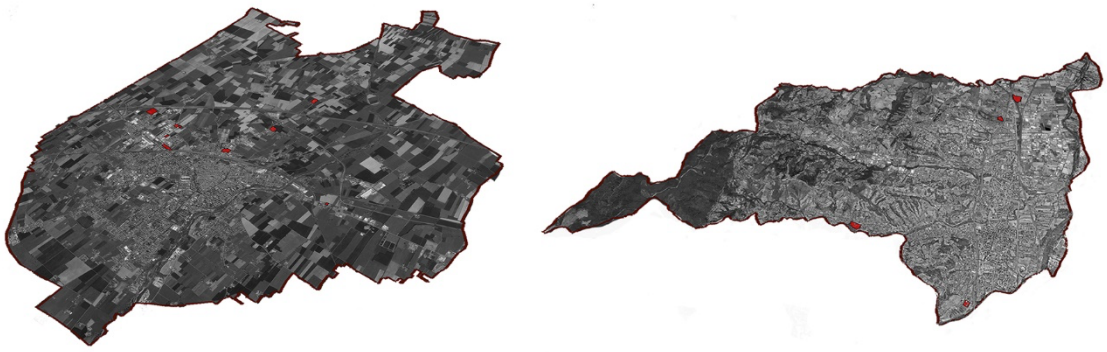

Fig.7 Functionally disused areas location, resulting from the census carried out in the municipalities of Voghera (left) and Rende (right)

4.3 GIS-based automated process results

The proposed methodology was applied on the two sample municipalities. The data collection was a rather simple operation because all data are open source and easily available. The acquisition of Voghera historical maps, necessary for the Vn parameter determination, was the only difficulty encountered. However, it has not been a problem because the Vn parameter is not discriminatory. The figures below illustrate the different GIS-based process phases carried out on the municipality of Voghera (Fig.8) and on the municipality of Rende (Fig.9).

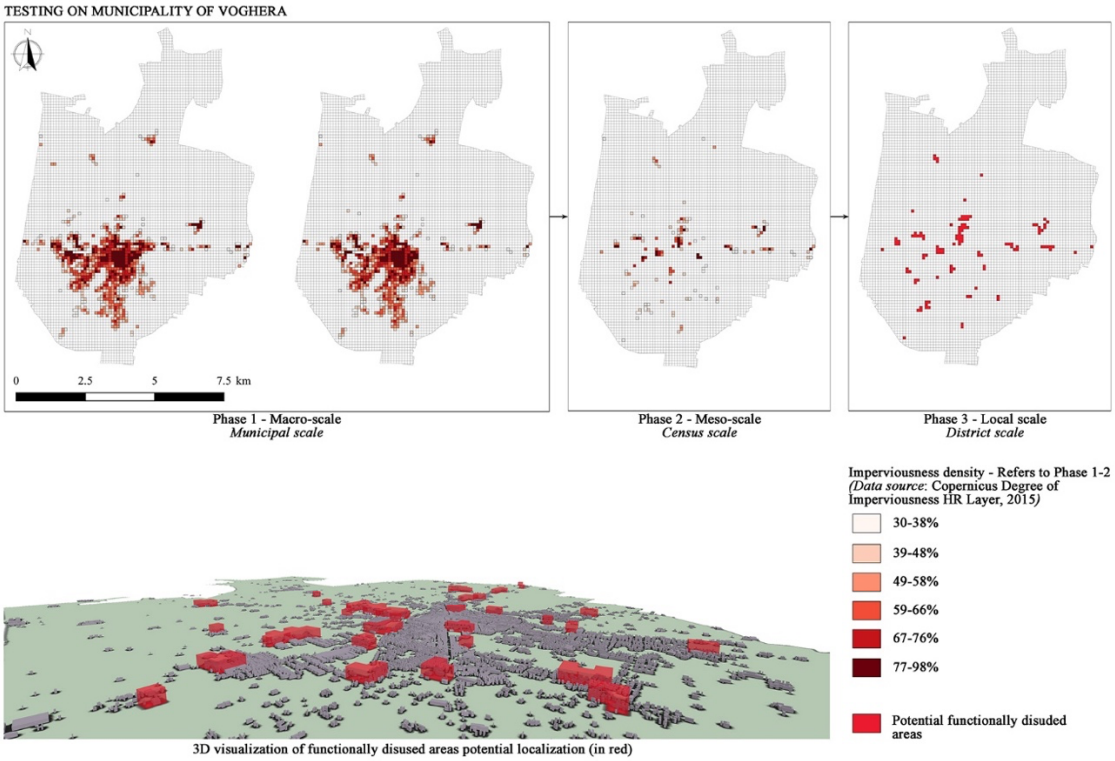

Fig.8 Results in GIS environment regarding the municipality of Voghera

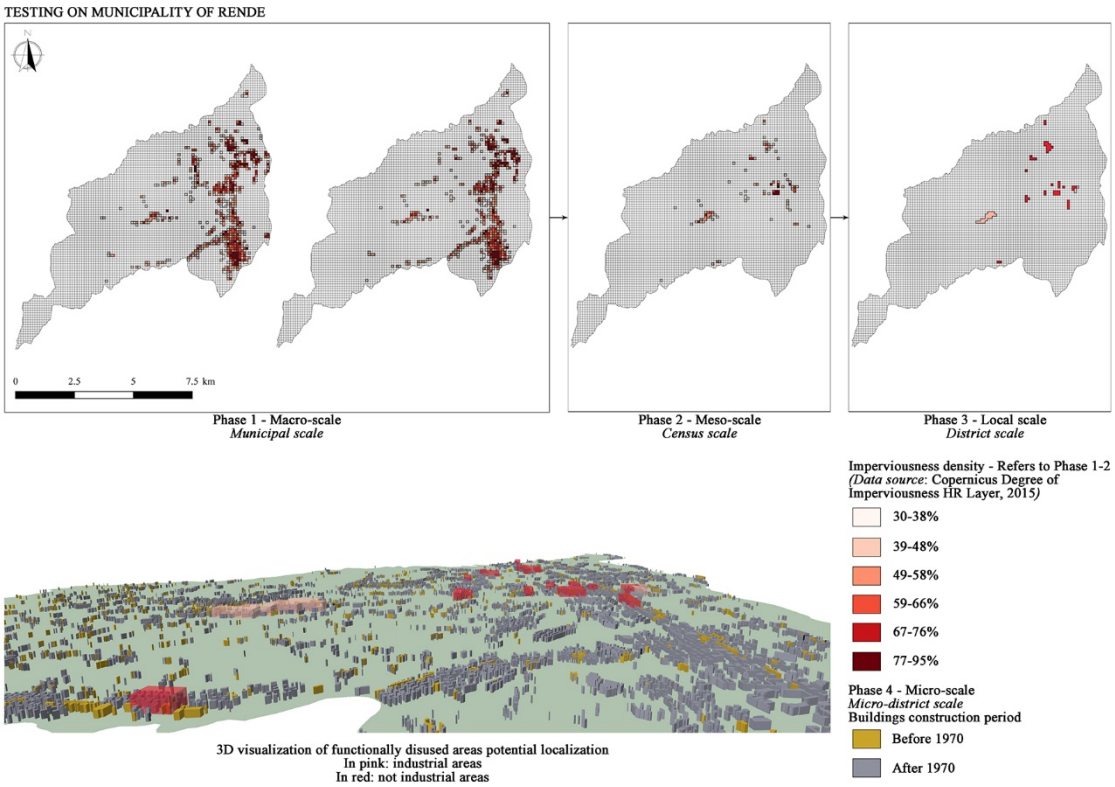

Fig.9 Results in GIS environment regarding the municipality of Rende

4.4 Discussion of the results

The comparison between data obtained from the local census and results obtained from the proposed methodology shows satisfactory similarities in both case studies.

The resulting remarks are similar for the two municipalities.

It is interesting to note firstly that the GIS-based process identifies a total surface of potential functionally disused areas greater than that indicated by local authorities. This aspect reflects expectations, because the aim of the tool is to provide a general localization of the areas, which local technicians have to "refine" using their in-depth knowledge of the territory. Moreover, this result underlines the usefulness of the methodology from two point of view. On one hand, with regards to the municipality of Voghera – in which QGIS process results were compared to disused areas regional census results – it should be considered that traditional local census are complex proceedings that involves various professionals and therefore need rather long technical time to be completed. Consequently, results are not constantly updated, and they often no longer reflect current situation. On the other hand, with regards to the municipality of Rende – in which QGIS process results were compared to data obtained by the filled-out census forms – the result confirmed that often local technicians do not have complete knowledge concerning with disused real estate existing in the municipal territory. An anomaly is recorded in the case study of Voghera: three of the nine areas indicated by the municipality are not detected by the GIS-based process. However, this mismatch is due to a forcing present in the census form, because despite the regional format requiring exclusive consideration of sites in which the covered surface area is greater than the explicit thresholds[21], this parameter is not respected in the three areas concerned[22].

It is necessary to audit the cell aggregations that do not cover the areas indicated by the municipalities. This operation has been performed through in situ surveys in the Municipality of Rende and by visual analysis through the Google Earth software regarding the municipality of Voghera.

Tab. 4 summarizes the results.

	Nr. of detected areas	**Nr. of disused or underused areas[23]**		**Nr. of areas devoid of current or prior disuse features**	**Nr. of areas regarding which no useful data are available (no data)**
		Industrial	**Not industrial**		
Voghera	33	15	10	3	5
Rende	14	4	7	2	1
Total	47	36		5	6
Percentages	100%	76.60%		10.64%	12.76%

Tab.4 GIS-based process results regarding the two case studies

5. Conclusions and future developments

In the context of sustainable densification of European cities, the regeneration of disused urban areas offers an important potential of surfaces to be recaptured (Laprise et al., 2015). The knowledge gap related to the nature and scale of the disused areas in Europe is the cause of the main problems related to the recovery of these sites. This lack is a significant aspect, as knowledge is essential for any regenerative policy (CABERNET Network Report, 2006). Most of the current research focuses on the evaluation and definition of the intervention methods to be implemented in disused areas; a much smaller number of studies investigate how to identify these areas.

21 The Lombardy Region under the census carried out between 2008 and 2010 asked the various municipalities to identify disused areas in which the covered area was greater than 2000 m^2 with regards to industrial areas, and greater than 5000 m^2 with regards to areas with different uses (note that threshold values are more restrictive than those imposed by the GIS-based process).

22 In the census forms, indeed, reference is made to the paved surface area instead of the covered surface area.

23 The column refers both to areas currently affected by disuse or underuse phenomena and to areas that have been affected by these phenomena in the past and have undergone redevelopment (reuse of existing buildings, new construction, etc.) at a later date than the reference data collection period.

The research proposes a general definition of functionally disused areas, resulting from a critical review of the existing literature and based on objective parameters. The main aim is to expand the concept and not to make it coincide (as often happens) with that of brownfields, also including all those sites with a different use than the industrial one that are currently in state of abandonment or underuse in the definition.
The proposed definition is used to develop the described operational methodology. The second aim of the research is indeed to provide an operational tool developed in GIS environment able to support planners during the identification phase of disused areas located in the municipal territory.
Even though verification by competent professionals is necessary, the tool offers them a valuable help by operating a substantial screening of the territory that allows a much more immediate identification of sites potentially affected by disuse phenomena.
The application of the methodological approach on the municipalities of Voghera and of Rende has shown positive results, which can be summarized as follow:

- over 75% of the cell aggregations detected by the GIS-based process actually contain areas that are (or were, at the time of the reference data collection) in disuse conditions. This shows that the methodology allows the data obtained through local census not only to be verified but also to be increased. The proposed automated procedure provides results much faster than standard census, and this allows to update information more frequently. In this way, even the most recently disused areas are detected by the procedure. In addition, particularly interesting is the case of Rende, in whose territory the GIS-based process has allowed the identification of a functionally disused area that had not been reported in the filled-out census forms. This area has larger surface than all the others and enjoys a favourable position, because it is located only a few minutes from the city centre and close to one of the main roads. As mentioned in the previous paragraph, this result underlines methodology usefulness. Through the QGIS process, indeed, a strategic disused site that had not been mentioned by local technicians has been detected;
- almost all the areas indicated by the two censuses are correctly identified by the GIS-based process. The only exceptions are due to the non-updating of data concerning the number of not used buildings (Ev parameter);
- the percentage of areas devoid of current or prior disuse features, which is of just over 10%, is due to the particular conditions of the incorrectly detected sites (for instance, a museum/school complex in the municipality of Voghera which, while respecting all the required parameters, cannot be considered a disused area).

In conclusion, it can be said that the proposed methodology provides results that are useful for the rapid identification of potential functionally disused areas.
This study contributes to the scientific discussion on the definition and identification of disused areas and aims to open new perspectives to be investigated to transform these sites into "smart" urban districts. Pursuing this goal, next research phases will be concerned with identification of indicators useful to assess the "quality" of the detected sites (in order to determine the intervention priority) and with analysis and definition of urban parameters that allow optimization of the energy efficiency of districts to be built in disused areas. These sites could be transformed into mixed-use districts – contributing to the soil consumption reduction – or into mono-use districts where specific "social infrastructures" could be realized, contributing to the urban density reduction. Recent Covid-19 crisis, indeed, questioned the dense urban model and underlined the dematerialization of services happened in the last years (Angiello, 2020), which involved misuse of collective spaces and, therefore, the dissatisfaction of city users needs (Esopi, 2018). The identification of these urban fragilities could represent a new first step in order to develop and to propose methodological and operative innovations for the planning and the management of the urban transformations (Papa, 2018). Research aim,

hence, is to help in the realization of smart, sustainable, and resilient districts, with special attention also to the energy saving issues.

Exploiting the many environmental, social and economic benefits that the recovery of these areas may entail is both our right and a moral duty to our planet.

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Fig.3: Authors;

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TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 329-351
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/7143
Received 2nd September 2020, Accepted 7th November 2020, Available online 31st December 2020

www.tema.unina.it

Land surface temperature and land cover dynamics. A study related to Sardinia, Italy

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Abstract
This study aims at analyzing analogies and differences between the spatial relations regarding land surface temperature (LST) and land covers in May and August 2019. Land cover data are drawn from the most updated spatial datasets available from Copernicus, while LST is retrieved from Landsat 8 satellite images made available by the U.S. Geological Survey. The methodology couples GIS spatial analysis and regression analysis; the latter is used to implement spatial inferential analysis as regards LST. Moreover, on the basis of a "what if" assessment, the impact of future afforestation, as regards rural areas, is detected with respect to decrease in LST, building on the outcomes of the model which relates LST to land cover types. The Sardinian region is taken as case study because its climate homogeneity and its self-containment allow for a pretty straightforward identification of the regional boundaries. The correlation between the spatial distribution of LST and land cover reveals, in the two time periods, that urbanization and the spatial dynamics of heating phenomena are closely connected. The methodology can be easily implemented in other regional contexts, and comparison of analogies and differences are quite effective and useful in identifying stylized facts and policy implications.

Keywords
Land surface temperature; Land cover; Regulating ecosystem services.

How to cite item in APA format
Lai, S., Leone, F., & Zoppi, C. (2020). Land Surface Temperature and land cover dynamics. A study related to Sardinia, Italy. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 329-351. http://dx.doi.org/10.6092/1970-9870/7143

1. Introduction

In the last decades, land cover transformations and transitions have been characterized by significant changes (Chadchan & Shankar, 2009; Nguyen et al., 2019) related to fast urbanization and progressive anthropization. Natural and semi-natural areas, such as forests and woodlands and shrubs, have changed into anthropized areas, which include not only urban areas, but also agricultural areas (Kim & Baik, 2005; Cui & Shi, 2012). According to the 2020 report on land take issued by the System for environmental protection of the Italian government, from 2018 to 2019 artificial areas increased by 57.5 square kilometers, which corresponds to a 16 hectares per day increasing trend (Munafò, 2020). Land-taking processes in coastal areas, plains and valley floors, and agricultural areas adjacent to urban zones show the most outstanding figures (Munafò, 2020). Moreover, the report highlights the tendency to convert natural zones into artificial areas within urban settlements (Munafò, 2020). The main problems connected to land-taking processes are identified by landscape fragmentation, urban heat island (UHT) and loss of ecosystem services. In terms of fragmentation, in 2019 around 35% of the Italian territory is classified as highly or very highly fragmented, whereas in relation to temperatures the difference between urban and suburban areas and rural zones is about 3.1°C in the Metropolitan City of Cagliari and 6.3°C in the Metropolitan City of Turin (Munafò, 2020). Moreover, according to the same source (Munafò, 2020), from 2012 to 2019 the national gross domestic product decreased by 69,956,781 Euros due to land-taking processes concerning agricultural land, which determined a huge loss in agricultural production, or, in the supply of an important provisioning ecosystem service (Millennium Ecosystem Assessment, 2003).

According to a number of studies (Weng et al., 2004; Feizizadeh et al., 2013; Pal & Ziaul, 2017) land cover changes influence the surface temperature due to the different heat capacity of soils associated to a given amount of solar radiation (Fonseka et al., 2019). From this perspective, the variation in land surface temperature (LST) represents a key variable to analyze the effects of land covers on local temperatures (Akinyemi et al., 2019; Zhang & Sun, 2019; Al Kafy et al., 2020).

According to Hulley et al. (2019), *Land Surface Temperature (LST) is a fundamental aspect of climate and biology, affecting organisms and ecosystems from local to global scales. LST measures the emission of thermal radiance from the land surface where the incoming solar energy interacts with and heats the ground, or the surface of the canopy in vegetated areas*. Moreover, according to the NASA Earth Observatory, LST is *how hot the 'surface' of the Earth would feel to the touch in a particular location. From a satellite's point of view, the "surface" is whatever it sees when it looks through the atmosphere to the ground. It could be snow and ice, the grass on a lawn, the roof of a building, or the leaves in the canopy of a forest. Thus, land surface temperature is not the same as the air temperature* [1]". From this point of view, the interaction between the spatial distribution of LST and land cover changes is an important parameter to assess the effects of land-taking processes on climate change (Alfraihat et al., 2016; Li et al., 2016). Al Kafy et al. (2020) analyze land cover changes and their influence on LST in relation to three years, 1999, 2009, and 2019, by means of Landsat TM/OLI satellite images in the area of Rajshahi City Corporation, Bangladesh. Gohain et al. (2020) investigate the relation between LST variation and land cover changes between 1990 and 2019 through remote sensing and GIS techniques in Pune city, India. Tran et al. (2017) study the impacts of land cover types on LST variation in the urban area of Hanoi through a methodology based on three phases: in the first phase, the authors investigate the relations between LST and vegetation, human induced features and agricultural areas by calculating normalized vegetation and built-up indices for each land cover class; next, the relations between land cover changes and urban heat islands are investigated by implementing hot spot analysis and urban landscape analysis; finally, a non-metric regression model is used to assess future urban climate scenarios. Akinyemi et al. (2019) focus on the relations between LST and vegetation changes between 2000

[1] This definition is available on the NASA Earth Observatory's website: https://earthobservatory.nasa.gov/global-maps/MOD_LSTAD_M (accessed on 31 August 2020).

and 2018 in the semi-arid areas of Caborone, Botswana's Capital city, through MODIS daytime and night-time LST, and Normalized Difference Vegetation Index (NDVI).

The impacts of land cover changes on LST were analyzed in some studies focusing on Italian cases, mostly focusing on urban areas. In particular, Zullo at al. (2019) analyze the impacts of urbanized areas on LST in relation to the Po Valley with reference to the 2001-2011 time period. Guha et al. (2018) focus on Florence and Naples by investigating the relations between LST, NDVI, and normalized difference built-up index (NDBI). Scarano & Sobrino (2015) assess the impacts of landscape composition and urban morphology on LST in Bari. Moreover, Stroppiana et al. (2014) study the relations between LST, land cover changes, topography and solar radiation in four Italian contexts related to the Basilicata, Campania, Molise, and Apulia regions.

Moreover, it has to be highlighted that the Sardinian Regional Administration has recently approved the Regional Strategy for the adaptation to climate changes, which assumes heat islands and waves among the most relevant impacts generated by high temperatures. Adaptation and mitigation policies should address heat islands and waves in order to enhance the liveability of natural and urbanized environments, and eventually local societies' quality of life (Regione Autonoma della Sardegna, 2019a). The Regional Strategy identifies several categories of extreme events as direct or indirect impacts of climate changes, such as sudden and disrupting floods, extended fires, droughts, heavy rains and, indeed, heat waves and heat islands in urban environments (Regione Autonoma della Sardegna, 2019b). From this standpoint, a clear-cut research gap in the Regional Strategy is represented by the lack of identified relations between the impacts of climate changes and spatial, social and economic covariates.

This study aims at filling a part of the gap by analyzing the connections between LST spatial distribution and land cover types and changes, and by doing so, at identifying narratives to explain heat waves and islands (Echevarria Icaza et al., 2016). The literature identifies two outstanding aspects to be further analyzed as regards the relations between LST and land cover changes. First, the regional dimension is under-researched and needs to be appropriately addressed (Ding & Shi, 2013). Secondly, spatial strategies grounded upon empirical evidence should be identified and recommended so as to be included in regional and local planning policies in order to decrease LST (Shirgir et al., 2019).

Under this perspective, the methodological approach proposed in this study aims at investigating the impacts of land cover changes on LST by combining GIS-based analysis with regression analysis, and at suggesting strategies and policies in order to decrease LST. The methodology is implemented in the regional context of Sardinia, Italy. In particular, this study investigates if, and to what extent, land cover transitions influence LST, on the basis of data related to the spring and summer periods.

The study is structured into five sections as follows. The second section provides a description of the study area, defines data and discusses the methodological approach used to assess the impacts of land cover changes on LST. The third section reports the results derived from the implementation of the methodological approach as regards the Sardinian region. The fourth section discusses the implications of the outcomes by comparison with analogous studies. Finally, the fifth section discusses the implications of the study in terms of strategies and policies to decrease LST and directions for future research.

2. Materials and Methods

2.1 Study area

Located in the western Mediterranean area (Fig.1), Sardinia is an Italian autonomous region with a size of around 24,000 km^2 and a population of 1,639,591 inhabitants[2].

[2] 2018 data, retrieved from SardegnaStatistiche—Popolazione e Famiglie—Popolazione (2007–2019). Available online: http://www.sardegnastatistiche.it/documenti/12_103_20191028124604.ods (accessed on 31 August 2020).

Sardinia was chosen as case study for this research because of its being an island, which makes it easier to explore environmental issues at the regional scale. Moreover, as far as the climate is concerned, the island shows great homogeneity: it has Mediterranean hot and dry summers, while in winter the temperature is mild and moderate rain occur (Canu et al., 2015). Sardinian landscapes are mostly hilly and wild; the island hosts only a few plains (the bigger of which is the Campidano plain, the light grey diagonal clearly visible in Fig.1, which stretches from the central-western part of the island to the south) that are significant for their agricultural uses; a number of small coastal valleys are also present, and their primary production potential is undermined by the pressure of coastal urbanization. Only some major groups of mountains, always lower than 2,000 m, mark the rugged landscape of the island (Pungetti et al., 2008).

As for land covers, the most significant traits of the island are its herbaceous vegetation associations, many of which endemic, and its scrubs: Mediterranean maquis and garrigue (Cardil et al., 2014). Agriculture and pastures, also comprising wooded grassland similar to Spanish *dehesas* (Seddaiu et al., 2013), i.e. multifunctional agro-sylvo-pastoral systems consisting of pastures with oaks and cork oaks, are also significant (Canu et al., 2015), while urbanized areas make up less than 3.8% of the region, which is a very low figure, if compared to the Italian average, recently assessed at 7.6% (Munafò, 2019).

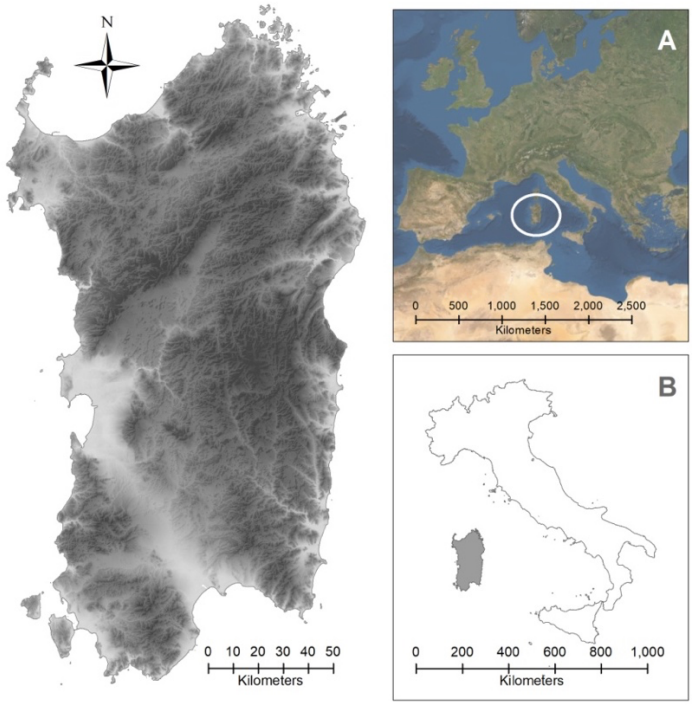

Fig.1 Topographic map of Sardinia and its location within Europe (A) and Italy (B)

2.2 Data

A number of satellite data are currently freely available; the most prominent are those distributed by the European Union's Earth Copernicus Observation Program[3] and by the USGS's Earth Resources Observation and Science[4]. The latter distributes, among many, Landsat 8 TIRS (Thermal Infrared Sensor) and OLI (Operational Land Imager) images, which were used in this study. Two searches were performed; the first concerns the mid-summer season (15 July - 30 August 2019), in which temperature peak in Sardinia, while the second concerns the mid-spring season (15 April - 31 May 2019), in which vegetation growth is at its highest, before the dry season and the annual crop harvesting. For each time period, five images were

[3] Copernicus. Europe's Eyes on Earth. Available online: https://www.copernicus.eu/en (accessed on 31 August 2020).

[4] USGS. Science for a Changing World—EarthExplorer. Available online: https://earthexplorer.usgs.gov/ accessed on 31 August 2020).

retrieved, two belonging to Landsat scene 192 (on May 16 for the spring search and August 20 for the summer search) and three to Landsat scene 193 (on May 23 for the spring search and August 11 for the summer search). Details for each image are provided in Tab.1, while Fig.2 provides the spatial layout of scenes 192 and 193, shown as dotted rectangles, and the images' footprints, shown as colorful squares inside the scenes.
Land cover data in Europe are usually classed in a hierarchical structure, in accordance with the European program CORINE (COoRdination of INformation on the Environment) (Kosztra et al., 2019). The Land Monitoring Service of the European Union's Copernicus Earth Observation Program (CLC, 2018) makes freely available both raster and vector land cover datasets obtained through satellite image interpretation; such datasets have a minimum mapping unit (MMU) of 25 hectares and describe land covers at the third-level of the CORINE hierarchical taxonomy. As for temporal resolution, datasets are available for the years 1990, 2000, 2006, 2012, and 2018; for this study, the latter, and most recent, dataset was used.
The third input data for this study is a regional Digital Terrain Model (DTM) produced by the Regional Administration of Sardinia in 2011, freely available from its geoportal[5], and having a spatial resolution of 10 meters.

Image code	Scene	Cell size	Date	Season
LC08_L1TP_192032_20190516_20190521_01_T2	192	30 m	May 16, 2019	
LC08_L1TP_192033_20190516_20190521_01_T1	192	30 m	May 16, 2019	
LC08_L1TP_193031_20190523_20190604_01_T2	193	30 m	May 23, 2019	Spring
LC08_L1TP_193032_20190523_20190604_01_T1	193	30 m	May 23, 2019	
LC08_L1TP_193033_20190523_20190604_01_T1	193	30 m	May 23, 2019	
LC08_L1TP_193031_20190811_20190820_01_T1	193	30 m	August 11, 2019	
LC08_L1TP_193032_20190811_20190820_01_T1	193	30 m	August 11, 2019	
LC08_L1TP_193033_20190811_20190820_01_T1	193	30 m	August 11, 2019	Summer
LC08_L1TP_192032_20190820_20190903_01_T1	192	30 m	August 20, 2019	
LC08_L1TP_192033_20190820_20190903_01_T1	192	30 m	August 20, 2019	

Tab.1 Selected Landsat 8 images

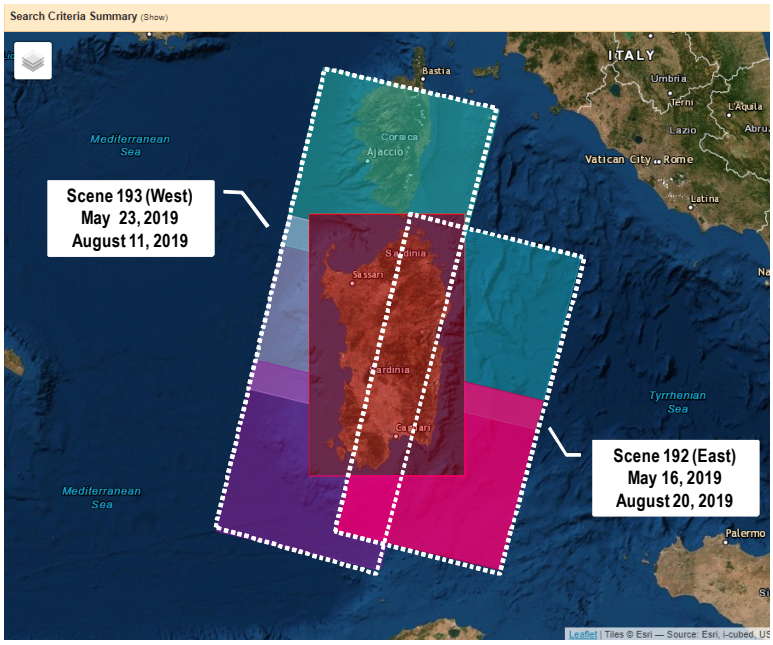

Fig.2 Spatial layout of the ten Landsat 8 OLI-TIRS images selected for this study

[5] DTM passo 10 metri [DTM Sampling Rate 10]. Available online: http://webgis2.regione.sardegna.it/catalogodati/card.jsp?uuid=R_SARDEG:JDCBN (accessed on 31 August 2020).

2.3 Methodological framework

The methodology implemented in this study is based on two steps, as follows. The LST spatial taxonomy is derived through the procedure described in subsection LST Extraction and Spatial Layout; data related to elevation and land covers are next processed (subsection Land Cover Types and Elevation) in order to set up a spatial database that integrates the three items (subsubsection Land Cover Types and Elevation). Finally, a linear regression model is implemented to identify the relations between LST and land cover types (subsection Linear regression model), on the basis of the spatial database described in subsection Land Cover Types and Elevation. A graphical summary of the methodology adopted in this study is provided in Fig.3. The outcomes of the regression model implemented with reference to summer 2019 are then compared with the results of an analogous model concerning spring time 2019, in order to identify seasonal analogies and differences related to the impacts of different land covers on LST.

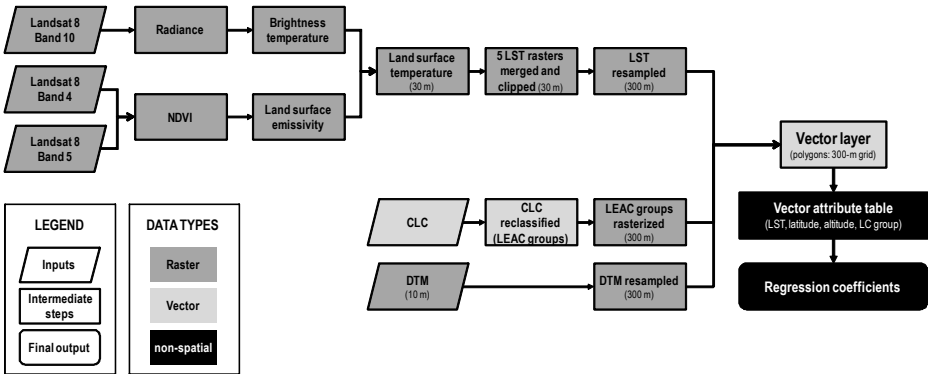

Fig.3 Overview of the methodology

LST Extraction and Spatial Layout

The ten images listed in Tab. 1 were separately processed through Ndossi and Avdan's QGIS plugin (Ndossi & Avdan, 2016), which has been used in a number of studies (for instance, Alves, 2016; Barbierato et al., 2019; Dhar et al., 2019; Lai et al., 2020) to retrieve LST from Landsat satellite images. This retrieval process comprises five steps, of which the first is the calculation of the top-of-atmosphere spectral radiance (ToA) for each pixel, based on pixel values of Landsat 8 band 10 as per equation (1):

$$ToA = (M \cdot Q) + A \tag{1}$$

where[6] M and A are two rescaling factors (respectively, multiplicative and additive) provided in the image's metadata, and Q is band 10 pixel value quantized and calibrated.
Next, the top-of-atmosphere brightness temperature (BT, measured in Kelvin) is calculated through equation (2):

$$BT = \frac{C_2}{\ln\left(\frac{C_1}{ToA} + 1\right)} \tag{2}$$

where[5] C1 and C2 are two thermal conversion constants that can be retrieved from the image's metadata.
Subsequently, the plugin calculates the normalized difference vegetation index (NDVI) based on Landsat 8's bands 4 and 5 pixel values following equation (3) (Townshend et al., 1985):

[6] Using the USGS Landsat Level-1 Data Product. Available online: https://www.usgs.gov/land-resources/nli/landsat/using-usgs-landsat-level-1-data-product (accessed on 31 August 2020).

$$NDVI = \frac{N - R}{N + R} \quad (3)$$

where N is the near-infrared band and R is the visible red band, i.e., for Landsat 8 images, band 5 and band 4 respectively.

In the final two steps, where Land Surface Emissivity (LSE) and LST are calculated, the user can choose among various available algorithms. In this study, for LSE the algorithm by Zhang et al.'s (2006), which assesses LSE based on NDVI values, was chosen since it has been considered as the most reliable one (Ndossi & Avdan, 2016), while for LST the Planck function was used, because it does not require atmospheric variables and is therefore regarded as easier to use (Ndossi & Avdan, 2016). The Plank function is provided in equation (4):

$$LST = \frac{BT}{1 + \left(\lambda \cdot \frac{\mathrm{BT}}{\alpha}\right) \cdot \ln(\mathrm{LSE})} \quad (4)$$

where λ is the wavelength of the emitted radiance (equaling 1.0895·10-5 m for Landsat 8 TIRS (Zhao et al., 2018), and α = h·c/σ (where h is Planck's constant; c is the velocity of light; σ is Boltzmann's constant), equaling 1.438·10-2 mK (Avdan & Jovanovska, 2016). LST and BT are both measured in Kelvin.

By implementing the steps in the plugin, ten LST raster maps were retrieved. Each of these maps, having cell size 30 meters, corresponds to one Landsat image listed in Tab. 1. The five spring images were next merged, as well as the five summer images; in this way, two LST regional maps were obtained, one for the time period 16-23 May, 2019 and one for the time period 11-20 August, 2019. Since in both cases the images pertaining to scene 192 overlap the ones pertaining to scene 193 (as shown in Fig.2), and since in both cases the maximum values always correspond to pixels belonging to scene 193, for overlapping pixels the value associated to images in scene 193 was consistently retained. Finally, the two regional LST maps were resampled, and the final resolution was set at 300m, so as to lower computational time and efforts in the following steps.

Land Cover Types and Elevation

The 2018 CORINE Land Cover (CLC) vector dataset was retrieved from the Copernicus program website and processed so as to extract only polygons concerning Sardinia. These were subsequently reclassified, meaning that land covers were grouped on the basis of the Land and Ecosystem Accounting (LEAC) taxonomy established by the European Environment Agency (EEA, 2006, p. 98) for environmental accounting purposes. As shown in Tab.2, the 44 third-level classes of the CLC nomenclature are grouped into seven LEAC groups.

	Land and Ecosystem Accounting (LEAC) groups	**CORINE Land Cover Classes**			
ART	Artificial surfaces	1.*			
INTAG	Intensive agriculture (permanent crops and arable land)	2.1.*	2.2.*	2.4.1	
EXTAG	Extensive agriculture (pastures and mosaic farmland)	2.3.*	2.4.2	2.4.3	2.4.4
FWS	Forests, woodlands, and shrubs	3.1.*	3.2.4		
SHNG	Sclerophyllous vegetation, heathland, and natural grasslands	3.2.1	3.2.2	3.2.3	
OPEN	Open spaces with little or no vegetation	3.3.*			
WATER	Water bodies and wetlands	4.*	5.* (except 523-sea)		

The asterisk (*) marks any sub-classes of a given class, or any sub-sub-classes of a given sub-class. (CORINE: Coordination of Information on the Environment).

Tab.2 CORINE land cover classes and LEAC groups

From the CLC vector dataset, a second vector layer providing the spatial distribution of the LEAC groups for the study area was thus obtained and next converted into a raster map having the same grid as the resampled

LST and, therefore, a spatial resolution of 300 meters. Values for each cell in this raster map corresponded to the prevailing LEAC group in that cell.
As regards altitude, the DTM retrieved from the regional geoportal was resampled so as to obtain a new raster file matching both the LST and LEAC group raster maps as far as both the grid and the spatial resolution (300 meters) are concerned. Linear interpolation was performed to resample the DTM because this technique is deemed to best suit continuous data[7], as elevation.

Land Cover Types and Elevation

To begin with, a vector layer was created, whose polygons coincide with pixels in the three raster maps (LST, LEAC groups, elevation) derived as per the previous subsubsections. This vector layer is therefore, from a spatial perspective, a squared grid where every polygon is a 300m by 300m square in the projected reference system WGS 84 / UTM zone 32N (code EPSG 32632[8]), the same as that of the three above mentioned raster maps.
A "spring" vector dataset was then created by assigning to each polygon (square) the values of the three raster maps as attributes. Hence, the attribute table of the vector datasets brings together, for each polygon, the May LST value, the prevailing land cover group, and the altitude. To these, two further attributes were added: first, the latitude of the polygon's centroid, because the temperature is likely to depend upon the latitude; second, a field taking the value 1 or 0 depending on whether the polygon is contained in scene 193 (that is, the western one in Fig.2), or in scene 192 (that is, the eastern one in Fig.2). Polygons comprised in both scenes were considered as belonging to scene 193, which is consistent with the fact that the maximum LST value, which always corresponded to images in scene 193, was retained when building the regional LST map.
A "summer" vector dataset was also created, which only differs from the spring one as regards the LST values, which were retrieved from the August Landsat images.

Linear regression model

The polygons described in the previous subsection are identified as the spatial units to estimate a multiple linear regression which takes the following form:

$$\mathrm{LST} = \alpha_0 + \alpha_1\,\mathrm{ART} + \alpha_2\,\mathrm{INTAG} + \alpha_3\,\mathrm{EXTAG} + \alpha_4\,\mathrm{FWS} + \alpha_5\,\mathrm{SHNG} + \alpha_6\,\mathrm{OPEN} + \alpha_7\,\mathrm{HEIGH} + \alpha_8\,\mathrm{LATIT} + \alpha_9\,\mathrm{WEST} \quad (5)$$

where:

- independent variables from ART through OPEN identify the LEAC groups of land covers; these variables are Boolean, each of them taking either value 1 or value 0, depending on the prevailing size of the area of a LEAC group in a cell compared to the other LEAC groups sizes; consequently, if the area of the ART group is the largest in a cell, the variable ART is equal to 1, if not, it is equal to 0; if the area of the INTAG group is the largest in a cell, the variable INTAG is equal to 1, if not, it is equal to 0, etc.; each estimated coefficient of regression model (5), α_i, i = 1, …, 6, shows the LST variation of a cell whose largest area corresponds to the covariate identified by α_i (namely, ART, INTAG, and so on) compared to the reference condition represented by the largest area of the cell being identified by the covariate WATER (Wetlands and water bodies);

[7] ArcGis Help. Resample. Available online: https://pro.arcgis.com/en/pro-app/tool-reference/data-management/resample.htm (accessed on 31 August 2020).
[8] EPSG 32632. Available online: https://epsg.io/32632 (accessed on 31 August 2020).

- "HEIGH" is the elevation, in meters, associated to the polygon, computed as shown in subsubsection Land Cover Types and Elevation;
- "LATIT" is the latitude, in meters, associated to the centroid of the polygon, as described in subsubsection Land Cover Types and Elevation;
- "WEST" is a Boolean covariate, which equals either 0 or 1 as per subsection Land Cover Types and Elevation.

The estimated coefficients of regression model (5), α_i, i = 1, …, 6, class the zone types on the basis of the marginal effects on LST identified by the values of α_i.

This study compares the outcomes of regression model (5) implemented as regards two times of the year 2019. Namely, the values of LST were detected in May and in August, in order to assess analogies and differences between the spatial relations regarding LST and land covers. Moreover, on the basis of a "what if" assessment, the impact of future afforestation, as regards rural areas, is detected with respect to decrease in LST, building on the outcomes of the model which relates LST to land cover types.

The covariates HEIGH and LATIT are included in the model to control the effects of a cell's elevation and latitude on LST; therefore, if the estimated coefficients α_7 and α_8 were significant in terms of their p-values, this would imply that the elevation and latitude have impacts on LST, which are expected to be negative, since a higher elevation and a greater latitude are expected to be related to a lower LST, ceteris paribus. Lastly, the covariate WEST controls the effect of the timing of the Landsat 8 images, which are likely to exhibit a systematic difference with reference to the two May's and August's days the Landsat 8 images were taken. In both cases, May and August, the images related to Western Sardinia (Scene 193 of the Landsat 8 images) were taken on sunny and clear days, whereas the other cells, located more to the Eastern side of Sardinia, were taken in partly cloudy days. That being so, the cells belonging to Scene 193 should exhibit higher LSTs, ceteris paribus, and the expected sign of WEST is positive.

3. Findings

The findings coming from the implementation of the methodology described in the previous section are shown as follows. First, the spatial distribution of LST is presented, on the basis of steps (1) through (4). Secondly, model (5) is operationalized with reference to August 2019 and the impacts of LEAC groups on LST are described, which define a taxonomy of the LEAC groups, from water bodies and wetlands (lowest level) up to intensive and extensive agricultural land (upper levels). Moreover, differences and analogies between the spatial relations regarding LST and land covers as regards May and August 2019 are presented as well. Finally, the effects of changes in selected LEAC groups, namely afforestation, as regards rural areas are described on the basis of a "what if" assessment.

3.1 The LST Spatial Layout

Fig. 4 provides all of the maps obtained from the Landsat satellite images concerning the spring season by following the procedure explained in subsection LST Extraction and Spatial Layout. As clearly visible in Fig.4, spring images are affected by the presence of clouds, which in turns locally affected both NDVI and LST values. For this reason, cloudy pixels (amounting to approximately 25,000, less than 9.4% of the total number of cells, equaling 266,818) were removed for the spring images only, since this issue does not affect summer images. Fig. 5 provides a full picture of the spatial dataset that were used to build the attribute table next used as input data for the regression: LST (minus the cloudy cells for the spring dataset only), LEAC groups, and finally elevation.

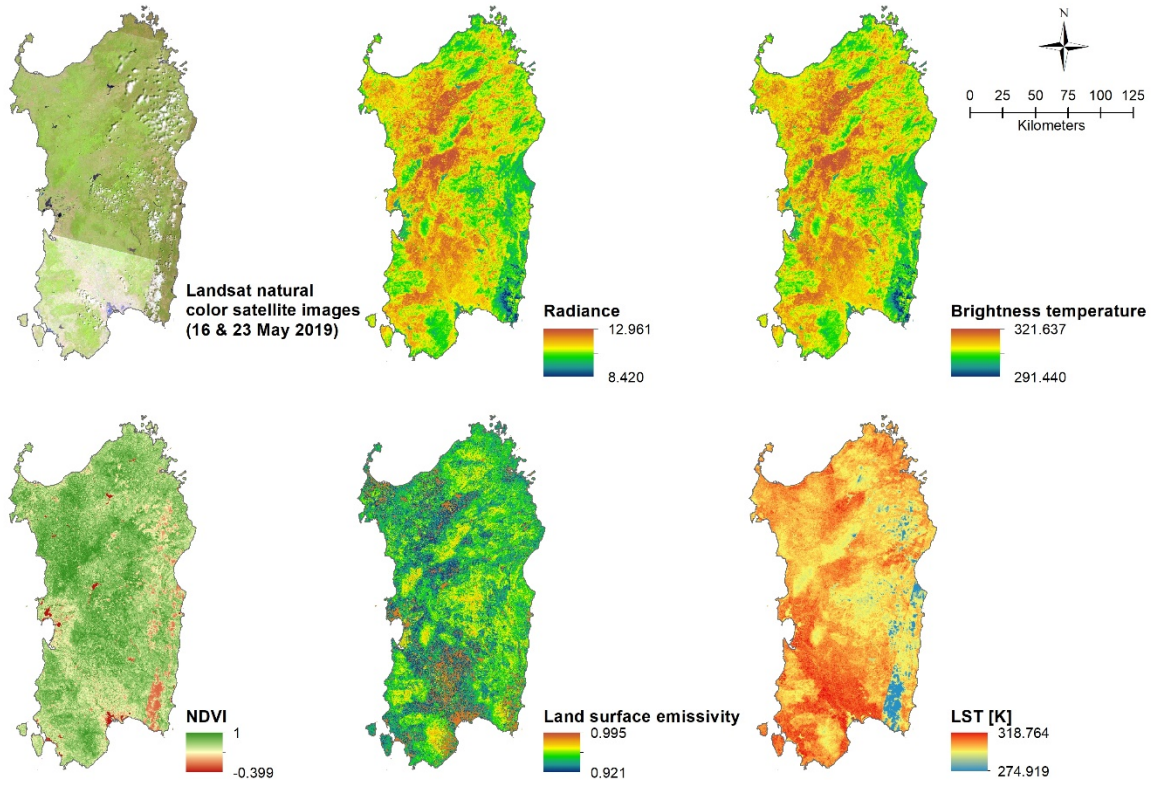

Fig.4 From Landsat images to LST: all of the maps extracted as per Subsection LST Extraction and Spatial Layout

3.2 The Implementation of the Regression Model

The estimated coefficients of the regression model show the impacts of the six LEAC groups of land covers on LST. The estimates of the dichotomous covariates identify the differential impact of each covariate with respect to the LEAC group "Water bodies and wetlands," whose impact on LST is the least relevant.

Tab. 3 reports the regression estimates and statistics for the summer dataset.

Moreover, Tab.4 shows the differences between the estimates of the coefficients reported in Tab.3, concerning two days of August 2019 (August 11 and August 20), and the estimated coefficients of regression model (equation 5) applied to the LST spatial distribution related to two days of May 2019 (May 23 and May 16). These represent the differential impacts of the LEAC groups on LST as regards the selected summer and spring periods. If the difference is negative, the summer impact is lower than the spring impact and the other way around.

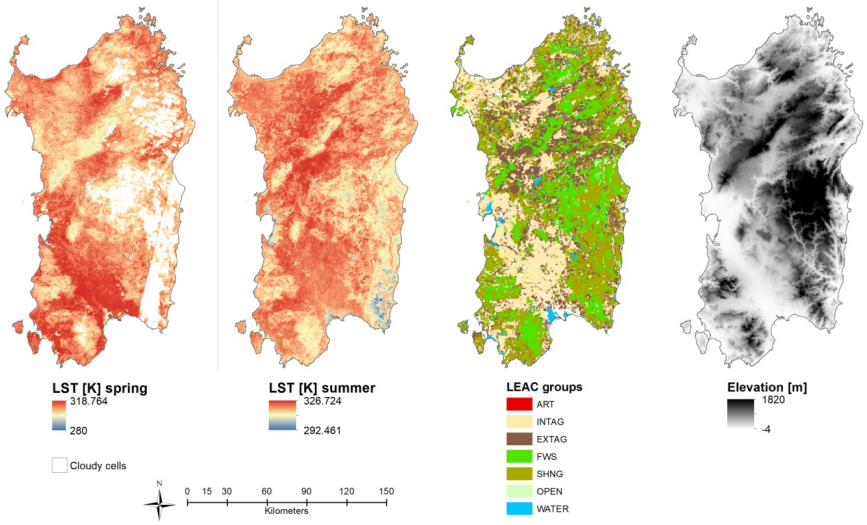

Fig.5 Spatial distribution of LST in May and August 2019, of LEAC groups, and of elevation

Independent Variable	Coefficient	Standard Deviation	t-statistic	p-value	Mean of the Independent Variable
ART	8.297	0.0685	121.039	0.000	0.0295
INTAG	11.576	0.0595	194.578	0.000	0.247
EXTAG	10.491	0.0601	174.673	0.000	0.218
FWS	4.584	0.0611	74.955	0.000	0.175
SHNG	7.365	0.0598	123.113	0.000	0.302
OPEN	7.312	0.0756	96.792	0.000	0.0178
HEIGH	−0.000117	0.0000260	−4.481	0.000	339.347
LATIT	−0.000000643	0.0000000991	−6.484	0.000	4437093.555
WEST	5.004	0.0249	201.055	0.000	0.926
Dependent variable: LST: 313.751 K; Standard deviation: 4.453; Adjusted R-squared: 0.476.					

Tab.3 Regression results for the summer dataset (August 11 and 20, 2019)

The estimated coefficients of latitude and height show significant p-values and the expected signs. That being so, consistently with expectations, higher altitudes and larger latitudes correspond to lower LST. As regards altitude, an increase of 100 meters will entail a decrease of 0.0117 K in LST, while a 10 km increase in LATIT will imply a 0.0006 K decrease in LST. The estimated coefficient of variable WEST is significant and shows the expected sign as well. This entails that, on average, a cell whose LST was identified by the satellite images on August 11 shows an LST 5 K higher than a cell whose LST was taken on August 20, everything else being equal.

Independent Variable	Difference
ART	-0.62
INTAG	3.06
EXTAG	3.08
FWS	−0.20
SHNG	1.09
OPEN	−0.04
HEIGH	0.0063
LATIT	0.000015
WEST	0.69

Tab.4 Differences in the estimated coefficients between summer and spring days (K)

Moreover, as reported in Tab.4, the differences between the regression models implemented with reference to the summer and to the spring periods are negligible, so the results related to latitude and height can be considered quite robust across year 2019. That being so, the estimated coefficients of the three control variables are consistent with expectations and statistically significant, which makes pretty consequential and reliable the identification of the impacts on LST related to the six LEAC groups associated to the Boolean variables from ART to OPEN.

The estimates of the coefficients of the six covariates are significant with reference to a standard p-values test and imply the following outcomes, under the condition that everything else remains the same.

Intensive and extensive agriculture show the highest impacts on LST. The estimates of the coefficients entail that the cells characterized either by arable land and permanent crops or by mosaic farmland and pastures show a temperature higher by: 11.6 or 10.5 K than cells belonging to the water bodies and wetland LEAC group; 3.2 or 2.1 K than cells belonging to the ART LEAC group; 4.2 or 3.1 K higher than cells belonging to the SHNG and OPEN LEAC group; 7.0 or 5.9 K higher than cells belonging to the FWS LEAC group.

Secondly, intensive and extensive agriculture have much higher impacts on LST in the summer period than in spring, as shown in Tab.4. The summer differential impacts of INTAG and EXTAG are more than 3 K higher

than in the spring period, which makes intensive and extensive agriculture effects on LST even higher than the impact of urbanized land LEAC group, which shows the highest effect as regards the spring period.
Another relevant finding is that land covers characterized either by sparse or rare vegetation (OPEN) or by grassland and heathland (SHNG) have lower effects on LST, even though the latter LEAC group shows a higher impact than in the spring period, that is more than a 1 K increase, as reported in Tab.4.
Finally, the FWS LEAC macroclass, that is forests, woodlands and shrubs, shows the most relevant impact on temperature mitigation, with almost complete consistency between the summer and spring periods, as reported in Tab.4.

3.3 The Impact of the Covariates Change on LST Based on a "What If" Assessment

The outcomes of the regression analysis shown in Tab.3 make it possible to develop "what if" scenarios and spatially represent them.
A possible scenario is one in which afforestation measures are implemented in rural areas to mitigate LST. Such measures would be unlikely to target INTAG, because these represent the most profitable agricultural areas and harsh conflicts would inevitably arise; rather, they would target EXTAG, where conflicts would be milder because some farming activities, such as sheep or goat grazing, quite significant in the island, could still take place, and might even be mitigated through incentives that can be allocated to land-owners under the current European financial schemes concerning agriculture and rural development. The "what if" assessment is therefore based on the hypothesis that all of the EXTAG cells in rural areas are targeted by afforestation measures and, therefore, are turned into FWS. This is, of course, only a hypothetical and extreme scenario, which could further be refined by assuming that only a certain percentage of the cells that meet some predefined selection criteria (for instance based on elevation, slope, distances from already afforested areas) can effectively be turned into FWS.
Under this working hypothesis, cells having EXTAG as LEAC type were selected; this returned 58,220 cells out of the 266,818 total cells comprising both the summer and the spring datasets. Out of the 58,220 EXTAG cells, 3,211 are included within either the "inhabited centers" or the "inhabited nucleuses" as defined by the National Institute of Statistics[9], while the remaining are located within rural areas. The latter 55,009 cells can therefore be targeted by afforestation policies, taking for instance the form of incentives under the European Agriculture Fund for rural Development.
As regards the summer seasons, if an EXTAG cell were turned into an FWS cell, then its LST would decrease by 5.904 K, which equals the difference between the corresponding coefficients in Tab. 4. Some visual examples of how this change in the LEAC types would affect the spatial distribution of the LST at the local level are shown in Fig. 6: panels A1, B1, and C1 provide details of the LST map retrieved from the Landsat images (i.e., of the map shown at the bottom in Fig.5), while panels A2, B2, and C2, relating to the same areas as A1, B1, and C1 respectively, show how the LST would change as a result of afforestation policies targeting rural EXTAG areas only.
As for the spring seasons, if an EXTAG cell were turned into an FWS cell, then its LST would decrease by 2.627 K, which equals the difference between the corresponding coefficients from the regression analysis concerning the spring dataset (i.e., 7.413 and 4.786, respectively, for EXTAG and FWS (Lai et al., 2020)). Some visual examples of how this change in the LEAC types would affect the spatial distribution of the LST at the local level are shown in Fig.7: panels A1, B1, and C1 provide local details of the LST map retrieved from the Landsat images (i.e., of the map shown in Fig.5), while panels A2, B2, and C2, relating to the same areas as A1, B1, and C1 respectively, show how the LST would change as a result of afforestation policies targeting rural EXTAG

[9] Basi territoriali e variabili censuarie [Territorial units and census variables]. Available online: https://www.istat.it/it/archivio/104317 (accessed on 31 August 2020).

areas only. Spring cells, quite diffuse in panels B1 and B2, were removed from the map, since the LST retrieval process is deeply affected by the presence of clouds.

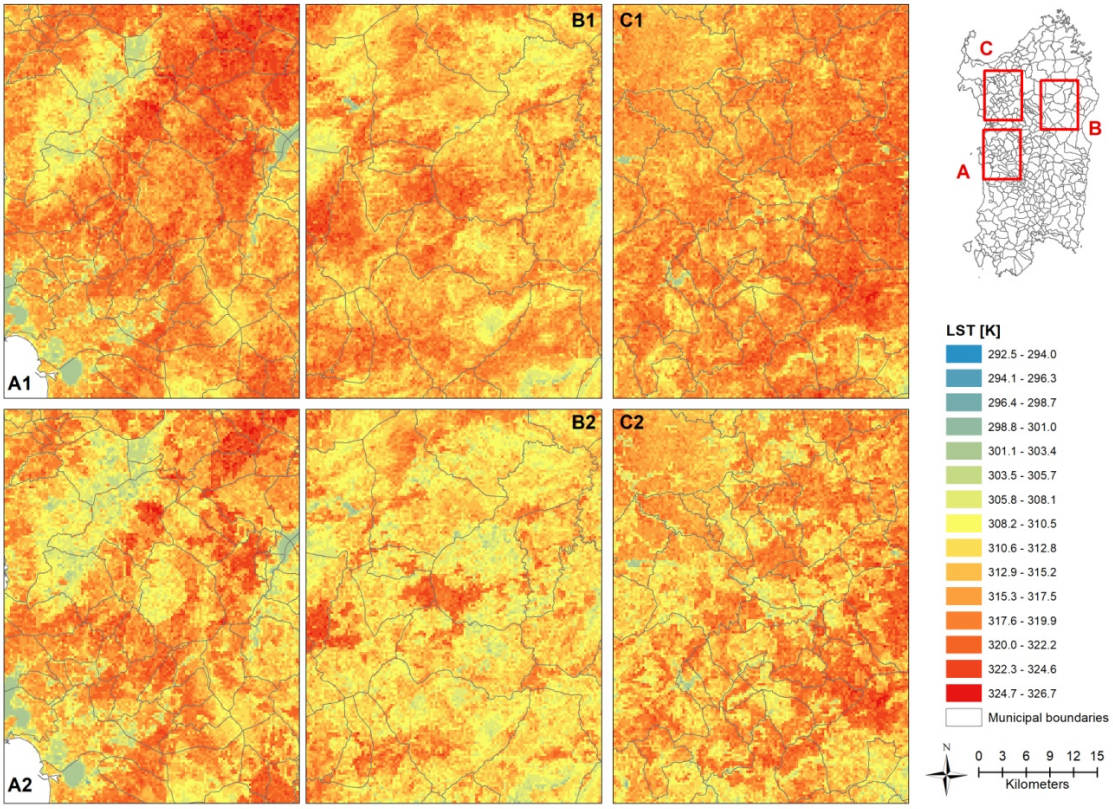

Fig.6 "What if" assessment: actual (A1, B1, C1) and simulated (A2, B2, C2) LST summer maps

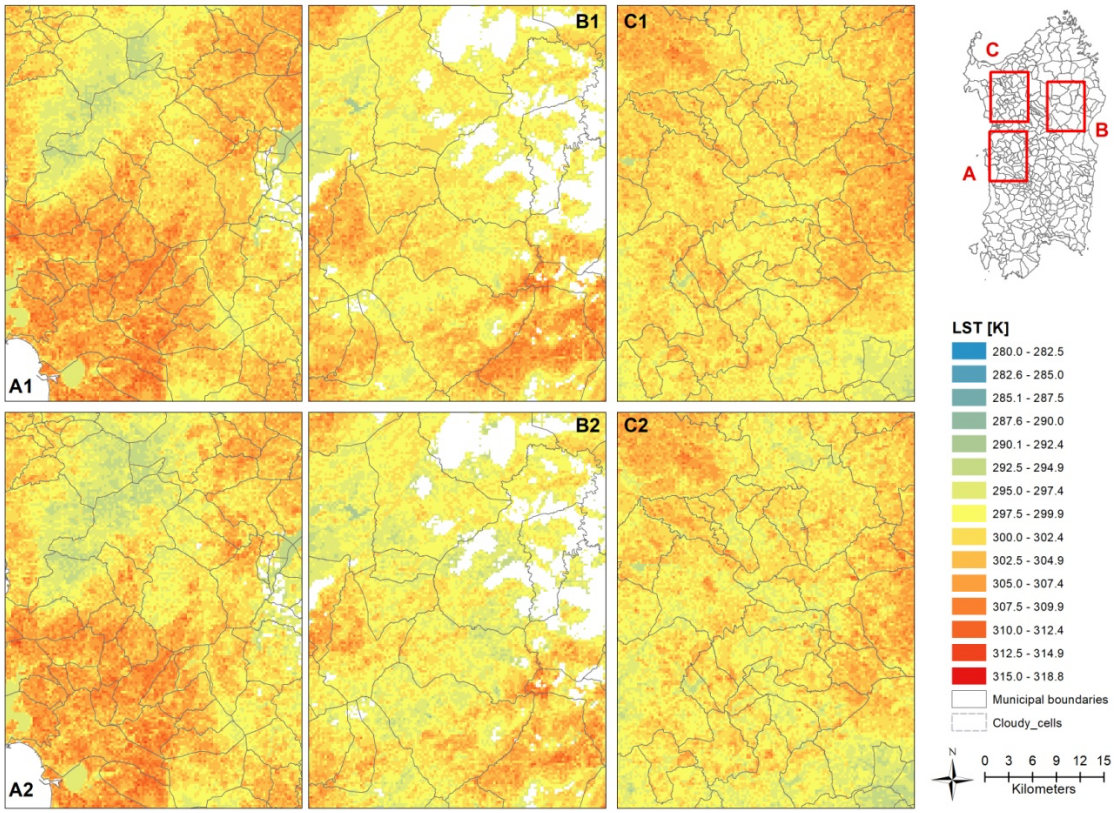

Fig.7 "What if" assessment: actual (A1, B1, C1) and simulated (A2, B2, C2) LST spring maps

4. Discussion

The regression model presented in section 3.2., which investigates the impacts on LST of land cover changes, classified according to the LEAC groups, provides findings consistent with the literature. With reference to the model estimates related to the summer period, arable land and permanent crops (INTAG), and mosaic farmland and pastures (EXTAG) show the most relevant impacts on LST increase, that is around 11.6 and 10.5 K higher than cells belonging to the water bodies and wetland LEAC group (WATER). This result differs from the outcomes related to the spring period, where artificial areas (ART) show the most relevant impact on LST increase (8.9 K) and the effect of intensive farming (INTAG) is slightly lower than that of artificial areas (8.5 K) (ART) (Lai et al., 2020). Both these findings are consistent to the results of analogous studies. As for the spring outcomes, the higher values related to the ART LEAC group are connected with sealed soils that either prevent or reduce air circulation, and with downwind cooling (Oke, 1988). Indeed, on the one hand, vegetation, which positively influences the thermal comfort in urban areas, is absent or scarce (Skelhorn et al., 2014; Zucaro & Morosini, 2018; Geneletti et al., 2019), and, on the other hand, artificial surfaces prevent evapotranspiration (Demuzere et al., 2014) and generate high radiant temperature (Ding & Shi, 2013). Moreover, according to Fonseka et al. (2019), an increase in LST may be correlated to the higher heat discharge generated by human activities entailed by the growing population that characterizes urbanized areas. All these factors cause higher LST in urban contexts than in non-artificial areas. From this perspective, increasing vegetated areas through green roofs, rooftop gardens, and urban forestry is likely to mitigate heat-island phenomena in urban areas (Fischer & Schär, 2010).

INTAG and ART LEAC groups are characterized by similar conditions in terms of downwind cooling, air circulation, thermal comfort, and evapotranspiration. Indeed, intensive farming areas are characterized by dense low-growing vegetation with little or no trees (Irmak, 2012; Launeau et al., 2018). The situation is made even worse by transitions from natural areas to arable and permanent crops due to the change of climate-related variables, such as soil moisture, surface roughness of vegetation and leaf conductance. In addition, the continuous supply of water needed by intensive farming increases physical evaporation and evapotranspiration; however, it also entails a decrease in sensible heat flux that cools the land surface. As a consequence, rainfalls are affected by the latent heat produced by the moisture flux in the atmosphere (Ge, 2010). Higher LST values in rural areas correlated to higher values of the ART LEAC group are reported in other studies as well (Munafò, 2020). The already-quoted Italian report on land take (Munafò, 2020) presents the results of a study on the difference in average daytime LST between urban and rural areas in relation to fourteen Italian metropolitan cities during the 2018 and 2019 summer periods. The findings show negative differences, which implies higher LST values in rural areas, within the metropolitan cities of Bari and Palermo, both located in Southern Italy. This outcome is related to the particular climate conditions of Southern Italy, where large agricultural areas with poor vegetation cover generate an increase in LST during summer (Munafò, 2020). The same results are reported in a study by Gohain et al. (2020), according to which the measured difference between LST in the city center and in a 5 kilometer-buffer rural zone around the consolidated urban tissue was -1.4 Celsius degree, as a consequence of the formation of an urban cool island. According to Mendonca (2009), some soil features, such as mineral composition, compactness and color, affect thermal variation; in particular, naked and dry soils show low albedo. These conditions, combined with direct sun flow, entail lower values of thermal inertia in agricultural areas with respect to green urban areas. As a consequence, rural areas may show a higher LST than urban areas. The urban cool island phenomenon is common across urban contexts characterized by semi-arid climate (Mohammad et al., 2019; Peng et al., 2012; Rasul et al., 2015; Rasul et al., 2016).

Furthermore, according to the results of a study by Walawender et al. (2014), in relation to the city of Krakow, Poland, the INTAG and EXTAG LEAC groups change their behaviors in terms of LST during the year. In the early vegetative period (i.e., in Poland, April and May), the higher values of LST in intensively farmed areas

are related to the absence of vegetation, which entails that such agricultural areas show the same thermal properties as bare soils. As regards extensively farmed areas, at the beginning of the vegetative period the thermal property is different to that of arable land. In addition, rainfalls affect the capacity of regenerating living biomass by preventing continuous forage production during the vegetative period (Feldhake et al., 1996). Moreover, the decrease in LST within rural areas implies important advantages in terms of water shortage mitigation, and economic and social issues (Mokhtari et al., 2011). Indeed, the negative correlation between vegetation density and LST reported in a study by Sruthi & Aslam (2015) is relevant during drought periods, when scarce rainfalls and soil humidity entail a decline in productivity, which is likely to generate economic and social unrest (Dodo, 2014; Kaniewski et al., 2020). This outcome is particularly significant in relation to regional contexts characterized by the massive presence of rural areas, such as Sardinia, where agricultural areas cover around 50% (11,500 km^2) of the regional territory and 7.5% (41,000 people) of the work force employed in the agricultural sector (Centro Studi di Confagricoltura, 2015).

Heathland, natural grasslands and sclerophylous vegetation (SHNG) and Open spaces with sparse or absent vegetation (OPEN) show lower values of LST than the other LEAC groups with the exception of Forests, shrubs and woodlands (FWS), during both the summer and the spring periods. The presence of vegetation delivers evapotranspiration that reduces the heat stored in soils (Youneszadeh et al., 2015). Moreover, the vegetation shade generates air movement and heat exchange, by preventing or decreasing the solar radiation absorbed by the land surface (Geneletti et al., 2019). However, seasons affect the influence of vegetation on LST. Indeed, findings from a study by Zhou et al. (2014) show that the tree canopy is responsible for about 69% of LST decrease during the spring period, whereas, during the summer period, the evapotranspiration is limited due to leaf fall, and the positive effect of the tree canopy is almost totally prevented. This study shows that in the spring and summer periods, Forests, shrubs and woodlands (FSW) show positive effects on LST mitigation. This result is consistent with Walawender et al.'s work (2014), implemented as regards the city of Krakow, Poland. Moreover, the study focuses on the seasonality that characterizes different land covers in terms of LST mitigation. In fact, in March, before the flowering period, LST of waters is significantly lower than forests' figures. During the beginning of the vegetative period (May, in Poland), the difference between the LST of the two LEAC groups (WATER and FSW) becomes negligible. At the end of the vegetative period (between June and August, in Poland), the difference becomes close to zero. The main factor that affects the behavior of the two LEAC groups during the year, according to the research concerning Krakow, is evapotranspiration, that peaks during the vegetative period.

The findings of this study entail a number of policy implications.

As regards the consolidated urban tissues of small villages, towns and cities, where heat island and wave phenomena are likely to take place as a consequence of high LSTs, the implementation of micro-scale measures, such as planting new green areas or enlarging existing ones, or plantation of trees, can be very effective (Geneletti et al., 2019; Ustaoglu & Aydinoglu, 2019).

Important urban micro-scale policies are based on green wall and facades and blue and green grids as well. A relevant example of these measures is the London Green Grid (Mayor of London, 2006). This study tackles a 3 K temperature increase in the metropolitan area of London, which will cause important negative effects on the local living quality, community health, production of water, vermin and insect outbreak, drought, public parks and green areas. The London Green Grid conceptual framework was implemented through the East London Green Grid, which implies a fabric of blue and green infrastructures which implements an urban landscape which integrates the built environment, featured by people living and working there and characterized by sealed soils, commuting centers, and the Green Belt that envelopes the Thames and London (Pötz et al., 2016).

The increase in the provision of ecosystem services aimed at regulating LST implies relevant positive impacts on the urban living quality (Gómez-Baggethun & Barton, 2013). These policies integrate different types of

planning measures which are likely to encourage best practice-oriented behaviors by the local societies, residents' organizations, building firms, and public bodies (Mazzeo et al., 2019). A relevant question is related to the strict connection between urban land prices and the allowed building volume, be it for housing or for services. As a consequence, newly-planted vegetated areas or the extension of existing green ones, which entails a relevant decrease in the value of these areas due to the loss in permitted building cubage, should imply the adoption of integrated planning policies which should take account of landowners' interests and of urban sustainability-oriented goals. First, sound building regulations should establish that new developments, and existing settlements as well, should have an adequate endowment of green areas, which may possibly consist of green facades and roofs or of the implementation of green or blue grids into part of the newly-developed land, as it has occurred in the case of East London (Mathey et al., 2011; Jenning et al., 2016). Secondly, since financial support is important as well, a framework of incentives should be implemented in order to develop vegetated roofs and facades, and blue and green grids in newly-planned and existing settlements, so as to make them attractive to investors (Webster, 2005; Bramley & Watkins, 2014). Financial support can be based on impact fee decrease, property tax and VAT reductions, incentives granted to developers to improve the landscape quality through greening operations, etc. (Buijs et al., 2019; Slätmo et al., 2019). Finally, greening operations, based on grids, infrastructure and so on, is a matter of visibility concerning the public administration's commitment towards the implementation of planning measures and policies, which can be made explicit through public purchase offers regarding areas where new green and blue grids are planned (Fors et al., 2015; Pérez-Urrestarazu et al., 2015).

The other side of the coin is represented by the impacts on LST generated by the non-artificial LEAC groups. The most effective LEAC land cover group in reducing LST is FWS (forests, woodlands and shrubs), while the impacts generated by OPEN (open space with sparse or rare vegetation) and SHNG (sclerophyllous vegetation, grassland and heathland) are similar to the negative effects of urbanized land (ART). Even more negative are the impacts coming from the intensive and extensive agriculture LEAC groups (INTAG and EXTAG), which are likely to occur for the reasons discussed in Section 4. This outcome implies that the LEAC FWS macroclass should be identified as a point of reference to target land cover transitions with the aim of reducing LST and mitigating the related phenomena, such as heat islands and waves.

That being so, afforestation is the most relevant reference for planning policies designed to decrease LST as regards non-urbanized areas, such as rural zones[10]. A thorough analysis of the issue of land cover change from croplands to forests is developed in an article concerning economic and social determinants of afforestation coming from agricultural land, which gives particular attention to public decision-making processes thereof (Ryan & O'Donoghue, 2016). Under this perspective, perceived non-market benefits from agricultural activities are relevant hurdles related to the implementation of afforestation (Howley et al., 2015). These points in favor of farming are mainly connected to the flexibility of agricultural practices (Duesberg et al., 2014), and to the reluctance on behalf of farmers to lose their abiding traditional know-how, which is often much more relevant than the predicted income increase generated by afforestation (Ryan & O'Donoghue, 2016). Furthermore, afforestation from intensive agriculture-related land cover (INTAG) and from extensive agriculture-related land cover (EXTAG) are quite different from each other (Kumm & Hessle, 2020). In the first case, a land cover change is quite difficult, while it is much more viable in the second case, since, on average, the expected rent from forests is higher than the rent generated by extensive agriculture, whereas intensive agriculture, which takes place in arable land through permanent crops, provides comparatively higher rents than forest farming (Kumm & Hessle, 2020). Furthermore, the regional land cover shares of the regional land of INTAG and EXTAG are close to each other (about 25% and 22%, respectively), as shown in the sixth column

[10] Small-scale forestry conference proceedings. Small-scale forestry and rural development - The intersection of ecosystems, economics and society - Proceedings of IUFRO 3.08 Conference hosted by Galway-Mayo Institute of Technology, Galway, Ireland, 3-6 July 2006. Available online: http://www.coford.ie/publications/reports/small-scaleforestryconferenceproceedings/ (accessed on 31 August 2020).

of Tab.4, and their spatial distribution is fairly homogeneous with respect to the whole Sardinian region. Planning policies aimed at decreasing LST should target both, INTAG and EXTAG, on the basis of the following approach. Afforestation should be promoted by means of incentives granted to farmers who earn low rents from agriculture, in order to become forest farmers. The incentives are likely to be very effective as regards rural areas whose land cover is classified as pastures and mosaic croplands according to the LEAC taxonomy (labeled EXTAG in this study), while it is not probable that farmers of arable land and permanent crops (INTAG land cover) be tempted by these incentive schemes (Hyytiainen et al., 2008). On the other hand, the afforestation expansion across rural areas characterized by high-rent agriculture should be a matter of careful evaluation on behalf of public planning bodies, since the financial resources needed to make the incentives attractive would probably be unaffordable, and the resulting weakening of the traditional agricultural structure may generate an unwanted decay of the social, economic and environmental situation of rural areas (Behan et al., 2006). From this point of view, the different levels of the public administration, local, regional, national, have an important task since they have to optimize the degree of afforestation with the size of the affordable investment needed to support the land-cover changes, mainly from extensive agriculture (Zavalloni et al., 2019).

The perception, on behalf of the local societies, of a sound commitment by the involved public administrations is a fundamental factor for a successful implementation of policies aimed at decreasing LST based on afforestation. Measures such as public purchase of low-rent agricultural land, pastures or open space characterized by rare or sparse vegetation are very effective in building community awareness and consensus (Brouwer et al., 2015).

5. Conclusions

This study proposes and develops a methodology to estimate, in quantitative terms, the effects of planning measures aimed at decreasing LST effects in Sardinian urban and rural areas. The findings not only imply that planning measures should be based on endowing new and existing buildings and urbanized land with green roofs and facades and urban areas with green and blue grids, or on implementing land cover transitions towards forests in rural areas, but also provide estimates of the quantitative size of the effects on LST caused by such measures. This knowledge is relevant to set up public investment aimed at addressing the LST decrease question taking account of the budget constraints which feature the public administrations' policy-making processes. Furthermore, the methodological approach implemented in this study is easy to export since the LST spatial layout can be straightforwardly identified through images from satellite, and the LEAC classification, based on CORINE land cover, is freely accessible for all the countries of the European Union. Moreover, the implementation of the methodological approach into the Sardinian regional spatial context helps explaining the correlations between one of the most outstanding negative impacts of climate changes identified by the Regional Strategy, that is heat waves and islands (Regione Autonoma della Sardegna, 2019a), and the spatial distribution of land cover types and transformations.

This study shows two main limitations concerning results validation and the complete implementation of policy recommendation proposed in this work. First, validation should be pursued through direct observations of LST values by following, for example, the methodology proposed by Nguyen et al. (2019). Secondly, Sardinian local administrations, such as both the regional administration and local municipalities, do not take into account measures for mitigating LST values, and, by doing so, public commitment and financial investments are lacking. In this situation, implementing this kind of measure into planning practice in the short run seems a utopia.

With reference to the results of this study, two recommendations for further research concerning the identification of planning measures and policies should be highlighted. First, a local network of data points to detect LST on-site would be very important to validate the spatial distribution of LST, which would make

possible to implement experiments based on policy measures used to decrease LST. The only way to develop experiments aimed at measuring the impacts on LST generated by green roofs and facades, green and blue grids, and so on, is to set up a data point network that can provide LST observations before and after the implementation of these policies, on the basis of an impact analysis approach (Gutiérrez Rodríguez et al., 2015; Gutiérrez Rodríguez et al., 2016). Secondly, testing the implementation of afforestation and blue and green urban grids policies would entail thorough participation of the local administrations and communities of urban and rural areas. Researchers and practitioners involved in action-research experiments aimed at implementing policies to decrease LST, and local urban and rural administrations and communities, should work together in order to attract public and private investments from national and international agencies and bodies to develop experimental projects to mitigate the negative impacts of heat islands and waves on the local communities' quality of life.

Acknowledgments

Author Contributions: Sabrina Lai (S.L), Federica Leone (F.L.), and Corrado Zoppi (C.Z.) collaboratively designed this study. Individual contributions are as follows: F.L. wrote Sections 1 and 4; S.L. wrote Sections 2.1, 2.2, 3.1 and 3.3 and Subsections LST Extraction and Spatial Layout, Land Cover Types and Elevation; C.Z. wrote Sections 3.2 and 5 and Subsection Linear regression model.

The study was implemented within the Research Program "Paesaggi rurali della Sardegna: pianificazione di infrastrutture verdi e blu e di reti territoriali complesse" [Rural landscapes of Sardinia: Planning policies for green and blue infrastructure and spatial complex networks], funded by the Autonomous Region of Sardinia for the period 2019–2021, under the provisions of the call for the presentation of "Projects related to fundamental or basic research" of the year 2017, implemented at the Department of Civil and Environmental Engineering and Architecture (DICAAR) of the University of Cagliari, Italy.

Authors Contribution

Author Contributions: Sabrina Lai (S.L), Federica Leone (F.L.), and Corrado Zoppi (C.Z.) collaboratively designed this study. Individual contributions are as follows: F.L. wrote Sections 1 and 4; S.L. wrote Sections 2.1, 2.2, 3.1 and 3.3 and Subsections LST Extraction and Spatial Layout, Land Cover Types and Elevation; C.Z. wrote Sections 3.2 and 5 and Subsection Linear regression model. Conflicts of Interest: The authors declare no conflict of interest.

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Image Sources

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Fig.7: Authors' elaboration.

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TeMA Journal of
Land Use, Mobility and Environment

Call for Paper

Special Issue TeMA (2021) The emergency plan for the use and management of the territory

Guest editor: Rosa Anna La Rocca, Annunziata Palermo, Maria Francesca Viapiana

A special issue entitled "The emergency plan for the use and management of the territory" will be published in the next year. The need to investigate this issue arises from the fact that, while the topics of land use planning, spatial planning and urban planning in risky areas have received more attention in academic debate, there are few examples of good practices that involve ordinary master plans embedding mitigation. Already last year the issue was addressed in a national conference organized by the Italian Society of Urban Planners (Società Italiana degli Urbanisti - SIU) and by the Department of Civil Engineering of the University of Calabria, with the patronage of the National Institute of Urban Planning (Istituto Nazionale di Urbanistica - INU). The Special Issue starts from the conference results in order to avoid that the responses to the effects caused by natural and anthropic risks are left to the territorial systems' spontaneity (Holling, 1973; Colucci, 2012; Bettini, 2014). In particular, it is aimed at better understanding how to obtain more effective results to promote resilient processes of territorial systems, starting from some considerations characterizing the integration between specific sectoral plans, such as emergency plans, and land use plans. The emergency plan can be considered the ideal operational plan to pursue risk mitigation strategies also aimed at favoring the pursuit of the resilience condition of specific territorial contexts. This above all if it is given a more articulated and dynamic meaning in terms of connection with the discipline of land use and assets. This integration is still an unexplored area of research, just touched upon in civil protection documents in some countries (such as Australia, New Zealand, Canada). This special issue aims to be a useful opportunity to reorganize some operational or territorial management plans in a more "resilient" way, preparing them to deal with crisis from different points of view (structural, ecological, social and economic), interlacing specific issues of risk mitigation with those of territorial planning. In this regard, the need to outline specific intervention tools to be integrated with current planning practices, for example connected to the use of GIS, (Chun and Artigas, 2012; Johnson, 2005; Zlatanova and Li, 2008), as well as the need to achieve greater integration of civil protection needs should be recognized in various "tools" of spatial planning of the territory (ordinary and strategic, general and sectoral), but also financial planning, at the various levels of intervention.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 353-374
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/7122
Received 26th July 2020, Accepted 20th December 2020, Available online 31st December 2020

www.tema.unina.it

Causes of residential mobility and Turkey practice

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Abstract
Residential mobility is an economic and social recovery process that determines urban growth and regional development. The urban population relocates due to the events in their lives or their dissatisfaction with the conditions. Such individual movements play a role in the construction of urban geography. The aim of the present study was to discuss the factors that affect the residential mobility in Ortahisar district in Trabzon, Turkey. To determine the mobility, a survey was conducted with 445 individuals in 11 neighborhoods with different socio-demographic, economic and physical attributes in Trabzon urban center. The survey findings were analyzed based on a) the analysis of the socio-demographic structure of households, b) evaluation of the residential buildings, c) the analysis of historical mobility, and d) the assessments of causality in mobility. In the study, the causal factors were analyzed based on the life cycle, life course and satisfaction approaches and mobility classification available in the literature, and the study findings were analyzed with descriptive statistics. It was determined that residential ownership, the structure of the household members, and proximity to the workplace factors were effective on residential mobility in Trabzon.

Keywords
Residential mobility; Urban growth; Urban geography; Satisfaction; Trabzon/Ortahisar

How to cite item in APA format
Özlü, S. & Beyazli, D. (2020). Causes of Residential Mobility and Turkey Practice. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 353-374. http://dx.doi.org/10.6092/1970-9870/7122

1. Introduction

Settlements grow and develop their unique spatial structure, subject to the factors influencing them (Pappu, 2018). At the same time, the cities are subject to continuous and rapid changes that generate instability conditions and make it fragile (Esopi, 2018). While the city and society constantly redefine the relationship between places and actors; unexpected and uncontrolled social conditions and lifestyles build new geographies and centers (Punziano & Terracciano, 2017). The key word to understanding these dynamic urban areas and the nature of society is change (Clark, 1982). Residence mobility is one of the most important factors in several processes that lead to structural change in urban space (Li & Siu, 2001). Today, the mobility of individuals increases every day; however, these individuals are not migrants but those who change their course of movement around the world (Tekeli, 2006). Over the last twenty years, improvements in quality of life and scientific and technological advances have led to an increase in life expectancy (Gaglione et al., 2019). As housing mobility and relocation with social and economic significance continuously increase, 15-17% of the United States population, about 8% of British homeowners, an average of 6.2% of Dutch citizens change their homes every year (Wang & Wang, 2020). Residence mobility, which is one of the important characteristics of human nature driven by socio-economic, political and environmental factors, affects not only households but also the settlements where the movement takes place (Clark, 1982; Parida & Madheswaran, 2010; Coulton et al., 2012). These individual movements lead to rapid changes in settlement design, urban population profile, land use patterns, and as a result, the relationship patterns in traffic flow, reorganizing the urban settlements (Clark, 1982; Clark, 2007). Residence mobility is both the cause and the outcome of the change in urban socio-spatial structures (Cadwallader, 1992). To make sense of these processes, it is necessary to analyze the socio-economic and demographic compositions of mobility and to investigate the changes in the socio-economic, demographic and spatial urban structures (Kamacı, 2013). While the materialisation of density in the built environment involves a wide variety of forms that affect urban and architectural qualities in different ways; how people value these qualities is a context-specific issue affecting the diversity of urban environments that exist not only in different places but also over time (Palacio et al., 2018). Therefore, understanding the structure of mobility aims the prediction of future changes in urban areas and recognition of the effects of policies that affect urban areas (Hanuskek & Quigley, 1978).

Housing mobility expectations dictate that similar individuals with respect to the housing market, economic conditions and social networks tend to live in the same neighborhoods (van Gent et al., 2019). However, the multidimensional differences between the individuals and urban spaces make it impossible to live in a neighborhood where perfect equality prevails. Thus, the phenomenon of residence mobility, which is considered to be an important foundation for the development and differentiation of cities and heterogeneous urban areas, and in planning of future settlements, was the topic of the present study. The study aims to discuss the factors that lead to residential mobility and were effective on shaping the urban areas with a multidimensional approach. It is aimed to find answers to this question in the study where the factors causing the movement are determined; 'What are the real and unique to the city -if any- factors that cause the decision to act?'. There is a need to increase the number of empirical studies dealing with housing mobility and the causes of movement, which vary according to time, place and the characteristics of the moving person. The determination of the profile that relocated to the neighborhood and the reason for selecting the particular neighborhood would be beneficial for planning management decisions.

2. Theoretical framework

Residence mobility entails the process of changing the places, residences, lives and neighborhoods of individuals and households in cities (Hanuskek & Quigley, 1978; Clark, 2007; Coulton et al., 2012). Certain studies described residence mobility as a key demographic process that leads to a permanent change in primary housing and shapes social dynamics, (Wang et al., 2018) as a mechanism that could reorganize the

housing, neighborhood, and local consumption of households based on changing needs and preferences (Coulter & Ham, 2013). Furthermore, it is also a micro-function of the household life cycle and a complex process with a power to transform its geography on a macro scale (Kamacı, 2013).

Although there are studies that approached residence mobility as a type of migration, (Brown & Holmes, 1971; Brown & Moore, 1970) residence mobility differs from migration movements based on the distance, scale, frequency, cause and consequences of the movements. Household change of residence occurs at different scales, including local, regional, national and international (Haque et al., 2020). Unlike long-distance and employment-oriented migration movements, residence mobility is short-distance and residence-oriented with a higher frequency (Clark & Huang, 2004; Dieleman, 2001; Baker, 2003).

Residence mobility has been a topic tackled by geographers, sociologists, economists and psychologists and they proposed a series of analyzes on the causes, destination and origin of the mobility. This multidisciplinary interest led to comprehensive studies on the causes and consequences of various social processes (Morris, 2017). Although the reasons for mobility were underlined by various goals based the conditions of the period, the common goal in all was to change the living conditions (Özgür, 2009) and early studies attempted to explain the phenomenon with economic approaches. According to the economy-oriented approach, the residential change was an attempt to create a balance in consumption within the framework of a reasonable pricing constraints (Hanuskek & Quigley, 1978) and households select a residence by analyzing the costs of components such as income, real estate prices, equipment and distance to work to maximize the benefits within their budgetary constraints (Clark & Dieleman, 1996).

Sociological and geographical approaches conducted to identify the determinants of housing mobility and immigration suggested that various familial, household and residence characteristics may inhibit relocation in addition to economic push and pull factors (Lei & South, 2020). After the 1950s, behavioral approaches were developed due to the increasing significance of human decisions and behavior in residence mobility. First, Rossi attempted to explain the phenomenon of mobility by associating the phenomenon with the concept of life cycle. Rossi considered residence mobility as a response to fundamental changes in life, especially changes in the family structure (Rossi, 1955; Kamaci, 2013; Clark & Withers, 2007). The life cycle concept describes the transition between consecutive stages, from the birth to the death of an individual (Clark & Withers, 2007). There is view which argued that households somehow change in response to events such as birth, death, marriage and divorce, and these changes affect the housing needs of the families at different points in their life cycle (Clark, 2017). By 1980s, due to the limitations of the life cycle approach to explain the complex structure of mobility, the multidimensional life course approach was adopted (Geist & McManus, 2008; Wang et al., 2018). The life course approach that describes a critical life cycle stage reflects changes in status or social roles (Brazil & Clark, 2019). Unlike the life cycle approach, the key to the latter approach was the variations in timing and the order of vital events (Elder et al., 2003). It focused on the experiences of individuals and households based on age, education, work, family structure, parenting and retirement (Eceral & Uğurlar, 2017; Clark & Huang, 2004). Although it has been assumed for a long time that housing mobility is a way for individuals to relocate to better homes and neighborhoods and lead to better socio-economic conditions, life course studies acknowledged that not all relocations were a preference, and mobility may not always result in a better life (Patel et al., 2020). Another behavioral approach to mobility was the approach of satisfaction due to the housing or environmental properties (Brown & Moore, 1970; Earhart & Weber, 1996; Pickvance, 1974; Speare, 1974). Based on this approach, when the stress or dissatisfaction of the household with the residential environment reaches a certain threshold, the household enters a process of search, which could lead to residential mobility (Clark et al., 2006).

Household's decisions about moving or staying from an existing location may depend on many variables (Saghapour & Moridpour, 2019). Primarily, socio-demographic factors and life events have varying effects on the scale of displacement (Haque et al., 2020; van Gent et al., 2019). The desire to change the residence is

mostly affected by factors such as age, family size, household income, the presence of children, and a gradually changing socio-economic structure in the life cycle, vital events, and educational background (Li & Sui, 2001; van Gent et al., 2019; Li & Mao, 2018). Age and household structure are the most important factors that affect residential mobility and among the most utilized concepts in mobility analysis (Ham & Clark, 2009; Wulff et al., 2010). Residence mobility is the highest among young adult individuals and the most active group includes 20-35 years old individuals. Residence mobility decreases with an increase in age (Clark & Onaka, 1983; Li & Sui, 2001; Rossi, 1955; Clark et al., 1984; Clark, 2009).

In addition to the age variable, increases in household size due to marriage and birth and decreases in household size due to divorce, death, and children leaving home also lead to residence mobility (Brazil & Clark, 2019; Greenlee, 2019; Kooiman, 2020; Saghapour & Moridpour, 2019; Wang & Wai Li, 2020; Feijten & van Ham, 2009; Rossi, 1955; Rabe & Taylor, 2010; Wang et al., 2018). Residence mobility is observed especially during the first years of marriage (Chevan, 1971) since couples without children are more active, and the presence of young children in the household prevents mobility (Ham & Clark, 2009; Kooiman, 2020). Also, according to Lei & South (2020); "Young adults who live independently are twice as likely to move in urban movements and four times more likely to move out of the city than young adults living with their parents". The residence mobility studies reported that level of education also affects mobility and educated people are more active when compared to people with lower education levels (Clark, 2009). Especially those with higher education, higher socio-economic status, or civil servants are also more likely to relocate to high-rise housing (Li & Mao, 2018). In addition to the education level, it was reported that income is an important factor in understanding the residential career of individuals (Clark et al., 2006). Changes in employment such as starting a new job, retirement and unemployment, relatively increase mobility (Morris, 2017; Wang et al., 2018). Home ownership and tenancy also affect residential mobility; homeowners are less likely to relocate when compared to the tenants (Saghapour & Moridpour, 2019; Greenlee, 2019). In addition to the socio-demographic and economic household properties, vehicle ownership, driver's license ownership accessibility pedestrian access and especially access to public transport have statistically significant effects on residence preferences and mobility (Kamruzzaman et al., 2020; Haque et al., 2019; Saghapour & Moridpour, 2019). Also, place of birth, job, financial difficulties experienced by the family (Voight, 2020), and ethnicity (Clark & Withers, 2007; van Gent, et al., 2019), also affect mobility.

Another phenomenon that causes households to act for residence purposes is the satisfaction / dissatisfaction with the house and its close environment. The change in housing satisfaction is mainly affected by changes in housing conditions and neighborhood environment. The main determinants of change in housing satisfaction are adjustments in housing conditions (length of residence and house space) and the neighborhood environment (physical design, social interaction, and access to various facilities) (Wang & Wang, 2020). As Aditjandra (2012) stated; urban form characteristics, such as density, settlement size, land-use mix, accessibility and local streets lay out are cumulatively affecting attitudes towards residential location preferences alongside socio-demographic characteristics, housing location and job location (Sinniah et al., 2014). In addition, neighborhoods and resident perceptions about the neighborhood are the main factors that affect the decision to relocate or stay. Neighborhood is considered as one of the components of developmental hierarchy of the cities which is a major element of identity of the cities as a classical component (Zali et al., 2016). As neighborhoods change, demographic and socio-economic changes may prompt residents to consider moving or to stay (Jones & Dantzler, 2020).

The factors that affect residence mobility were first classified as voluntary and involuntary factors by Clark and Onaka. While voluntary movements included organized and stimulated movements, involuntary movements included compulsory movements. While the regulated movements included the actions of individuals to improve their housing and environment due to dissatisfaction, stimulated movements occur as a result of changes in the life cycle or life course of households or individuals. Compulsory movements are less common

when compared to other movements; they occur due to the factors that could not be controlled by the households or the households could not affect the development of these factors (Tab.1) (Clark & Onaka, 1983).

It is necessary and important to make behavioral analyzes at the individual level in order to make sense of the reason for the change in urban space. Studies dealing with residential mobility, which can be considered new for domestic literature, will be useful in revealing context-specific dynamics. In the present study conducted in neighborhoods with different characteristics, the factors that lead to mobility were discussed comparatively based on the framework of the residential mobility classification proposed by Clark and Onaka and the life-course-life-cycle-satisfaction approaches.

Optional		**Involuntary**
Organized movements	Stimulated movements	Compulsory movements
1. Residential	1. Work / study	1. Residential
Space	Job changes	Evacuation
Quality / plan	Retirement	Accidents
House prices		Disasters
Change about savings		
2. District	2. Life course	2. District
Quality	Formation of the household	City renovation projects
Physical environment	Dispersion of households	Major infrastructure projects
Social composition	Change in household size	Environmental hazards
Public services	Bad event in the household	
3. Accessibility		
To workplace		
To shopping,		
To public services		
To family and friends		

Tab.1 Classification of residence mobility (Clark & Onaka, 1983)

The hypotheses that will form the basis of the study are as follows:

- The reasons based on the life course are more effective than the life cycle factors on movements for residential;
- Housing reasons have a direct impact on residential mobility;
- Involuntary / compulsory movements have little effect on residential mobility;
- Socio-economic variables have the greatest impact on residential mobility.

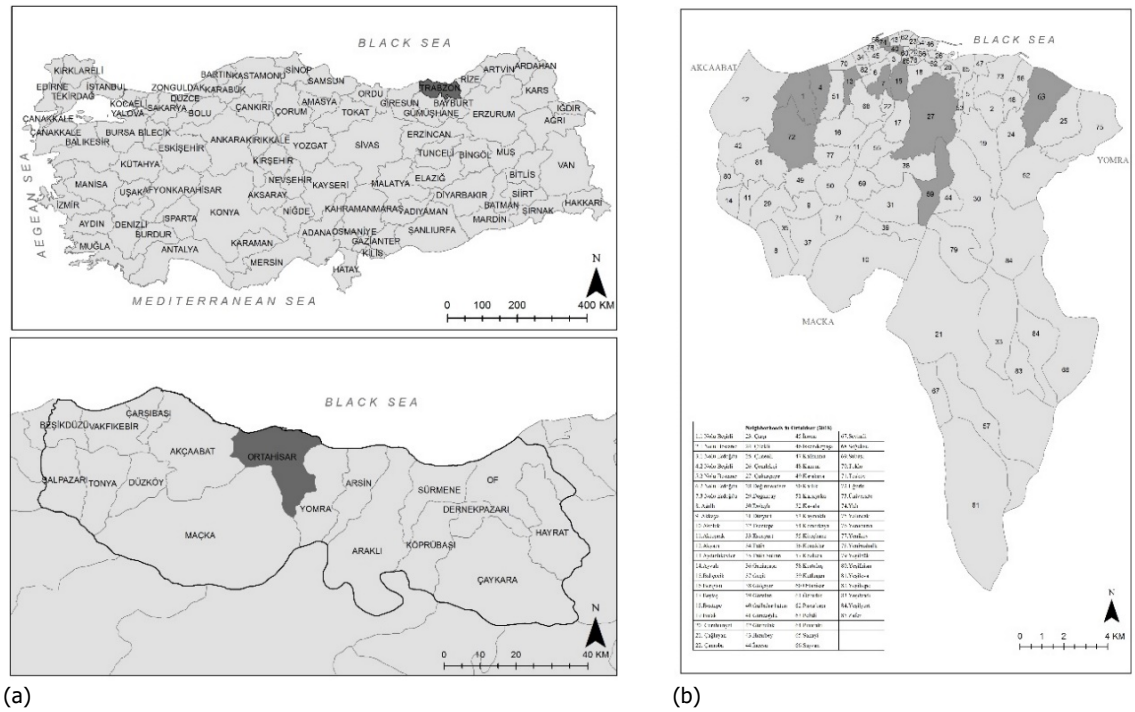
Within the scope of the study, the life cycle of the reasons that cause mobility, the life course and the holistic, comparative evaluation of the home satisfaction approaches, and the detailed classification of the reasons will also contribute to the literature. In addition to the determination of the factors that lead to mobility, the characteristics of mobility and the effects of individual mobility behavior in the urban space were also discussed in the study. It was considered that the improvements in built environment variables would affect the planning discipline and hence, the urban mobility.

3. Methodological approach

The present study focused on residential mobility, which was considered as an important foundation for understanding future urban development and planning. In the present study that was conducted to determine causality, the Ortahisar district in Trabzon province, Turkey was determined as the study area. The area was selected due to the following factors:

- the need and the goal to determine the mobility factors in a scale and geography that are different from the ones scrutinized in previous studies;
- the increasing population of the province;
- the fact that Ortahisar district was one of the most populated areas in the region;
- the expansion of the real estate industry and the transformations and changes observed in the city.

Trabzon province is located in eastern Black Sea Region and surrounded by Giresun province in the west, Rize province in the east, Bayburt and Gümüşhane provinces in the south and the Black Sea in the north. The surface area of the province is 462,800 ha. The total population in the province, which includes 18 districts and 688 neighborhoods, is 807,903 (Figure 1) (TÜİK, 2018).



(a) (b)

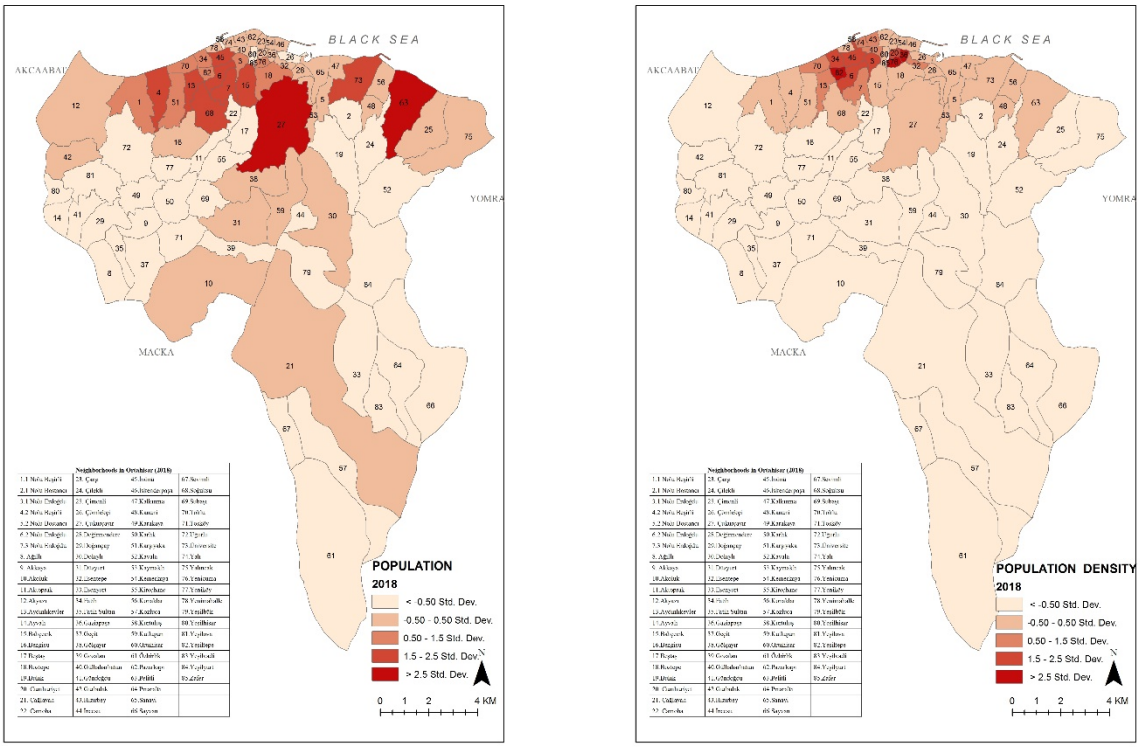
Fig.1 Section (a) Location of Trabzon and Ortahisar district; section (b) Spatial distribution of the neighborhoods in Ortahisar district

As of 2012, Ortahisar District was established with the inclusion of central municipalities and villages (43 in total) in Trabzon province with "Establishment of Metropolitan Municipalities in Fourteen Cities and Twenty-Seven Districts and Amendments in Certain Laws and Decrees" (Act No: 6360) in 2012. As of 2014, when the law came into force, there were 85 neighborhoods in the district and the surface area of the district was 23,200 ha and its population was 317,520 in 2018 (Tab.2).

According to the 2018 census, the neighborhood with the largest population was Çukurçayır (25958), which occupied 8.18% of Ortahisar district. Çukurçayır was followed by Pelitli (17,527) and Beşirli-2 (152,685) neighborhoods. The population of 24 neighborhoods was above the average district population (3,735). The analysis of the population growth between 2007 and 2018 demonstrated that the highest increase was observed in Çukurçayır (4,159.6 ‰) neighborhood. The neighborhoods with the highest population growth were Esenyurt (3,802.0 ‰) and Kanuni (1,951.0 ‰), respectively. In this period, it is observed that the highest population decrease was in Zafer (-962.6 ‰), Çömlekçi (-610.96 ‰) and Pazarkapı (- 560.75 ‰) neighborhoods. Based on the population variations between 2007 and 2018, the population of 51 neighborhoods increased and the population of 34 neighborhoods decreased (Tab.2 and Fig.2).

	Neighborhood	Population (2007)	Population (2018)	Population change (2007-2018) (‰)	Population density (per/hectar)
1	Beşirli-1*	7,238	9,742	346.0	36.22
4	Beşirli-2*	12,842	15,265	188.7	91.41
7	Erdoğdu-3*	13,336	12,836	-37.5	133.71
13	Aydınlıkevler*	8,640	12,695	469.3	154.82
15	Bahçecik*	9,092	11,008	210.7	88.77
26	Çömlekçi	2,329	886	-619.6	26.06
27	Çukurçayır*	5,031	25,958	4,159.6	36.20
33	Esenyurt	197	946	3,802.0	1.52
40	Gülbaharhatun *	3,545	2,504	-293.7	96.31
48	Kanuni	674	1,989	1,951.0	25.83
59	Kutlugün*	1,469	1,651	123.9	5.40
62	Pazarkapı	2,569	1,111	-567.5	31.74
63	Pelitli*	15,067	17,527	163.3	43.38
72	Uğurlu*	1,221	1,430	171.2	3.03
74	Yalı*	4,173	3,281	-213.8	149.14
85	Zafer	1,549	58	-962.6	9.67
Total (For 85 neighborhoods)		**292,513**	**317,520**		

Tab.2 Neighborhood population and population change in Trabzon (TUIK; 2007, 2010, 2014, 2018). The neighborhoods with the highest / lowest values in terms of population size are included in the table. In addition the detailed population values of the 11 neighborhoods* selected for the survey are also shown in the table



(a) (b)

Fig.2 Spatial distribution of the (a) population size and (b) population density of the neighborhoods

In the data collection phase of the study, which aimed to discuss the factors that affected residential mobility in Trabzon, survey method was used, and descriptive statistics and analysis of variance were used to analyze the findings in the framework of causality. Furthermore, the factors determined with

the survey findings were analyzed with the classification by Clark and Onaka and life course, life cycle and satisfaction approaches, and the results were compared with the literature. During the development of the survey questions, 9 domestic and 36 international studies were reviewed, and all variables used for the determination of residential mobility were listed. According to Table 3, the age variable has been the most repeated variable among among the 45 studies examining residential mobility. In addition to the age variable, income (35 repetitions), home ownership and occupation (34 repetitions) variables were also frequently used in mobility studies.

Variables and number of repetitions		Variables and number of repetitions		Variables and number of repetitions	
Age	37	Marriage	6	Economic trouble	3
Income (household)	35	Closeness to relatives	6	Duration of stay	2
Ownership	34	Poverty rate	5	Housing age	2
Education	34	Proximity to the city center	5	Housing source	2
Job / status	20	Location of the house	5	Public opportunities	2
Number of children / change	18	Proximity to work / school	5	Security	2
Marital status /change	17	Job change / appointment	5	Income exchange	2
Race / ethnicity / minorities	17	Unemployment rate (district)	5	Problem with the host	2
Household size	13	Number of friends in the field	5	Access opportunities	2
Gender	11	Building order	4	Cohabitation	2
Duration of use	10	Social opportunity	4	Traffic status	1
Room stress	9	Neighborhood calmness	4	Public transport proximity	1
Unemployment	9	Neighborhood pressure	4	Social class	1
Dissatisfaction	8	Missing	4	The prestige of the field	1
Marital status change	8	Retirement	4	School satisfaction	1
Housing type	8	Settlement size	3	Neighborhood quality ındex	1
Employment status	8	Number of bedrooms	3	Demolition of the house	1
Divorce	8	Aging / disease	3	Housing value	1
Living area size	8	Single person employment	3	Urbanization status	1
Neighborhood quality	7	Existence of parking areas	3	Heating problem of the house	1
Neighbourhood relationship	7	Neighborhood perception	3	The house's weakness	1
Appropriate rent	6	Time to work	3	Saving	1
Number of rooms	6	Job duration	3	Number of bathrooms	1
Age of the first child	6	Possibility of movement	3		
Movement number	6	Migration type	3		

Tab.3 Variables used in domestic and international literature and their frequency of use[1]

[1]The 45 studies examined in the table created by the authors are as follows: Wang et al., 2018; Eceral & Uğurlar, 2017; Ren & Folmer, 2017; Morris, 2017; Basolo & Yerana, 2017; Warner & Sharp, 2016; Yasak, 2014; Coulter & Ham, 2013; Liu et al., 2013; Kalelioğlu & Özgür, 2013; Kamacı, 2013; Clark, 2013; Coulton et al., 2012; Alkay, 2011; Clark, 2009; Ham & Clark, 2009; Clark, 2007; Clark & Withers, 2007; Duncan & Newman, 2007; Clark et al., 2006; Fattah et al., 2015; Kamacı, 2012; Sanchez & Andres, 2011; Alkay, 2011b; Huang & Deng, 2006; Kocatürk & Bölen, 2005; Özyıldırım et al., 2005; Clark & Huang, 2004; Clark & Huang, 2003; Li, 2003; Li & Siu, 2001; Clark & Drever, 2000; Clark & Mulder, 2000; Böheim & Taylor, 2000; Molin et al., 1996; Loikkanen, 1992; Landale & Guest, 1985; Clark & Onaka, 1983; Bach & Smith, 1977; Speare, 1974; Kan, 2007; Clark et al., 1984; Hanushek & Quigley, 1978; Kan, 1999; Boehm et al., 1991.

The survey form was developed based on housing satisfaction, location selection literature and questionnaire examples, and determined variables.

The form included open-ended and multiple-choice questions that reflected the socio-demographic structure, household structure, housing data, household mobility history, and possible future mobility of the household members.

Questions that aimed discuss the causality of the movement were developed as a 5-point Likert scale.

Questions that aimed discuss the causality of the movement were developed as a 5-point Likert scale.

The details of a total of 117 questions in the questionnaire prepared under six headings are as follows:

- questions about the socio-demographic structure of the household (12 questions) For each individual living in the household, gender, date of birth, marital status, marital status change, disability and disease status, education status, economic status, occupation, years of work, distance from workplace / school, unemployed time;
- Questions about household structure (5 questions) household size change and its reason, welfare level, total income, income change, vehicle ownership;
- Questions about housing and its immediate surroundings (12 questions) type of housing today, ownership status, age of the housing, the size of the housing, duration of use, number of rooms, rent / sales value, residence time in the neighborhood, the previous neighborhood, the reason for the last move, secondary home ownership;
- Questions about the mobility history of the individual participating in the survey (5 basic questions) the neighborhood where the first residence was located, the number of dwellings lived in, neighborhood information for each house, the reasons for movement and the years of movement;
- About possible movement (3 questions) desire for mobility, neighborhood suggestions and reasons of possible movement;
- Regarding the causality of the mobility (80 questions in total) 20 questions reflecting the characteristics of the household, 17 questions about the house, 11 questions about the home environment, 17 questions about the neighborhood, 8 questions about the social structure, 7 questions about the other factors.

After the study area was determined, the developed survey form was applied to a sample from Ortahisar district.

The number of questionnaires that should be applied to provide statistically feasible findings was determined as 383 questionnaires with a 5% error margin and 95% confidence interval based on 93,223 households, which were the total number of households in 2018, and the questionnaire was applied to 442 households with stratified sampling method.

The number of households in the neighborhoods was considered in the distribution of the survey conducted in 11 neighborhoods that represented Ortahisar district and with different socio-demographic, economic and physical structures (Fig.1b).

4. Findings

Residential mobility is both the cause and the outcome of changes in urban socio-spatial structures. Individuals react to their economic, demographic and political experiences, and changes in the demographic structure are reflected in residential mobility.

Therefore, to understand the mobility processes, it is necessary to investigate the socio-demographic structure and changes among mobile individuals.

In the next section, the survey findings are included, and the analyses are presented under four headings:

- The analyses conducted on the socio-demographic structure of the households and members;
- General analysis of the housing facilities;

- The analysis of household member mobility;
- The analysis of the factors that affect final mobility.

4.1 Socio-demographic analyses

The factors in the stimulated movement category are discussed under the life cycle and life course sections.

Life cycle

In this approach, gender, marital status, age, education, household size, disease, old age and disability sub-dimensions were analyzed. It was determined that 62.22% of the respondents were male and 37.78% were female, 94.12% were married, 5.88% were single.

The participant ages varied between 22 and 74, 29.66% of the respondents were between 40 and 44 years old, 24.75% of them were 35 and 39 years old, and 16.42% of them were 45 and 49 years old.

Most of the households were nuclear families, 42.12% included 4 individuals, 25.06% included 5 individuals, 15.50% included 3 individuals. The age of the first child was effective on residential mobility and 27,62% of them were between 10 and 14 years old, 20,99% of them were 5 and 9 years old, and 18,78% of them were between 15 and 19 years old (Tab.4).

The Life Course

In this approach, education, profession, income, employment, appointment, change of job, unemployment and welfare level sub-dimensions were analyzed.

It was determined that 37.10% of the respondents were college, 29.86% were high school and 9.05% were primary school graduates. While 66.74% of the individuals were employed, 22.40% were housewives, 8.37% were retired and 2.26% were unemployed.

Furthermore, 22.65% of the individuals had 10-14 years of professional experience, 21.60% had 15-19 years, and 21.25% had 20-24 years of professional experience. In 50.23%, 1 member was employed 2 members were employed in 21.95% and 3 members were employed in 0.90%.

The household income was TL 2501-5000 in 39.31%, TL 1501-2500 in 24.60%, and TL 5001-7500 in 17.70%. It was determined that the income in 63.86% of the households did not change, the income in 23.86% increased and the income in 12.27% decreased. In the household saving category, it was determined that 65.19% of the households owned at least one vehicle and 19% of households owned at least one home (Tab.4).

4.2 Housing analysis

The households were asked questions on the size, number of rooms, age of housing unit, ownership, type of residence, residence period and residence value in the category of organized movement.

Residence

It was determined that 49.02% of the households were between 121-160m^2, 25.37% were 81-120m^2, 21.46% were 161-200m^2, 66.11% were 3-room housing, 19.33% were 4-room housing, and 11.93% were 2-room housing.

About 33.33% of the households lived in 6-10 years old, 17.52% lived in 0-5, 13.87% lived in 11-15 years old residences.

About 62.95% of the participants were homeowners and 27.27% were tenants. 62.27% of the households lived in a condominium, 30.91% lived in an apartment and 6.59% live in a detached home, 38.46% resided in the same residence for 1-5 years, 35.10% for 6-10 years, and 12.98% for 11-15 years.

House market values varied between TL 100-400k, 20.34% varied between TL 251-300k, 16.90% varied between TL 301-350k, and 16.55% varied between TL 151-200k (Tab.4).

Stimulated movements						Regulated movement		
A) descriptive statistics about the life cycle			B) Descriptive statistics about life course			C) Descriptive statistics on satisfaction		
Variables		(%)	Variables		(%)	Variables		(%)
Gender	Female	37.78	**Education status**	Illiterate	0.45	**Living area size (m^2)**	56-80	2.20
	Male	**62.22**		Literate	0.45		81-120	25.37
Marital status	Single	5.88		Primary School	9.05		121-160	**49.02**
	Married	**94.12**		Middle School	8.37		161-200	21.46
Age	22-24	1.23		High School	29.86		201+	1.95
	25-29	1.96		University	**37.10**	**Number of rooms**	1	0.48
	30-34	8.82		Master	2.71		2	11.93
	35-39	24.75	**Economical situation**	Employed	66.74		3	**66.11**
	40-44	**29.66**		Unemployed	2.26		4	19.33
	45-49	16.42		Retired	8.37		4+	2.15
	50-54	8.09		Housewife	22.40	**Housing age**	0-5	17.52
	55-59	3.68		Student	0.23		6-10	**33.33**
	60-64	1.96	**Professional experience (year)**	0-4	9.06		11-15	13.87
	65-69	1.72		5-9	10.80		16-20	9.98
	70-74	1.72		10-14	**22.65**		21-25	8.52
Household size (person)	1	2.33		15-19	21.60		26-30	7.30
	2	8.27		20-24	21.25		30+	9.49
	3	15.50		25-29	8.01	**Ownership**	Houseowner	**62.95**
	4	**42.12**		30-34	4.18		Tenants	27.27
	5	25.06		35+	2.45		Lodgings	0.68
	6	6.72	**Number of employees (member)**	No	26.92		With Family	8.18
Age of the first child	0-4	16.64		1	**50.23**		With Family-p	0.91
	5-9	20.99		2	21.95	**Housing type**	Apartment	30.91
	10-14	**27.62**		3	0.90		Condominium	**62.27**
	15-19	18.78	**Total income (Tl)**	0-1,500	4.60		Detached Home	6.59
	20-24	8.29		1,501-2,500	24.60			
	25-29	7.18		2,501-5,000	**39.31**		Slum	0.00
	30-34	1.38		5,001-7,500	17.70	**Residence time (years)**	1-5	**38.46**
	35-39	0.55		7,500	13.79		6-10	35.10
	40-44	0.55	**Number of vehicles**	0	34.39		11-15	12.98
Number of children	No	11.28		1	**58.14**		16-20	6.25
	1	14.10		2	7.01		20+	7.21
	2	**44.87**		3	0.45	**Housing sales value**	100-150,000	11.38
	3	24.10	**Number of housing**	0	**81.00**		151-200,000	16.55
	4	5.64		1	16.29		201-250,000	13.45
				2	1.81		251-300,000	**20.34**
				3	0.90		301-350,000	16.90
							351-400,000	12.07
							400,000+	9.31

Tab.4 Factors causing stimulated and regulated movement

4.3 The analysis of individual mobility

In addition to the individual socio-demographics, their mobility background is also an important factor in the determination of their present and future impact on urban spaces.
The number of residential movements of individuals, their rhythm, type and direction of movement, causes, and categories of movement are discussed in this section.

The Number of Movements

The analysis of the total number of individual lifetime movements demonstrated that 20.81% of the individuals moved 2 times, 19.46% moved once, and 17.87% moved 3 times (Fig.3).

The Frequency of Movement

It was observed that 32.2% of the participants moved for the first time when they were 18-25 years old, 29.18% moved when they were 0-17 years old, and 19.46% moved when they were 26-30 years old.
The important threshold in the change of residence was the first year and it is accepted that individuals are more likely to move again when they move during their initial year of residence. 16.62% of the individuals moved during the first year and 68.25% moved during the first 5 years.
While the rate of a movement in the first 10 years was 86.80%, it was observed that the residence mobility frequency decreased as the residence period increased (Fig.3).

The Type of Movement

The movements of individuals throughout their lives were analyzed based on direction and distance, and short and long-distance movements were determined.
Residential movements between Ortahisar neighborhoods were categorized as short, and all other movements were categorized as long-distance movements. It was determined that 69.46% of the total movements were short, and 30.54% were long-distance movements. 16.52% of all movements were within the same neighborhood and 12.22% were between the neighborhoods.
The rate of the movements between provinces was 12.22%. The most common movement (69.46%) was the short distance movements within Ortahisar (Fig.3).

The Reasons for Movement

The reasons for lifetime residency mobility collected with the survey form were categorized based on the Clark and Onaka (1983) method. It was determined that 90.03% of the movements were voluntary and 4.04% were involuntary movements.
The remaining 5.93% could not be categorized based on Clark's classification system. 58.58% of the total movements were organized movements due to the satisfaction with housing and immediate environment, 31.45% were stimulated movements that reflected the individual or household structure, and 4.04% were compulsory movements due to residential and neighborhood conditions (Tab.5).

The factors that led to organized mobility

It was determined that 51.53% of the movements associated with the satisfaction approach were due to residential, 42.48% were due to accessibility, and 5.98% were due to district factors.
It was observed that 67.56% of the lifetime residence-oriented movements were due to savings preferences such as purchasing a home, 13.10% were due to quality, 10.71% were due to house prices and 8.63% were due to spatial reasons.
35.90% of the mobility within the neighborhood was due to the physical properties of the neighborhood, 33.33% were due to social causes, 20.51% were due to public services, and 10.26% were due to the quality of the neighborhood.
58.12% of accessibility-oriented movements were due to workplace access, 32.49% were due to access to public services, and 9.39% were due to access to family and friends (Tab.5).

The factors that led to stimulated mobility

36.29% of all lifetime stimulated movements were associated with the life cycle and 63.71% were associated with the life course. 99.21% of the work-based and work-related movements were due to job changes and 0.79% was due to retirement.

It was observed that 97.31% of the life cycle factors were associated with starting a new household, 2.7% were due to the end of the household, the change in the household size and the unfortunate events experienced in the household (Tab.5).

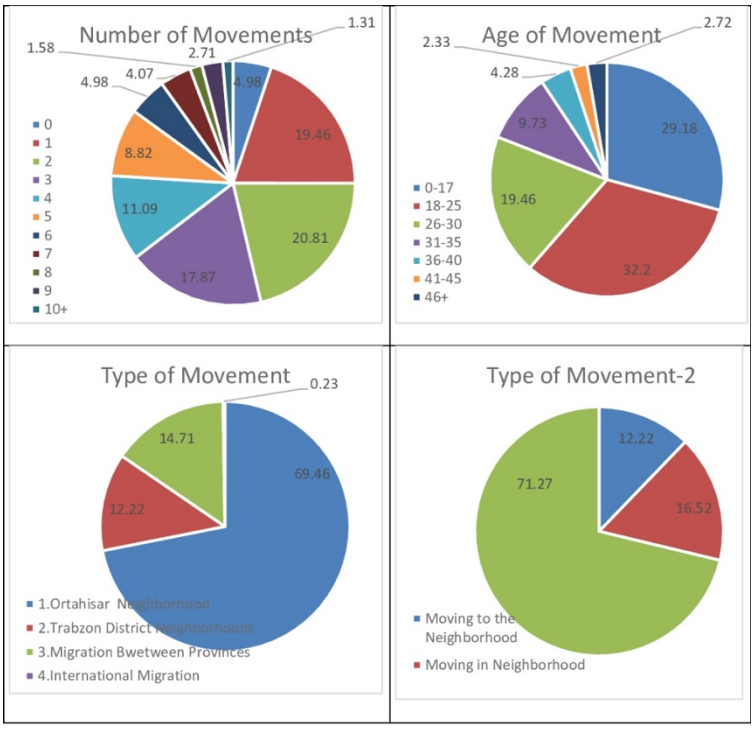


Fig.3. Mobility histories of individuals

The factors that led to compulsory mobility

These include factors associated with the residence and neighborhood and 82.22% of the compulsory movements were due to housing and 17.78% were due to neighborhood factors. 81.08% of the residential factors were due to evictions and 18.92% were due to disasters.

All neighborhood-oriented factors were associated with urban renewal projects.

The analysis of the lifetime mobility factors demonstrated that the most effective factors were the change in savings preferences (20,40%), the formation of a new household (19,49%) and proximity to the workplace (14,47%) (Tab.5).

The analysis of the mobility history of individuals demonstrated that the most effective factors behind the first individual movements in Ortahisar district included the formation of a new household (38.64%), proximity to the workplace (13.77%) and change in savings preferences (12.09%), respectively. In the second movement, it was observed that the most effective factor was change in savings preferences (20.00%).

The spatial and quality properties of the house, which was not mentioned in the first residential mobility, was effective on the second movement.

The factors such as the presence of public services, proximity to shopping, accidents, major infrastructure projects and environmental hazards were not determined as mobility factors in the present study (Tab.6).

Movement class	Movement sub-class	The factors causing the movement	The ratio of all causes (%)[1]	The ratio of causes in sub-class (%)[2]	The ratio of sub-class (%)[3]	The ratio of movement class (%)[4]
1. Organized movements	1.1 residential	Space	2.61	8.63	51.53	58.58
		Quality / plan	3.95	13.10		
		House prices	3.23	10.71		
		Change about savings	**20.40**	**67.56**		
	1.2. District	Quality	0.36	10.26	5.98	
		Physical environment	1.26	**35.90**		
		Social composition	1.17	33.33		
		Public services	0.72	20.51		
	1.3. Accessibility	Proximity to workplace	**14.47**	**58.12**	42.48	
		Proximity to shopping	0.00	0.00		
		Proximity to public services	8.09	32.49		
		Proximity to family and friends	2.34	9.39		
2. Stimulated movements	2.1. Work / study	Job changes	11.32	**99.21**	36.29	31.45
		Retirement	0.09	0.79		
	2.2. Life course	Formation of the household	**19.49**	**97.31**	63.71	
		Dispersion of households	0.18	0.9		
		Change in household size	0.18	0.9		
		Bad event in the household	0.18	0.9		
3. Compulsory movements	3.1. Residential	Evacuation	2.70	**81.08**	**82.22**	4.04
		Accidents	0.00	0.00		
		Disasters	0.63	18.92		
	3.2. District	City renovation projects	0.72	100	17.78	
		Major infrastructure projects	0.00	0.00		
		Environmental hazards	0.00	0.00		

Tab.5 Classification the survey results according to the classes of movement[2]

	Movement sub-class	The factors causing the movement	1. Movement	2. Movement	3. Movement	4. Movement	5. Movement	6. Movement	7. Movement	8. Movement
1. Organized Movements	1.1 residential	Space	0.00	4.91	2.21	1.71	1.28	0.00	0.00	0.00
		Quality / plan	0.00	6.42	2.21	5.98	3.85	8.70	7.14	0.00
		House prices	3.83	4.15	2.76	2.56	6.41	0.00	0.00	0.00
		Change about savings	12.09	**20.0**	**22.7**	**29.1**	**28.2**	**30.7**	**35.7**	**30.77**
	1.2. District	Quality	2.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Physical environment	1.18	1.89	1.10	0.85	1.28	0	0.00	0.00
		Social composition	0.29	1.51	3.31	0.00	0.00	2.17	0.00	0.00
		Public services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.3. Accessibility	Proximity to workplace	13.77	13.6	16.0	14.5	19.2	17.4	14.3	0.00
		Proximity to shopping	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Proximity to public services	10.03	7.17	12.2	6.84	8.97	10.9	7.14	23.08
		Proximity to family and friends	1.77	4.15	2.76	1.71	5.13	0.00	3.57	7.69
2. St...	2.1. Work/study	Job changes	0.00	10.9	17.7	19.7	12.8	19.6	10.7	23.08
		Retirement	5.01	0.75	0.00	0.00	0.00	0.00	0.00	0.00

[2] 1.This column shows the ratio of factors causing movement within the total movement.
2.This column shows the ratio of factors causing movement within the movement subclass.
3.This column returns the proportion of subclasses within the motion class.
4.All movements are grouped under three headings: organized, stimulated and compulsory.

	2.2. Life course	Formation of the household	**38.64**	15.5	0.00	8.55	10.3	10.9	14.3	15.38
		Dispersion of households	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.00
		Change in household size	0.58	1.13	8.29	0.00	0.00	0.00	3.57	0.00
		Bad event in the household	0.59	0.00	0.00	0.85	0.00	0.00	0.00	0.00
3. Compulsory movements	**3.1. Residential**	Evacuation	3.82	5.66	6.63	5.13	2.56	0.00	0.00	0.00
		Accidents	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Disasters	1.47	0.75	0.55	0.00	0.00	0.00	0.00	0.00
	3.2. District	City renovation projects	0.29	0.75	1.66	0.00	0.00	0.00	3.57	0.00
		Major infrastructure projects	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Environmental hazards	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tab.6 Movement histories of individuals

4.4 Causality analysis for residential mobility

The effects of 80 mobility propositions, which have been/are effective on the mobility of individuals and were developed based on all variables reported in the literature, were analyzed with a 5-point Likert-type scale.

	Factors that may be effective in the residential movement	**Not effective at all (%)**	**Less effective (%)**	**Moderately effective (%)**	**Quite effective (%)**	**Very effective (%)**	**Quite+very effective (%)**
Individual features	Age of household head	36.07	25.80	23.52	8.22	6.39	14.61
	Marital status	15.98	19.41	20.55	21.92	22.15	44.06
	Death of one of the spouses	14.91	20.64	29.36	20.64	14.45	35.09
	Education status	18.71	16.40	32.10	20.55	12.24	32.79
	Number of households	10.37	12.90	29.26	31.11	16.36	47.47
	Number of children in household	9.89	14.94	28.28	28.05	18.85	46.90
	The birth of the first child	29.36	31.88	19.50	11.93	7.34	19.27
	Starting school of children	8.24	16.93	30.21	26.09	18.54	44.62
	Leaving home of children	19.91	26.62	27.55	16.44	9.49	25.93
	Household income	4.37	10.80	20.92	33.79	30.11	63.91
	Number of employees (household)	10.85	13.39	27.25	29.33	19.17	48.50
	Individuals' professions	12.21	16.36	23.50	27.42	20.51	47.93
	Appointment	4.15	3.46	8.76	16.82	66.82	**83.64**
	Number of unemployed (household)	10.14	18.89	21.20	25.12	24.65	49.77
	Household accumulation	11.06	9.45	29.03	29.03	21.43	50.46
	Retirement	11.42	15.53	29.91	26.48	16.67	43.15
	Number of sick in the household	12.41	19.54	31.26	22.07	14.71	36.78
	Number of old person (household)	12.36	20.59	33.87	18.54	14.65	33.18
	Number of disability in the household	10.11	13.79	27.82	26.21	22.07	48.28
	The desire to live independently	11.72	17.24	26.21	26.21	18.62	44.83
Reasons about housing	Interior design of the housing	13.56	17.93	32.87	23.91	11.72	35.63
	Number of floors of the housing	15.26	27.33	31.89	17.54	7.97	25.51
	Age of the housing	6.64	12.81	32.72	29.75	18.08	47.83
	New housing	9.36	10.96	25.11	30.37	24.20	54.57
	Property ownership	3.87	5.24	15.03	29.61	46.24	75.85
	The size of the housing	5.49	9.38	27.23	33.18	24.71	57.89
	Duration of stay at housing	13.07	24.08	28.44	21.10	13.30	34.40
	Number of rooms in the housing	5.49	9.15	29.29	32.72	23.34	56.06
	The soundness of the housing	5.09	5.79	17.36	35.88	35.88	71.76
	Heating status of the housing	3.42	6.62	15.75	36.53	37.67	74.20
	Lift presence of the housing	4.12	10.30	20.37	35.01	30.21	65.22
	Affordable rent	4.79	5.02	14.16	34.70	41.32	76.03

	Parking facilities of the residence	8.94	12.39	30.50	28.44	19.72	48.17
	Maintenance costs of the housing	5.26	9.84	30.21	32.72	21.97	54.69
	The view of the house	10.78	17.89	33.72	20.41	17.20	37.61
	Advertising of the housing	29.20	24.37	25.52	13.56	7.36	20.92
	Reliable contractor	10.96	14.16	27.17	27.40	20.32	47.72
Reasons to housing environment	To be in the site	8.22	14.16	26.71	31.51	19.41	50.91
	Desire to live in a luxurious housing	9.38	12.13	27.46	28.15	22.88	51.03
	Residential opportunity with a garden	5.48	15.53	25.57	26.26	27.17	53.42
	The security of the residential environment	1.83	6.18	18.99	30.21	42.79	73.00
	Presence of a playground around the residence	4.35	10.76	23.57	30.43	30.89	61.33
	Common area around the housing	6.85	10.73	29.45	30.14	22.83	52.97
	Privacy	4.13	8.72	22.02	29.13	36.01	65.14
	Construction density	6.22	18.89	31.57	25.35	17.97	43.32
	The harmonization of the residential area with the environment	7.14	15.21	29.26	28.11	20.28	48.39
	Suitability for climate	11.81	18.98	26.16	26.16	16.90	43.06
	Security of residential areas against natural disasters	2.77	7.16	17.78	23.33	48.96	72.29
Reasons for the neighborhood	Location of the neighborhood	3.67	7.57	26.38	30.28	32.11	62.39
	The size of the neighborhood	10.98	25.86	35.93	18.08	9.15	27.23
	Planned structure of the neighborhood	9.01	15.70	27.02	30.02	18.24	48.27
	The prestigious structure of the neighborhood	9.38	14.42	29.75	26.32	20.14	46.45
	Duration of stay in the neighborhood	8.94	16.51	30.05	26.15	18.35	44.50
	Proximity to work	2.97	5.26	21.74	32.72	37.30	70.02
	Proximity to daily trading centers	2.51	7.31	20.09	36.30	33.79	70.09
	Proximity to different trade centers	6.19	16.51	30.96	27.52	18.81	46.33
	Proximity to the city center	4.58	9.15	22.88	34.55	28.83	63.39
	Proximity to children's school	2.74	6.16	11.42	33.56	46.12	**79.68**
	Proximity to the health facility	3.44	8.94	23.85	34.40	29.36	63.76
	Proximity to religious facilities	10.53	17.39	30.21	25.63	16.25	41.88
	Proximity to sports fields	8.47	19.22	34.55	24.49	13.27	37.76
	Proximity to recreational and leisure areas	9.43	19.54	37.70	20.69	12.64	33.33
	Proximity to public transport line and stops	3.70	10.16	21.71	36.26	28.18	64.43
	Infrastructure status of the neighborhood	4.79	7.08	16.89	34.25	36.99	71.23
	Vehicle density in the neighborhood	5.26	12.36	30.66	30.43	21.28	51.72
Social reasons	Similar social structure	9.20	13.10	26.67	34.25	16.78	51.03
	Proximity to parents	10.85	16.63	31.18	21.48	19.86	41.34
	Proximity to relatives	19.04	22.94	32.80	13.76	11.47	25.23
	Distance to relatives	20.97	30.11	32.80	1.88	14.25	16.13
	Neighbourhood relationships	8.51	11.95	32.64	27.36	19.54	46.90
	Crowd of people	12.39	21.79	32.80	19.27	13.76	33.03
	Neighborhood calm	5.98	12.87	28.97	27.82	24.37	52.18
	Dialogue with the landlord	6.94	7.18	19.68	29.40	36.81	66.20
Other	Neighborhood cleaning	3.90	7.80	21.33	33.26	33.72	66.97
	Feeling safe in the neighborhood	2.76	5.30	7.83	25.81	58.29	**84.10**
	Natural disasters	3.66	5.26	14.19	26.32	50.57	76.89
	Potential to invest of neighbourhood	8.74	8.51	23.45	30.11	29.20	59.31
	Closeness to job opportunities of neighbourhood	7.66	10.21	29.93	31.32	20.88	52.20
	Number of housing changes	21.73	23.36	30.37	15.89	8.64	24.53
	Sales with government assurance	17.92	19.10	31.13	20.05	11.79	31.84

Tab 7. Variables that are or may be effective in mobility

The cell (s) with the highest repetition rate for each variable are indicated by padding. 2. The most effective variables specified in the mobility are indicated by the red frame. 3. Variables are listed according to the effect level by giving points from 1 to 5. (1: Not at all effective, 2: Less effective, 3: Moderately effective, 4: Effective, 5: Very effective)

The results of the analysis conducted based on the variable frequency in each effect level demonstrated that factors such as appointment, neighborhood safety perception and natural disasters were "very effective," being "warm" towards the house, the proximity to the malls, and the proximity to public transport stations were "quite effective," proximity to recreational and leisure areas, neighborhood size and proximity to sports centers were "moderately effective," the birth of the first child, the distance to relatives and the number of floors in the buildings were "less effective," the head of the household, the birth of the first child, and the advertising about the house were "not effective at all" (Tab.7).

5. Discussion and conclusion

Residential mobility is the desire and process of individuals or households to change their residences and immediate environment as a result of both dissatisfaction and changes in their life cycle and life course. The factors that shape the demographic, economic, social and physical structure of the individual or their city are the foundations of this desire for change. In the present study conducted in Trabzon province Ortahisar district, the reasons for residential mobility that shaped the urban spaces were determined based on location, and information about the general characteristics and movement preferences of the residents were identified. Statistical analysis conducted on the variables about the individual, household, residence and the environment and mobility variables revealed the results listed below:

- There were correlations between individual mobility for residential reasons and household size, number of children, educational status, total income, type of residence, the length of residence, the length of residence in the same neighborhood, and number of rooms in the residence;
- It was determined that the increase in household size first increased then decreased residential mobility, the highest mobility (above 10 moves) occurred in 3-individual households, 26% of the individuals without any residence movement in their lifetime were 2-individual (highest rate) households;
- Childbirth initially increased mobility, the mobility decreased after two children, and the highest rate (36.8%) in the non-mobile households belonged to no children households;
- Based on the educational level, the most mobile group included college graduates, only literate and those with graduate degrees moved at least once in their lifetime, 40% (maximum rate) of the immobile group included primary school graduates;
- The increase in household income increased residential mobility, the households with the highest income (TL 7500+) moved at least once in their lifetime, while the immobile group (54.5%) had an income level of TL 1501-2500;
- As the length of residence in the house and neighborhood increased, mobility decreased, and the highest mobility was observed among those who were residents for 1-5 years in the same home and neighborhood;
- As the housing age increased, residential mobility decreased, and the highest number of movements were observed in individuals who lived in 11-20 year old homes;
- The residential mobility of the households with 1-2 individuals differed from the mobility of households with 3-4 individuals;
- The mobility of the households without children was different when compared to those with 1 child;
- The residential mobility of the college graduate individuals was different when compared to that of the literate, primary school and middle school graduates;
- The mobility of the household with an income of TL 7500 and over was different when compared to all other income groups (except TL 5001-7500 income group);
- The mobility of the households with 1-5 years length of residence was different when compared to all other groups.

In general, it has been observed that a significant portion of individuals perform their first movements between the ages of 18-25, short-distance movements occur more than long-distance movements, and a very small part of the movements are caused by compulsory reasons. With the study, it was observed that the factors related to the satisfaction of the residence and its close surroundings were more effective than the neighborhood satisfaction in the mobility of the individuals residing in Ortahisar district throughout their lives. It was concluded that the factors affecting the life course approach, which replaced the life cycle over time, were more effective in Ortahisar mobility. According to the mobility histories of the individuals, the first mobility was mainly due to household formation, and the subsequent movements were due to housing ownership. It is seen that these results obtained from Ortahisar district field study are compatible with literature and hypotheses. In addition to these, it was concluded that the factors regulated regarding the satisfaction of the house and its surroundings are more effective than the induced reasons that describe the socio-demographic and economic structure of the individuals. This result does not support the related hypothesis of the study. Furthermore, it was concluded that the reasons based on the satisfaction approach were more effective than the life cycle and life course factors on movements for residential purposes in the present study. The most important factors that led to movements for residential reasons included the changes in savings preferences, household changes, and proximity to the workplace. The detailed interpretation of the factors that cause the regulated movement is a guide for local administrations, researchers, planners and implementers in terms of questioning the housing sector, accessibility decisions and livability levels.

In conclusion, it is known that the changes in the spatial structure in urban areas is mainly the result of housing mobility. The past and future impact of individual mobility on cities is an issue that should be addressed in a holistic manner on separate scales. It is important to analyze the individual, household and the urban factors that lead to mobility and to determine the changes in the process. As Yakubu & Spocter (2020) mentioned, it is important to accept the general limitations of traditional perspectives on residential mobility based on the differences in housing market dynamics in various cities with different socio-economic and cultural realities. In the study conducted on selected neighborhoods in Ortahisar district, it was observed that the individual factors that affected mobility mostly coincided with the reports in the literature. In addition to the general acknowledgments of residential mobility, a broad and multidimensional causality debate was conducted in the study. In addition to the determination of the mobility profile and comparison with the literature, the characteristics of the selected urban settlements in Ortahisar district were revealed with the housing/neighborhood selection decisions and mobility reasons. The findings of this the present study aimed not only to contribute to the literature on residential satisfaction and mobility, but also to help improve urban planning and housing policies.

The heterogeneous consequences of relocation should be further explored since the improvement of residential and neighborhood satisfaction is a determining factor in mobility decisions, and context-specific measures should be developed to improve living conditions. Finally, identification and classification of the factors that lead to mobility would provide planning guidelines through association of the variables of urban service areas, adequacy of these areas, and quantitative variables related to urban spatial problems and opportunities.

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Image Sources

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TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 375-388
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/7158
Received 10th September 2020, Accepted 25th October 2020, Available online 31st December 2020

Project role for climate change in the urban regeneration. Reinventing cities winning projects in Milan and Rome

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Abstract
The effects of the climate change employ a strong impact on the city and on the inhabitants, in fact the risk appears to be particularly clear in the metropolis. The urban setting fulfils a leading role in the consequences on the climate situation and the cities turn out to be the mainly responsible for the emissions of pollutants. In this situation the urban regeneration, as an opportunity to operate on the city's "wounds" through an accurate plan, tries to improve the reactions of the urban territory even in terms of environmental sustainability. Becomes particularly important summarising the different kinds of knowledge of the various disciplines to assure the management of complex processes, like those of the transforming city that need a new way to intervene in the urban project. The urban regeneration is a "multidisciplinary container" that can efficaciously face the needs of the territory, a way to obtain the urban quality. The Italian metropolis manifest the will to align to the international expectations through the implementation of targeted urban regeneration built-in programs. The Reinventing Cities projects present solutions attributable to those typological features necessary by now in the sustainable urban regeneration projects, showing vision of a renewed architectural projects.

Keywords
Climate change; Urban regeneration projects; Metropolitan cities; Reinventing cities

How to cite item in APA format
Strippoli, V. (2020). Project role for climate change in the urban regeneration. Reinventing cities winning projects in Milan and Rome. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 375-388. http://dx.doi.org/10.6092/1970-9870/7158

1. The city regeneration to answer to world change

The effects of the climate change employ a strong impact on the city and on the inhabitants. The atmospheric pollution, as declared by the European Environment Agency (EEA), continues to significantly impact the citizens in the urban areas (EEA, 2019). The risk appears to be particularly clear in the metropolis, where three-quarters of the population are exposed to very high level of concentrations of particulate.[1] The climate change is the direct result of the atmospheric pollution and appears today as the biggest environmental threat for the human well-being. Significant impacts of the climate change influence more and more all the countries and the people worldwide (Papa et al., 2015). The threat of the phenomenon has persuaded to act even the United Nations, that have introduced the goal n° 13 among the "Sustainable Development Goals (SDGs)", aimed at fighting the climate change, for the decrease of the pollution and the global warming. A fight that starts from the city, as disclosed by the goal n° 11 of the 2030 Agenda of the United Nations: it is necessary to make the cities and the villages long-lasting and sustainable (ISTAT., 2019). It is inevitable to think to a strict relation among environment, sustainability and city. The urban setting fulfils a leading role in the consequences on the climate situation; the cities turn out to be the mainly responsible for the emissions of pollutants in the atmosphere, primarily due to urban mobility, buildings and factories (Leoni & Viti, 2018). To turn the tide, it is necessary to start again from the cities, transforming them from pollution generation to urban lungs. The urban regeneration, as an opportunity to operate on the city's "wounds" through accurate plan, tries to improve the reactions of the urban territory even in terms of environmental sustainability (Di Lascio & Giglioni, 2017). A well-structured action that, among the main goals, is determined to: reduce the polluting emissions through implementation strategies that favour the use of the sustainable mobility; support the use of renewable energies, sustainable and environmentally friendly materials, preferring them to polluting building materials (CNAPCC, 2012). An eco-friendly core that behaves as "multidisciplinary container" (Fig.1), that includes the totality of aspects such as social, economic, environmental, landscape, architectural, technical etc. (Cabras, 2017). According to this premises two questions are founded: can the coordinating role of the different fields that act on the urban transformations be led to the architectural project? How can the project action answer to the atmospheric pollution of the cities, in terms of environmental sustainability and urban regeneration?

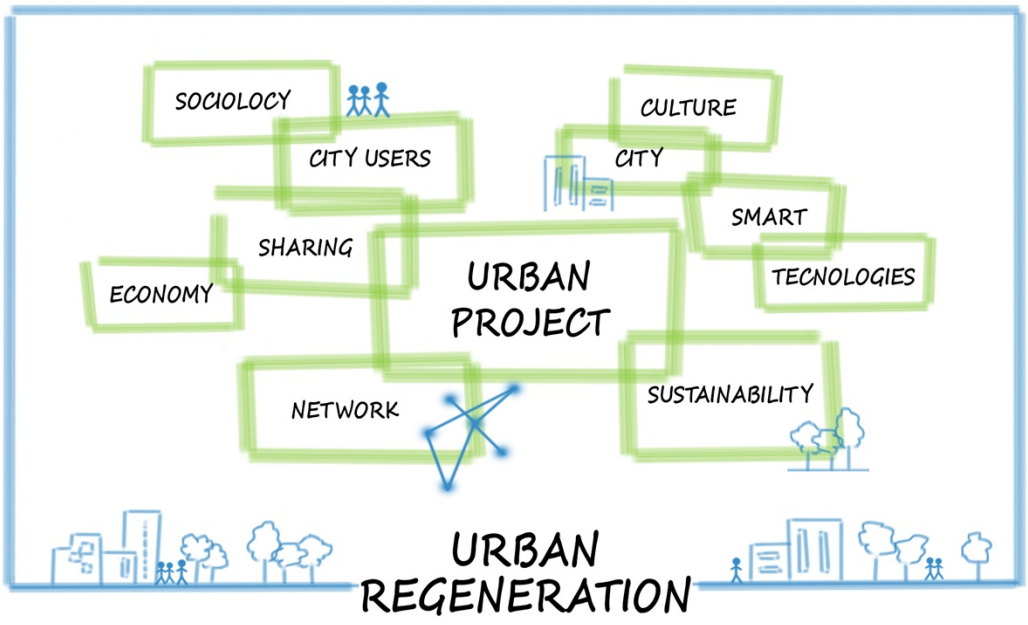

Fig.1 The shared centrality role of project in Urban Regeneration, a multidisciplinary container of urban items

[1] The WHO (World Health Organization) sets PM 2,5 as limit for the particulate.

Those aspects, structured and integrated with each other, give rise to complete policies able to efficaciously face the needs of the territory. Becomes particularly important summarising the different kinds of knowledge of the various disciplines to assure the management of complex processes, like those of the transforming city that need a new way to intervene in the urban project. With this statement, the aim is to confirm as the urban project is evolving from unconditioned centrality to "shared centrality". The challenge recognizes an occasion to reach a common goal in the potentialities of the integrated projects: the urban quality (Berdini, 2014).

1.2 The urban quality

"The image of object seen for the first time may be identified and related not because it is individually familiar but because it conforms to a stereotype already constructed by the observer [..]. A workable image requires first the identification of an object, which implies its distinction from other things, its recognition as a separable entity. This is called identity, not in the sense of equality with something else, but with the meaning of individuality or oneness. Second, the image must include the spatial or pattern relation of the object to the observer and to other objects. Finally, this object must have some meaning for the observer, whether practical or emotional. Meaning is also a relation, but quite a different one from spatial or pattern relation."[2]

The quote by Lynch (1960) inspires to think about the importance of the image of the city and its perception, an aspect strictly connected to the quality of the city spaces, compromised in the case of a crumbling urban environment. The goal declared by the regeneration relies on this aspect, indicating as ultimate purpose the achievement of the urban quality, as well as the renovation of the city from the current crumbling image (De Carlo, 2013).

Pursuing the urban quality means to dynamically relate all the elements linked to the redevelopment of an area to the wider ones connected to the background where it stands (Blečić & Cecchini, 2016).

The sum of several good projects is not enough, indeed, to guarantee the improvement of the quality in the urban experience for the inhabitants, but it offers a vision physically limited to the reinstatement of the quality of the project area (Cocco, 2017).

The parameters to consider for an action that has such purpose are countless; however, it is not possible to analyzed the possible scenarios in their entirety because each place is subject to the influence of several variables, whether physical or not, that condition the urban area.

The good architect, to chase this purpose, must accept the "new planning analysis" proposed by the regeneration schedule and must analyzed the city to regenerate from a wider and more critical point of view (Falzetti, 2004).

To clarify the concept, it is necessary proposing some examples of territorial and social markers useful for the achievement of the goal. Those parameters can't be neglected; they are observed in most cases, that can represent a starting point for a more extensive and contextualize analysis:

- A performance analysis of the urban setting, the energies and the materials used for the control of the polluting emissions. Knowing the "sustainability level" of the urban area;
- The identification and the analysis of the urban fabric that characterize the urban morphology;
- A qualitative analysis related to the consolidated construction industry, with the identification of dynamic areas for the uncontrolled expansion that need regulatory and upgrading interventions;
- The process of locating of cornerstone areas for public and social life;
- Analysis of the local economy related to the urban background;

[2] Kevin Lynch, back in the '60s, with his book "The image of the city", expresses an idea still efficient and actual. He describes as the image of the city is perceived by the inhabitants and how this vision influences the identity of the urban place itself. The today's issues on the urban regeneration recalls the theories of Lynch, directing the way toward the renovation of a quality urban image.

- The process of locating of the administrative and public activities and a quantificational and qualitative analysis of the public and private services for the inhabitants (transport, pedestrian and cycle mobility, itineraries and parks, public areas) (Bertuglia & Vaio, 2019).

As a support for the actualization of regenerative actions, finalized to the achievement of the urban quality, AUDIS has developed the urban regeneration document and the urban quality matrix (Tricarico & Wanner, 2012). The document clarifies and deepens the concept of quality itself and it shows a model to adopt for urban projects for the fulfilment of plans finalized to the sustainable urban improvement. Among the essential requirements listed in the document for urban regeneration by AUDIS, it is especially highlighted the one related to:

- *Environmental quality*, that aims to equilibrate the relation between the environment and the built, in favour of a sustainable development. To achieve the goal, it is necessary starting from an accurate evaluation of the pre-existing environmental conditions; it is important acting to preserve the environmental conditions in favour of the inhabitants' health. This marks the first step for the assignment of the intended use of the places;
- *Energetic quality*, for the cities prefigured as energy-intensive organism, composed of buildings mainly constructed during the half of the last century. The plan proposes a change of course to make the buildings' cases more efficient, to reduce the waste of energy. Converting the cities into eco-cities, characterized by a control of the consumptions and use of the renewable resources. An attitude finalized to the environmental and human well-being, that experience the built[3].

In the urban regeneration plan, the "building issue" represents, therefore, an important role, in the matter of energetic efficiency of pre-existing buildings, to renovate and newly built.

The projects in line with the principles of urban regeneration must inevitably include the use of sustainable materials and renewable energy, in case of rehabilitation projects of the pre-existing buildings, preferred to the newly built projects, and act to improve the energetic class of the older buildings, therefore substituting the old heating system with those of the latest generation, that use renewable and green energy (Lombardi, 2008).

The role of the project is to take on the sustainability challenge, including the answers on the energetic and environmental efficiency, for a new ecosystem built of sustainable and energetic auto-sufficient spaces. The architectural project, therefore, is able to provide a concrete reply to the need of greener and cleaner cities, showing a new awareness and a renewed will to act, answering to the contingent request of renewed liveability and sustainability of the territory and of the inhabitants themselves (La Varra, 2016).

So, the project supports an intervention line for the cities finalized to the achievement of the "urban welfare" that satisfies the needs of both the city user and the urban resilient organism, meant as an active organism able to evolve and change depending on the needs change (Bertoglio, n.d.).

A first step toward the decrease of the emissions of the urban organism is linked to the transport network, to the pedestrian and cycle mobility (Bianco, 2008). If each city succeeds to guarantee a more efficient transport network, a cycle lane network across the entire city, well-structured and safe pedestrian paths and sharing services, the use of private vehicles would be reduced improving the quality of the air. The issue of the transport has a huge role in the pollution of the city; however, is just one of the culprits of the climate change (D'Ambrosio, 2015).

The problem indeed is more entrenched, and it can't be limited to the smog due to the transport but it should be deepened, as suggested in the document about quality by AUDIS, in terms of several aspects intrinsic in the urban background.

[3] The issues disclosed come from the synthesis of the definitions of quality suggested in the urban regeneration document by AUDIS (Tricarico & Wanner, 2012).

1.3 Milan and Rome, the sustainable action to urban regeneration

The atmospheric pollution is one of the main problems that affect the "metropolitan city"[4]. In fact, the improvement of the air quality is the first goal to be achieved to obtain the urban quality in the cities. Rome and Milan are the symbol of this topic. Their territorial extension, the inhabitants' density, the mobility and the land-use negatively affect the environmental efficiency of the urban system, contributing to the increase of the climate pollution (Mazzeo, 2019). In this context, the environmental aspects are a fundamental component to city planning. The actions for the development in the strategics and territorial plans converge toward an urban planning and a social-economics development of the city, integrating sustainable solutions for the transport management, the increase of the sustainable mobility, the promotion of the pedestrian and cycle mobility, the reforestation of city areas with high building density, the conversion of municipal waste management towards a policy based on 70%-80% on recycled resources. These are solutions aimed to reduce the pollutant emissions and to the purification of microparticles emitted by the city as an energy-consuming organism. However, the applied effort is not enough to reach the goal of making the cities sustainable. In fact, the climate change fulfils a leading role in the Italian metropolis, in which the particulate emissions overcome the maximum level during most of the year. As showed by the annual report published by Legambiente[5], the riskier situation involves the major cities in Italy, first Milan and Rome (Fig.2). Despite the "unlawful"[6] Italian cities decreased from 62 to 26 entities in the last 10 years, Milan is still first in line having exceeded the limit of emissions 10 years of 10. Rome, instead, even if it is lower in the list, is still far from being a sustainable city, recording an excess of emissions 7 years of 10 (Fioravanti et al., 2020).

YEARS IN WHICH THE LIMIT IS EXCEEDED	CITIES THAT HAVE EXCEEDED THE LIMIT OF FINE DUST (PM10) FROM 2010 TO 2019
10/10	Alessandria, Asti, Brescia, Cremona, Frosinone, Lodi, **Milano**, Modena, Napoli, Padova, Pavia, Reggio Emilia, Rimini, Rovigo, Torino, Treviso, Venezia, Verona, Vicenza
9/10	Bergamo, Ferrara, Monza, Parma, Piacenza, Terni
8/10	Avellino, Como, Mantova
7/10	Benevento, Novara, Ravenna, **Roma**, Vercelli
6/10	Biella, Bologna, Palermo, Pescara, Trieste, Varese
5/10	Forlì, Pordenone, Prato
4/10	Cagliari, Firenze, Lecco, Lucca, Pesaro, Sondrio
3/10	Ancona, Caserta, Cuneo, Perugia, Salerno, Trento
2/10	Genova, Latina, Macerata, Pisa, Udine

Fig.2 List of cities that have exceeded the limit (50 microgram per cubic foot) of PM 10 in the last 10 years by Legambiente (Legambiente, 2020)

Doing a parallelism between the two metropolitan situations, we can identify as in Milan the change toward the "sustainable future city" has already started. The very urban morphology that characterizes the city allows an easier insertion of systems of pedestrian and sustainable mobility. The presence of different metro and tram lines, indeed, favours the use of the public transport, as well as the possibility to use sharing car or bike systems whether electrical or not. The action is not limited exclusively to the use of an eco-friendly means of

[4] The Italian metropolitan areas are identified by a national law, n. 56/2014, which provides for the institution of ten "metropolitan cities" on the territory of the previous provinces. The new institutional subject interest the cities of Rome, Milan, Naples, Turin, Genoa, Venice, Bologna, Florence, Bari and Reggio Calabria. They are characterized by a specific system based on qualitative consideration and on their social, cultural, economic and territorial topic of the cities (Mazzeo, 2018).

[5] Legambiente, with the report "Mal'aria di città 2020", launches a further warning about the increase of the pollution in the Italian city, whose emissions are mainly due to: traffic, domestic heating, factories and rural activities. The primary particulate represents the 30% of the total emissions, divided in turn by the combustion of the wood (60%) and by the cars (12%). The second particulate is instead responsible of the 70% of the pollutant emissions, namely those developed from trailblazing gasses such as ammonia, nitrogen oxide and volatile organic composites, mainly coming from the rural field and from the traffic.

[6] With "unlawful" are meant all those cities that exceed the set limit of PM 10 emissions.

transport but it also aims to a re-statement of the urban territory toward a scenario that places the city user in the centre of the urban planning, meant as "pedestrian" user in the city, giving to it the chance to experience the territory through the increase of the pedestrian paths, the public places such as squares, parks and green areas, converting the city in a series of "urban opportunities" for the psychophysical well-being of the user. So, the public urban areas will not be just meeting points for the inhabitants but they will become the connection between city and nature, building a bridge between built environment and nature, that embellishes itself of a strong common and social value for the city users (Zanchini et al., 2019). A very significant fact that proves how Milan is ready for a change, with its "multimodal" population, namely used to use different mobility systems in addition to their own means of transport, with a percentage of 90%; a fact that in Rome is less significant showing a percentage of 35%. On the other hand, the capital, both for its morphology and its territorial expansion, must face problems that make it difficult to effect plans focused on the realization of pedestrian and shared itineraries; nevertheless, the purpose is to convert even such a huge city into an urban territory "suitable" for a multimodal population. The evaluative comparison is finalized to understand the development phase of two Italian metropolises, located in two different territorial background far from each other (north and centre of Italy), to identify the differences and understand the reasons, with the goal to extract a critical analysis related to the regenerative and sustainable action in place in the Italian cities.

2. Reinventing Cities: the urban projects

Among the atmospheric pollutant, produces by combustion processes, one of the most dangerous is obviously the CO_2, predominant greenhouse-effect gas; together with ozone and soot from diesel fuel, they all have a huge impact on climate, being responsible for the global warming (European Commission, 2016; European Parliament, 2020). To fight the problem of the emissions, with special attention for the decrease of the CO_2 emissions, it is important to display the action conducted by the C40 Cities plan, a network of cities located worldwide and active in their fight against the pollutant emissions, working for a more sustainable future with zero carbon emissions projects to spread all around the cities. An action that materializes with the launch of the international competition "Reinventing Cities", a global design competition for climate change and resilience[7] a call for urban regeneration of unused or crumbling sites, now at the second edition.

"The Reinventing Cities competition has inspired exactly the inventive collaboration we need to combat the climate crisis – from the skills and creativity of architects, artists, environmentalists and entrepreneurs. Reinventing Cities is more than an innovative competition – it is providing vital solutions to build the urban future we want."[8]

The project "Reinventing Cities" performs an action toward a better future for both city and inhabitants, aiming to globally stimulate new zero carbon emissions projects by effecting the best ideas to transform under-used or unused sites into symbols of sustainability and resilience. A competition among cities and sustainable development. We need to work on the cities, that are the bigger culprits for the global pollution. The challenge launched by the call C40 aims to contrast the planning attitude that has led to the actualization of the current environmental problems to encourage an aware action to build a better and more respectful world. The main goals of the Global Competition are:

- Reducing the emissions from the buildings to decarbonize the built environment;
- Stimulating an innovative urban planning and new sustainable services for the cities;
- Creating smart and reproducible solutions;

[7] A resilient city is an urban system that is not limited to the adaptation to current changes, in front of which the cities are more and more vulnerable, but it is a community that transforms itself planning social, economic and environmental innovative answers that allows it to resist for long time to solicitations from environment and history.

[8] Mark Watts. C40 Executive director. 4 Decembrer 2019. https://www.c40.org/press_releases/reinventing-cities-competition-2.

- Catalysing an ecologic revolution and a change of paradigm in the urban development.

Within the 2050, another 2.5 million people will live in the cities; it will so necessary building almost a billion of new houses. To decrease the emissions, it will be necessary planning more performing buildings, fulfilled with sustainable and recycled materials helping to reduce the consumption of the global resources of which the construction industry is responsible for the 30%. The buildings are totally responsible for the 50% of the urban emissions in the cities; therefore, the sustainable planning in the regeneration plans performs a fundamental role. The action on the buildings is one of the three issues listed in the plan C40, from which the following goals are taken:

- BUILDINGS: making sure of each new house is zero-emissions within the 2030;
- MOBILITY: making zero-emissions both public transportation and entire urban areas; promoting walking and cycling schemes;
- WASTE: reducing by 50% the total amount of waste and reducing the production of garbage by 15% per capita.

The methodology actualized for the realization of the plan considers the initial identification of under-used or unused urban sites, from the public entity, to be sold or assigned for the redevelopment. Then it organizes and supports the competition C40, to which the multidisciplinary teams who attend it, composed of architects, engineers, entrepreneurs, economists, artists, etc., will propose their ideas as integrated regeneration plan. Finally, per each listed site, the projects that best answers to the suggested goals will be chosen. To date, there have been two editions of Reinventing Cities: the first ended in 2019 in which participated only Milan, like an Italian city; the second edition[9], not yet completed, with the participation of Milan and Rome, showing the willing to take steps to sustainability (De Stefani, 2020).

2.1 The first edition of "Reinventing Cities"

The first edition of the call C40 has responded with great success to the environmental and social requests, establishing new models of city project. Eco-construction projects, wooden buildings, use of bio and local materials (mud bricks, hemp), reuse of scrap material from demolition sites are promoted. Sustainable design projects and passive and reversive buildings, co-housing; high energy efficiency buildings, that produce clean energy from renewable resources. The adoption of alternatives such as sustainable mobility, car-free places, bike sharing, electrical vehicles validates the sustainability of the proposed ideas. Milan is the first Italian city to take part to the competition "Reinventing Cities" with 4 winning projects (Fig. 3):

- Scalo Greco Breda, winner with the project "L'innesto", the first zero-impact Social Housing in Italy;
- Scuderie de Montel, winner with the project "Teatro delle terme", a new urban park characterized by blue-green infrastructures (water-park), transforming a historical building into a thermal place in a strategic location (Sar Siro neighbourhood);
- Viale Doria (Doria Site), winner with the project "Co-Inventing Doria", manifesto of the urban sustainable regeneration, where public and private spaces interact, creating a resilient and sustainable spaces for the city users;
- Via Serio (Serio Site), winner with the project "Vitae", a permeable architecture that poses itself as bridge between private and public life; nature is its main constituent, the building able to "breathe" and purify the air.

L*'innesto*: a new way to live in sustainability; it is an element for mending the urban fabric able to create connections; it integrates and valorises the project area with the surrounding neighbourhoods, both from energetic and social point of view. The project is characterized by three purposes:

[9] The second edition of Reinventing Cities in not yet completed, for this reason in this paper will see in detail only the winning project of first edition, to comprehend the role of architectural project in the regeneration programs of cities.

- Environmental sustainability: aiming to balance the emissions of CO_2 making them equal to zero;
- Economic sustainability: providing a system of resources, spaces and community management, embracing the basis of the circular economy;
- Social sustainability: realizing a human adaptive zone inside the neighbourhood.

Fig.3 Reinventing Cities I call: winning projects in Milan

The winning project proposes a new neighbourhood for the social housing in Milan, the first in Italy with zero emissions, synergistic and sustainable. It is surrounded by the green that covers more than 60% of the total surface, among community vegetable gardens, greenhouses orchards, didactic green spaces and pedestrian public itineraries. Moreover, it is expected the tree planting of 640 species to mitigate the emissions of CO_2 and reforest the urban areas. As further solutions for the decrease of the impact on the environment, itineraries for the pedestrian, shared and electric mobility are integrated. The proposed strategies to reduce the car ownership and encourage the use of ecologic vehicles, public transport, bicycles and seamless mobility would convince a behavioural change, thus limiting the use of their own vehicles with a decrease of CO_2 emissions amounting of 8.022 tons until 2050. The project will be managed with resilient and coordination, thanks to the involvement of several public and private stakeholders, establishing a collaborative and inclusive neighbourhood. The buildable surface measures approximatively 24 thousand square meters; 21 thousand square meters will be intended to social housing (up to 1,500 new inhabitants) and 3 thousand to additional function (coworking spaces, commercial activities, supermarket). The new accommodations will be all "Nearly

Zero Energy Buildings (NZEB)", mostly fulfilled with sustainable, renewable or recycled materials, integrated with construction and technological prefabricated systems to minimize the emission of CO_2 and the production of construction waste, allowing to disassemble and reuse the structure 100%. It is considered a structural system able to adapt to different design needs, with flexibility and attention to the entire life cycle of the buildings. A prefabricated construction system allows the optimization in the use of materials, according to their physical-mechanical characteristics, allowing the containment of material waste and minimizing the production of construction site waste. The buildings are equipped with heating systems with radiant floor panels and with photovoltaic systems, an architecture based on sustainability. They also provide for sustainable water management for the reuse of rainwater 100% in situ, saving the 30% on drinking water and the 15% of black water. The water will also be heated with a fourth-generation heating system, powered by renewable energy sources. To make the buildings emission-free is the high-performance and low-consumption thermo-acoustic insulation system that allows the user to monitor and manage their consumption. Finally, great attention will be given to the waste cycle, providing a separate collection system with weight detector. Great value is given to the concepts of community and inclusion, with the birth of a Human adaptive zone consisting of spaces and services for everyone: laboratories, food hub, circular economy district, energy centre; areas that adapt to the needs of the inhabitants, in which interaction and social cohesion are facilitated and promoted. The sharing spaces were created as flexible and multifunctional places, aimed to encourage relations between the inhabitants, involving the entire neighbourhood in the care of the common areas, generating a sense of belonging to the place (Reinventing Cities, 2019a).

Teatro delle terme: a multifunctional centre, which recovers the relationship with water, land and vegetation, exploiting the logic of well-being and balance as a connection between the urban community and nature. The Thermal Park and the SPA find space within the new urban park, the result of the recovery of the existing stables and green areas, thus defining a harmonious confluence between architecture and nature. The goal is to provide the city users with an urban oasis, made up of gardens, vegetable gardens and green paths, for the psycho-physical well-being of people. Starting from the recovery of an existing building already represents a design approach based on sustainability; however, the volumes of new construction integrated with the pre-existing ones are minimal and made almost entirely from eco-sustainable materials, low energy consumption, highly performing for the constant maintenance of comfort living inside the building. The materials used (biocompatible, removable, replaceable and reusable) have low CO_2 emissions both during production and in life and they are recyclable at the end of their life cycle. The construction method is sustainable, mainly of the "dry" type, minimizing the use of materials and reducing construction time. In addition, particular attention was paid to the recovery of the existing building, in order to ensure energy containment; were used solutions for the energy improvement of the building envelope (thermal insulation, opaque vertical surfaces, thermal break windows). To complete the building, were added performance and energy-saving systems that use advanced technologies for air treatment, exploiting the characteristics and the thermal energy of the air outside the building. Inside the building, the thermo-hygrometric comfort is guaranteed through innovative plant solutions, equipped with a high-efficiency heat recovery system. The energy intended for the SPA comes from renewable sources, specifically from the thermal solar panels installed on the 110 m^2 roof. In this case, the focus was on two main aspects, the energy and material and the naturalistic one, presenting a highly performing project that integrates itself with a strong presence of greenery as a compensation for CO_2 emissions (Reinventing Cities, 2019b).

Co-Inventing Doria: the project of an innovative hostel with public functions, that opens to an innovative urban sociality, understood as accommodation connected to the social context and to the use of innovative technologies for the containment of energy consumption. The proposal puts pressure on the concept of sharing economy, overcoming the idea of ownership for the definition of a public quality. Places of social cohesion made up of gardens, woods and tree-lined avenues, linked by squares, cycle paths and services; versatile

spaces, capable of reconfiguring themselves to accommodate different functions over time. The area has excellent accessibility, enhanced by cycle-pedestrian mobility systems, soft mobility and sharing platforms. The building is part of a congested area between two buildings and, therefore, not being able to act on the orientation of the building, a compact building was proposed, with a maximized coverage area for the exploitation of solar energy. The building envelope is composed of a Breathing Wall that takes on the function of heat collector and filter, inside which are generated air flows for the ventilation of the building. An ad hoc module A.M.I.C.A. (Integrated Modular Environmental Control Apparatus) was invented for the project, able to modulate the air flow through a mechanical ventilation system placed above the windows, reducing the use of air conditioning systems. The building has a hybrid system consisting of a hydrothermal heat pump that will cover the heating and cooling load, while most of the energy needs will be covered by the roofing photovoltaic system. In addition to the use of energy originated from renewable sources, there is particular attention to the use of sustainable materials, such as wood for the bearing structure mixed with ready-mixed concrete consisting of 55% recycled materials and reinforcement bars with 96% recycled material. The goal of the project is to aim at the shared use of urban spaces; experimenting new approaches for the management and use of public spaces, *Co-Inventing* promotes the development of Apps to encourage sustainable behaviour for shared space (Reinventing Cities, 2019c).

Vitae: An advanced model of urban coexistence, result of a cross-fertilization process from different fields of interest. The project shows a domestic soul designated as guest house that it adds up to several functions, such as office and cancer research laboratories. Within the complex the vetrine Horto are located, a catering project uniquely sustainable, that uses zero food miles products and from a hydroponic greenhouse.

The working space are conceived as sustainable spaces that guarantee a thermal comfort combined with energy saving; spaces that intertwine with the green pedestrian path that surround the whole building establishing a strong harmony with nature, in which the selection of the plants was made in order to defend the biodiversity.

A Green Spiral to connect the terraces, surrounded by greenery, that hosts activities dedicated to health and to wellness, solutions aimed to the re-acquisition of the high quality of life in the office and the improvement of the liveability of those who live there. With the presence of green areas that develop throughout the building, a connection is established between inside and outside, a necessary bridge to bring the external environment into the inside and the work that takes place inside becomes practicable also in the outside, improving the quality of work.

The building is constructed with a hybrid construction system, using different materials (concrete and wood), able to respond to different spatial configurations. The building is powered by certified green energy, partially from on-site renewable sources, photovoltaic panels, rainwater recovery and groundwater source. The latter is used for heating domestic water and for building air conditioning, so it was not necessary providing thermal solar panels, thus maximizing the extension of the green roofs. The building system is completed with an innovative technological system for the façade, which allows to adapt the envelope to different sun exposure, weighing the amount of shading according to the intensity of the sun's rays. To minimize the waste, the project envisages the adoption of a BACS (Building Automation and Control System) system for the automatic regulation of plants, integrated with renewable source and safety & security systems.

The introduction of BMS systems (Building Management System) and the application of IoT technologies are also planned, for the intelligent monitoring of energy consumption, for the reduction of pollutants present in the air and for the automatic regulation of environmental comfort in function of the individual user and of the changing external climatic conditions. Solutions to improve the performance of the building envelope, for energy saving and for thermo-hygrometric well-being for those who experience the spaces.

A green lung to improve the quality of air and life, which is part of a regeneration process for the environment and for humans, focusing on the importance of people's psychophysical conditions in the workplace (Reinventing Cities, 2019d).

2.2 The emerging disciplines in the scenario of the urban regeneration

The description of the winning proposals of the first edition of the C40 call shapes up to be a representative process for a comparison among the design interactions and the disciplines that are most involved in the current scenario of the urban transformation. These proposals present a homogeneity of technological solutions, almost classifiable in a "typification of interventions", with contents that are now essential in the sustainable urban regeneration projects. The fundamental and recurring aspects are related to:

- bioclimatic design, which focuses on the use of technical solutions for the saving of energy consumption, making the buildings highly performing (NZEB buildings);
- the use of recycled and sustainable materials, designed to be reused at the end of their life-cycle;
- the reduction of polluting emissions, providing design solutions for an urban reforestation and a stimulation for soft and sustainable mobility (CNAPCC, 2012).

Finally, the weight of the environmental sustainability in the regeneration of the cities also represents a further confirmation of the widespread theming of common principles and aims, reconfirming itself as a key issue articulated among multiple application fields. A highly specialized network that confirms the importance of synergic actions in the urban project. The architectural project, "historically" exclusive and centralized in urban redevelopment, combines with different declinations of well-known fields, related to the city, initiating new professionalisms (Haddock & Moulaert, 2009). Their inclusion allows to involve sectoral issues that become complementary to the urban project, hypothesizing fruitful connections aimed to solve the city's vices through the application of a single articulated plan. A complex network of contaminations affects the planning and design subject, "compromises" it in its autonomy, bringing into it the technical-scientific conditions about environment, economy, finance and society (D'Onofrio & Talia, 2015).

Reinventing Cities[10] represents the example of how professionalism and fields oriented to economic and social development, although differentiated, can work in synergy and for articulated projects. In fact, a fundamental requirement to participate in the call for tenders sees the establishment of a multidisciplinary team as a strength (De Stefani, 2020). To this end, the participation of economists, sociologists, climate and transport experts, etc., plays a decisive role in the cognitive phases of the city and in the re-organization of the related analytical data in all its aspects, an organizational chart guaranteeing the achievement of the identified aims. The local regeneration plan is thus precisely focused both on the needs of the territory and on the involved disciplinary declinations (Bollini, Laniado & Vittadini, 2018). The emerging professionals are placed in the process of the urban project and the project on the scale of the building at different moments of its definition: one that proceeds in parallel to its preliminary settings, the other that interacts with its solutions. The first is aimed to search for objective data, useful for reading and understanding the economic and social configuration of the place; the second is rather aimed to build an operating program focused on the potential in terms of local economy, urban social release in the more general perspective of the

[10] Reinventing Cities shows even more his multidisciplinary approach in the second edition of C40. The requests and objectives of program have increased compared to the first edition, and they are grouped into 3 macro categories: *Carbon impact* (Energy efficiency and low-carbon energy, Life cycle assessment and sustainable materials management, Low-carbon mobility); *Resilience and Sustainability* (Climate resilience and adaption, Ecological services for the neighbourhood and green jobs, Sustainable water management, Sustainable waste management, Biodiversity, urban re-vegetation and agriculture); *Architecture and social impact* (Inclusive actions, social benefits and community engagement, Innovative architecture and urban design). Some challenges are mandatory in order to submit the projects and they are the ones aimed at meeting the primary objective of reducing the CO_2 emission in order to fight climate change; some others are optional and on completion as supplementary categories, in order to diversify as much as possible the competing proposals.

environmental sustainability. This interaction between the humanistic field of architectural design and the scientific one, typical of disciplines addressed to the environmental control and its economic enhancement, is what made C40's action successful.

Each winning project is related to a program that is developed by deepening differentiated aspects according to the area in question. This gives a greater resonance to the use of innovative technical solutions for the environmental sustainability, proposing within the regeneration plan initiatives for the "care" of sociality and the local economy (Haddock & Moulaert, 2009). Interdisciplinary plans that become activating tools of living citizenship and improvement processes of the local economy that aim to increase the commercial activities in the city in question (Di Giulio, 2013). The contamination between different types of knowledge aims to improve the cities, in their form and substance. A collaboration in which the designer is configured as the inventor and composer of the new urban shape, as a physical container, and the economists, sociologists, environmentalists, etc., become writers of the collective plan, which gives "substance" to the envelope in order to fulfil a complete and lasting regeneration of devitalized urban places (Andorlini, Bizzarri & Lorusso, 2017).

3. Results and conclusion about the role of architectural project

It is now clear that the architectural project, in the outlined scenario, can be a useful device to start vital actions that hinder the phenomena of urban decay and it is besides clear that its role is all-embracing with respect to the "built" (Dematteis, 2011). In this background, the urban project is asked to be inclusive, sensitive to the needs of the city user and integrated with the other professional fields (Bertell & De Vita, 2013). The innovative technical solutions, widely used in sustainable regeneration and urban planning today, such as the minimization of polluting emissions, the reduction of soil consumption and the decrease in the use of natural resources, are equally and clearly recognized. These two fields, both legitimized by the aim to improve the anthropic space, coexist among realities endlessly looking for balance; on the one hand the urban project, as a conceptual moment that prefigures future scenarios, free from determinist involvements, on the other hand the analytical models of the environmental disciplines that tend to bring complexity back into a measurable order, towards a "regulated development" of territories and urban places, which instead belong to the sphere of sustainability. In the multidisciplinary interaction, the project, whose role is crucial for the development of the urban regeneration program, becomes a "tool" that proposes formal solutions developed considering the requirements that emerge from analytical data (Cottino & Domante, 2017). The traced path confirms the great responsibility of the architectural project towards the dynamics of the urban transformation. The constant research for compliant solutions, result of the analysis of various disciplines and binding external conditions, forces the project to give integrated answers that meet the technical-environmental and climatic needs, without giving up its primary aesthetic paradigm: quality.

Fig. 4 Urban Regeneration: a transformation from polluted city to sustainable city. A conversion process to urban high quality

An example is the construction of the NZEB buildings, or the urban reforestation or the reduction of emissions that generally formulate the agenda of interventions establishing the starting conditions and requirements. Innovative technical solutions that embody the concept of environmental and social sustainability, combining the idea of natural inclusiveness within the building envelope. Same requests that are finalized in planning results that are not predictable or repeated. It is recurring to identify design solutions in which the facade is

transformed into a vertical forest, where the green dresses the building in its entirety, aiming at the goal of urban reforestation. Buildings that are reconfigured using innovative systems in response to the imposed premises, accepting limiting conditions, if related to the morphology of the place. In conclusion, the architectural project reinvents itself in a sustainable key, including soil and building projects in a single strength. In this vision, urban greenery and squares are incorporated into the composition of the building, as the connections, which become the tool to promote gentle and sustainable mobility. Hallmarks to achieve the goal that takes on typifying traits of sustainable design. So, the response of the project to the needs of a resilient urban environment shall not be only a fulfilment of sustainable solutions for the city regeneration (Fig.4), but it should be followed by a vision in which the architectural project reinvents itself, changes its rules and aligns its matrices.

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Image Sources

Fig.s 1-4: Images of the author.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 389-408
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/7007
Received 1st July 2020, Accepted 19th December 2020, Available online 31st December 2020

www.tema.unina.it

The Covid-19 pandemic from the elderly perspective in urban areas: An evaluation of urban green areas in ten European capitals

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Abstract
The global Covid-19 pandemic has reshaped lives and activities, especially in urban areas: national and regional authorities have had to react promptly to limit the spread of the coronavirus and avoid the collapse of healthy provision systems. Urban environments, as noted in several World Health Organization reports, are fertile ground for an epidemic's rapid transformation into a pandemic due to their high densities of people, activities, structures and networks. Cities around the world have thus rapidly reorganised to manage the coronavirus crisis. This paper focuses on the spread of the Covid-19 pandemic in European countries during the initial emergency phase and the importance of safe access to and uniform distribution of urban services. We focus on urban green areas as a means of achieving better quality of life, especially for vulnerable groups like the elderly. We selected 10 capital cities (Amsterdam, Brussels, Berlin, Copenhagen, Dublin, Lisbon, London, Madrid, Paris and Rome) to reflect the heterogeneous demographic, social and economic panoramas of European countries and cities. The outcomes of this study can support decision-makers in defining priority actions to reduce the negative impacts on the elderly in the coexistence phase of the pandemic and for future development.

Keywords
Covid-19; Urban areas; Elderly; Green areas.

How to cite item in APA format
Carpentieri, G., Guida. C., Ottavia, F. & Sgambati, S. (2020). The Covid-19 pandemic from the elderly perspective in urban areas: An evaluation of urban green areas in ten European capitals. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 389-408. http://dx.doi.org/10.6092/1970-9870/7007

1. Introduction

The spread of the novel coronavirus (Covid-19) has raised new and challenging issues closely related to demographic changes and the development of age-friendly urban environments (Oiu et al., 2020; Peters, 2020). The global population is ageing at an unprecedented rate: according to the projections of the World Health Organization (WHO; 2020), people over the age of 60 will number more than two billion by 2050 – more than twice the elderly population recorded by the end of 2019. Although the elderly today are healthier than in previous generations thanks to improvements in welfare and healthcare services, ageing is still commonly associated with greater vulnerability to disease (ARUP, 2015) and the Covid-19 pandemic has shown that people over the age of 60 are most likely to develop severe cases of the virus (WHO, 2020). In Europe, many countries are already facing these issues. Due to these epidemiological concerns, policymakers have needed to strengthen healthcare provisions, which is the most pressing issue in the short term, but also improve the resilience of urban areas to limit economic and social problems in the medium and long term (EY, 2020; Venter et al., 2020). The WHO (2020) has stated that cities are where factors such as high population and activity densities, public transport networks and available structures can function as multipliers of pandemic effects (Desai, 2020; Samuelsson, 2020). At the same time, older adults are mostly located in urban areas, which must be adequately equipped to ensure an acceptable quality of life from the elderly perspective (ARUP, 2015).

This paper is part of a series of Covid-19 studies conducted to more deeply examine the pandemic outbreak and subsequent waves of contagion in European countries and the importance of safe access to essential urban services such as green areas to achieve better quality of life, especially for vulnerable groups like the elderly. Referring to population ageing data and reflecting urban areas through the lenses of accessible mobility and built and digital environments, this research addresses how cities are prepared to face demographic challenges, especially in light of the Covid-19 outbreak and subsequent coexistence phases. A comparison of the trends and patterns in 10 European capital cities serves as the basis for further investigation of the relationship among ageing, politics and planning to face new challenges related to public health and urban governance.

The next section examines the condition of the elderly in urban areas, provides an overview of quality of life in cities and towns, analyses changes in the demographic structure of European countries with a focus on the ageing phenomenon and investigates the role of green urban areas in improving the living conditions of the elderly. The third section evaluates the spread of Covid-19 in Europe, considering the restrictions and limits to activities and services resulting from policies preventing the further spread of Covid-19 and highlighting the challenges of the forthcoming coexistence phase that involve both ageing and green urban areas. The fourth section analyses 10 European case studies selected for this overview, while the final section focuses on the analysis and results of the case studies.

2. The challenge of quality of life in urban areas from the elderly perspective

Quality of life refers to "the overall level of well-being and fulfilment that people enjoy from a combination of their social, economic and community environment and their physical and material conditions" (Morais et al., 2013). Numerous surveys have been conducted to measure quality of life in European cities and analyse residents' satisfaction with various aspects of urban life (European Commission [EC], 2013, 2020; WHO, 2007). Each study has been developed using different dimensions and indicators according to the focus of the analysis and the territorial, cultural and social context of the research (Morais et al., 2013).

In these studies, the presence of adequate public amenities, health and welfare services, and parks and urban green areas represent suitable indicators of the potential quality of life in urban areas. This paper reviews

accessibility in urban green areas from the elderly perspective and in light of the challenges connected to the Covid-19 outbreak and coexistence phase that will drive urban planning practices in the next several years.

The global population of those aged 60 or older is expected to double in the coming decades, reaching two billion before 2050 (WHO, 2020), due to decreases in mortality and fertility rates and the improvement of public health services (ARUP, 2015; Wen et al., 2020). In Europe, as in numerous Western countries, ageing will be one of the most significant economic and social challenges in future years. The ageing of the population is a priority for cities and urban areas, which will need strategies to manage this phenomenon, since about 90% of the world's population is expected to live in urban areas by the end of the 21st century (Artmann et al., 2017). Indeed, the ageing of the global population alongside rapid urbanisation will mean that more and more people will grow old in towns and cities, which will have to adapt to new features and needs in order to improve their inhabitants' quality of life.

In an increasingly urban age, ensuring the fulfilment of elderly people's rights and needs is key to building inclusive, secure, healthy and prosperous communities with a high quality of life (ARUP, 2015). Therefore, the great challenge for urban areas is to achieve a high level of satisfaction amongst the elderly through taking action on several factors that can improve their living standards (EC, 2020; Sun et al., 2010). In other words, cities governments have an essential role in becoming more attractive places for the elderly to live.

In particular, the WHO has emphasised the role of urban green spaces in age-friendly cities, considering safety, accessibility, cleanliness, design and pedestrian-friendly walkways as determinants of cities' suitability for older people (WHO, 2007). Urban green areas have beneficial effects on quality of life for the elderly: living within walking distance of green spaces can increase longevity, reduce health vulnerabilities, promote physical activity and otherwise contribute to elderly well-being, with a consequent positive impact on older people's quality of life (Artmann et al., 2017; Wen et al., 2020).

The following subsections highlight the main demographic trends and geographic distributions in European countries and their capital cities and the importance of green urban areas in defining elderly people's quality of life in anthropised environments.

2.1 The ageing phenomenon in Europe

In the last 60 years, Europe's demographic structure has gradually changed for several reasons. This change is attributable not only to longer life expectancy and improved well-being but also to lower birth rates and to immigration and emigration, which have caused fluctuations in the size of the working-age population in particular (EC, 2014). Combining these effects has modified the population pyramid shape, as shown in Fig. 1, foreshadowing significant social and economic consequences for all communities.

The proportion of the population aged 65 and above has significantly increased in recent years (Mestheneos, 2011; WHO, 2007, 2016).

Between the 20th and the 21st century, the percentage of older people increased in every European country (Mestheneos, 2011; WHO, 2016), albeit at a different pace in each state, and cities have demonstrated distinctive patterns. Whilst most cities have experienced population ageing, certain cities, such as Copenhagen, have become younger (ARUP, 2015).

Tab. 1 shows data concerning population ageing and its distribution within urban or rural areas provided by DataBank, an analysis and visualisation tool powered by the World Bank (2019). Regarding location, it is worth noting that on average about 74% of people live in cities and towns, ranging from 53.7% in Slovakia to 98% in Belgium (ARUP, 2015).

Hence, the greatest demand for services from the elderly is in urban areas, which also represent a potential turning point for more age-friendly policies and practices (WHO, 2007, 2016).

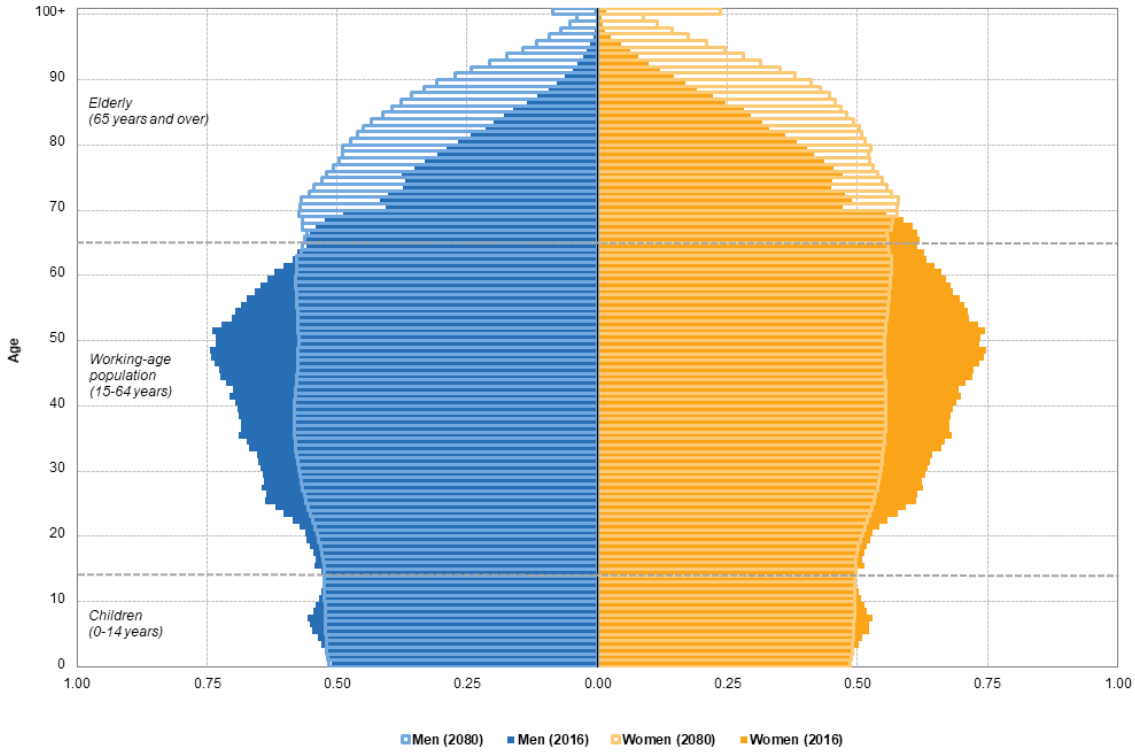


Fig.1. European population pyramid for 2016 and projections to 2080 (EUROSTAT, 2016)

The share of older adults is on average about 20%. By the end of the Decade of Healthy Ageing (2020–2030), defined by the WHO to promote improvement in life of elderly people, their families and communities, the share of people aged 65 and over will be 34% higher, increasing from 1 billion in 2019 to 1.4 billion in 2030 (WHO, 2017). By 2050, the global population of older people will have more than doubled, reaching 2.1 billion. There will be more than twice as many people over 65 years old than children under the age of five, outnumbering adolescents and young people aged 15–24 years (WHO, 2007). Data suggest that the European continent has already aged: by 2025, more than 20% of Europeans will be 65 or older, with a remarkably rapid increase in the number of people older than 80 years (EC, 2014; UN, 2018). As stated by EUROSTAT (2019), in the decades since 1962 – when the percentage of people over 60 reached the percentage of children under five – the share of people aged 65 and older has continued to increase while the natural growth rate has remained negative. Italy is an elderly country, with 23% of people aged 65 and older. According to recent studies, if Italy maintains its current fertility rates, it will need to raise the retirement age to 77 or admit 2.2 million immigrants annually to maintain its worker-to-retiree ratio (Lunenfeld & Stratton, 2013). This phenomenon will have several consequences for relevant sectors, including the overall demand system and the socioeconomic and tertiary systems (Alfano & Capasso, 2019). In particular, the ageing of the population will impact the organisation and management of many activities that characterise urban environments, such as leisure activities, healthcare, mobility and welfare services (Mobley et al., 2006; Somenahalli & Shipton, 2013), with consequences comparable to those of the Industrial Revolution (ARUP, 2015). Indeed, this issue will inevitably impact national and international labour markets and finances due to increased social spending for pensions and the decline of the workforce, which could be partially offset by lowering unemployment and childcare costs (Metz, 2000). Moreover, both the overall population and Europe's GDP will proportionally decrease compared to the rest of the world. As such, given the ageing population phenomenon, ensuring high quality of life for older people is key to building resilient, inclusive, secure, healthy and prosperous communities in the coming years (ARUP, 2015). The next subsection elucidates the relationship between quality of life and

urban green areas, highlighting the role of green spaces in the overall well-being of older people who live in cities and towns.

Countries	Total population	Urban population		Population over 65 years old	
	Inhabitants	Inhabitants	%	Inhabitants	%
Austria	8,877,067	5,194,416	58.5	1,693,354	19.1
Belgium	11,484,055	11,259,082	98.0	2,182,725	19.0
Bulgaria	6,975,761	5,256,027	75.3	1,482,556	21.3
Croatia	4,067,500	2,328,318	57.2	848,486	20.9
Cyprus	1,198,575	800,708	66.8	168,379	14.0
Czech Republic	10,669,709	7,887,156	73.9	2,112,682	19.8
Denmark	5,818,553	5,119,978	88.0	1,161,689	20.0
Estonia	1,326,590	916,024	69.1	265,209	20.0
Finland	5,520,314	4,716,888	85.4	1,222,233	22.1
France	67,059,887	54,123,364	80.7	13,674,430	20.4
Germany	83,132,799	64,324,835	77.4	17,925,919	21.6
Greece	10,716,322	8,507,474	79.4	2,351,319	21.9
Hungary	9,769,949	6,999,582	71.6	1,924,138	19.7
Ireland	4,941,444	3,133,123	63.4	702,813	14.2
Italy	60,297,396	42,651,966	70.7	13,875,719	23.0
Latvia	1,912,789	1,304,943	68.2	388,995	20.3
Lithuania	2,786,844	1,891,013	67.9	561,784	20.2
Luxembourg	619,896	565,488	91.2	8,849	14.3
Malta	502,653	475,902	94.7	104,638	20.8
Netherlands	17,332,850	15,924,729	91.9	3,398,161	19.6
Poland	37,970,874	22,796,574	60.0	6,879,144	18.1
Portugal	10,269,417	6,753,579	65.8	2,295,902	22.4
Romania	19,356,544	10,468,793	54.1	3,637,107	18.8
Slovakia	5,454,073	2,930,419	53.7	882,053	16.2
Slovenia	2,087,946	1,144,654	54.8	421,479	20.2
Spain	47,076,781	37,927,409	80.6	9,249,563	19.6
Sweden	10,285,453	9,021,165	87.7	2,077,514	20.2
United Kingdom	66,834,405	55,908,316	83.7	12,370,177	18.5

Tab.1 National, urban and over-65 population (The World Bank, 2020)

2.2 Quality of life and urban green areas

The scientific literature recognises that greenery-filled public areas provide comfortable and pleasant living environments for urban residents (Chiesura, 2004; EC, 2013, 2020; Sturm & Cohen, 2014; Gargiulo, 2016). Urban green areas can both directly and indirectly influence people's quality of life (Ugolini et al., 2020). Multidisciplinary research has concluded that the positive effects include, for example, the mitigation of the heat island phenomenon, improvement of air quality, reduction of the effects of climate change and encouragement of physical activity (Samuelsson et al., 2020; Sobral et al., 2020). Moreover, living near green areas is associated with lower risk of cardiovascular disease, obesity, diabetes, asthma hospitalisation, mental distress and mortality among adults and with lower risk of obesity and myopia in children (Ekkel & de Vries, 2017; Paquet et al., 2013; Sturm & Cohen, 2014). More significant quantities of urban green areas in a neighbourhood are also associated with better self-reported health and subjective well-being in adults and

improved birth outcomes and cognitive development in children (Sullivan et al., 2004). Urban green spaces, including parks and small green spaces, provide a wide range of ecosystem services, which can help people cope with many diseases and improve their quality of life and health status (Wolch, 2014). Specifically, stress harms psycho-physiological health, and leisure experiences in green environments such as parks improve these negative mood states (Orsega-Smith, 2004). Urban vegetation also impacts several issues related to urban physical environments: it can improve groundwater management (Puigdefábregas, 2005), protect slope stability (Pignatti et al., 2001), control soil erosion and water levels (Gedan et al., 2011), act as a noise barrier (Cook & Haverbeke, 1974), protect biodiversity (Kong et al., 2010), reduce air pollution (De Carvalho & Szlafsztein, 2019), improve microclimatic conditions, mitigate the heat island effect and reduce energy demand (Susca et al., 2011; Gargiulo, 2017; Papa, 2016). Furthermore, urban green areas offer economic benefits since their presence increases property values, as stated by international scientific researchers (Trojanek et al., 2018; Zhang et al., 2012). Hence, greenery represents an urban design resource that is both aesthetic and functional with regard to citizens' overall welfare (Ugolini et al., 2020).

These issues are closely related to the elderly's perceived quality of life in urban environments. Physical activities and social interactions are the most important benefits that gardens and parks provide for older people's quality of life (Artmann et al., 2017). Visiting green areas can improve health, increase longevity, lower stress, promote physical exercise (Artmann et al., 2017; Kabisch & Haase, 2013; WHO, 2007) and reduce the chances of suffering from pathologies common in the elderly population (Ekkel & de Vries, 2017; Sturm & Cohen, 2014). Moreover, green spaces enhance social interaction and active and passive recreation (enjoying the sun, chatting, relaxing, observing nature); provide recreational benefits; encourage meetings between individual people; and increase the elderly's perceptions of safety (Kabisch & Haase, 2013). According to Sun et al. (2011), older adults who have close contact with other people and take part in social and physical activities have a lower likelihood of developing problems related to mobility, pain, discomfort, anxiety and depression. Together, these aspects contribute to the overall well-being of older people in urban areas, enhancing their quality of life (Carpentieri, 2020; Wen et al., 2020; WHO, 2007). Greenery can thus significantly support the well-being of the elderly, which is under threat due to fundamental social changes that accompany ageing such as losing close relationships and independence (Artmann et al., 2017). As such, an appropriate design of urban green areas is crucial in satisfying older people's needs according to their age and health conditions.

However, taking into account the Covid-19 outbreak in our communities, there is a growing concern regarding the role of physical environmental factors in facilitating or modifying health behaviours. Currently, policymakers are facing this challenge in the context of a Covid-19 pandemic coexistence phase. Hence, the need to access and take advantage of secure green spaces could be particularly significant for the most vulnerable people, such as the elderly (Freeman & Eykelbosh, 2020).

The next section further investigates how Europe and its inhabitants – especially the oldest – have been deeply affected by the spread of Covid-19, proposing urban green area design as one way to afford the current coexistence phase.

3. The challenge of the Covid-19 pandemic in urban areas

In the first months of 2020, the entire world saw the spread of a novel coronavirus first detected in China at the end of 2019 that not only caused health emergencies but also raised social and economic issues not experienced in recent human history (Salama, 2020). This emergency did not spare Europe; indeed, since 13 March 2020, Europe has recorded more cases than China, such that the WHO considered European countries the new active epicentre of the pandemic. Relevant to the aim of our paper, among adults, the risk for developing severe Covid-19 symptoms increases with age, with older adults (over 65) at the highest risk

(Brooke & Jackson, 2020; Douglas et al., 2020; WHO, 2020). The data on infections and deaths indicate that the chance of becoming severely ill from Covid-19 increases with age, with eight out of 10 coronavirus-related deaths in Europe occurring among adults aged 65 years or older (Brooke & Jackson, 2020). Fig. 2 below focuses exclusively on the Italian context: the vertical axis indicates the number of deaths related to Covid-19, while the horizontal axis represents different age groups. This graph highlights that more than 95% of the people who have died were aged 60 or older. Other European countries present the same scenario.

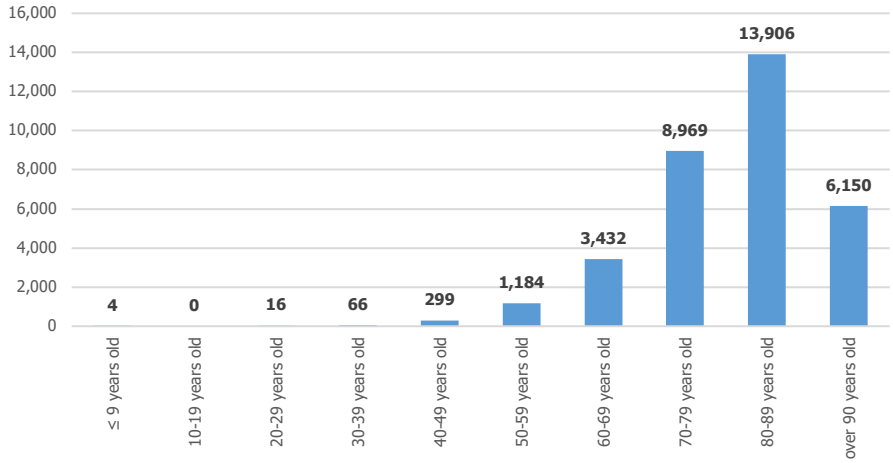


Fig.2 Covid-19 deaths in Italy as of 9 July 2020 by age (Italian Health Minister, 2020)

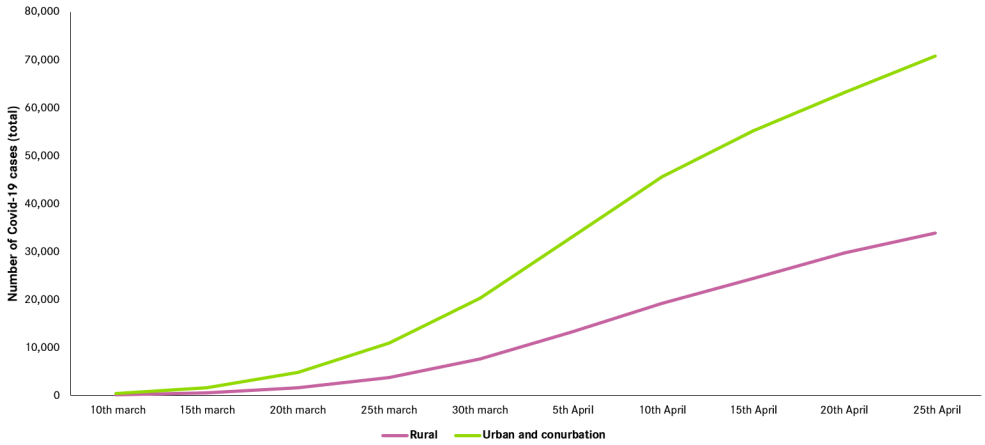


Fig.3 Growth in the number of Covid-19 cases in urban and rural areas in England (Public Health England, 2020)

While these data show that the elderly are particularly vulnerable to the spread of Covid-19 and consequent infections, Fig. 3 focuses on another significant issue related to the urban environment. Due to the high density of inhabitants and activities and the considerable number of opportunities for services and leisure, and consequent movements, the main features of the urban fabric multiply the effects of the pandemic's spread (Desai, 2020; Stier et al., 2020).

As for the UK, the number of cases registered in urban areas (green line) was more than twice the number recorded in rural environments (purple line) at the end of April 2020 (Office for National Statistics [ONS], 2020). Fig. 3 indicates that cities represent fertile ground for an epidemic's rapid transformation into a pandemic due to the presence of safe and efficient roads, railways, air and maritime networks, activities and opportunities, shopping and leisure centres and so on. To investigate the relationship between the Covid-19 pandemic and the main features of the urban fabric, we further analysed the pandemic's temporal evolution in European countries. We considered the number of certified cases at the end of June, the number of

infectious people until the peak day (i.e. the day with the highest number of new daily cases, which differs by country) and finally the speed of Covid-19's evolution (the ratio of the sum total cases until peak day and the number of days between the first detected case of Covid-19 and peak day per nation).

Country	Covid-19 cases through 30 June 2020	Peak day	Total cases until peak day	Covid-19 infection speed until peak day
		Date		Cases/day
Austria	17,766	27/03/20	7,399	411
Belgium	61,427	15/04/20	33,573	839
Bulgaria	4,831	10/07/20	6,672	53
Croatia	2,777	11/07/20	3,672	32
Cyprus	985	02/04/20	356	40
Czech Republic	11,954	27/03/20	2,395	160
Denmark	12,968	07/04/20	5,266	195
Estonia	1,989	26/03/20	538	45
Finland	7,248	29/03/20	2,301	105
France	164,801	31/03/20	52,128	1,682
Germany	194,259	28/03/20	48,582	1,799
Greece	3,302	22/04/20	2,401	63
Hungary	4,155	10/04/20	119	60
Ireland	25,473	16/04/20	13,176	399
Italy	240,578	21/03/20	53,578	1,848
Latvia	1,121	31/03/20	446	37
Lithuania	1,817	18/04/20	1,239	46
Luxembourg	4,299	25/03/20	274	34
Malta	670	07/04/20	293	10
Netherlands	5,027	10/04/20	23,097	745
Poland	34,393	08/06/20	2,716	316
Portugal	42,171	10/04/20	15,472	553
Romania	34,226	11/07/20	32,079	270
Slovakia	1,687	15/04/20	977	35
Slovenia	1600	27/03/20	632	45
Spain	249,271	26/03/20	75,486	3,019
Sweden	69,738	24/06/20	64,124	697
United Kingdom	312,654	12/04/20	84,279	2,161

Tab.2 Covid-19 spread data for European countries (National Governments, 2020)

Tab. 4 summarises the evolution of the pandemic in the European context and shows some significant differences, mostly related to restrictive policies and people's behaviours as well as the ordinary functionality of urban activities and structures. According to recent analyses (Fang et al., 2020; Qianying, 2020), it is worth noting that the measure of the infectious speed of Covid-19 could be useful in representing transmission dynamics. There are 11 countries among the 28 considered with a peak seed value higher than 350.

The relationship between the main features of the urban fabric and the spread of the pandemic, along with cities' demographic structures, has highlighted the vulnerability of the elderly living in urban areas and how urgently new solutions are needed to improve the lives of older people and their families. There is little evidence that older people are in better health today than in previous generations (WHO, 2015), which implies

more potential opportunities that could arise from increasing longevity. However, ageing is usually associated with poor health, social isolation and dependence on care such that individual ability to access the opportunities mentioned above depends on a person's intrinsic capacities (e.g. the combination of all of the individual's physical and mental capabilities), living environment (in the broadest sense, including physical, social and policy factors) and the interactions among them (EC, 2014; Somenahalli & Shipton, 2013). The Covid-19 outbreak has emphasised the vulnerability of this sociodemographic group, showing the limited ability of Western countries and cities to afford a world health emergency (Lithander et al., 2020). That said, old age itself is not an inherent vulnerability. It is the failure of policies, systems and society to respect and support the fulfilment of rights in older age that constructs older adults' vulnerability through their exclusion from processes and decision-making and their inequitable access to resources and services (ARUP, 2015; Freeman & Eykelbosh, 2020; Samuelsson et al., 2020). Neither are older people a homogenous group; rather, they are diverse in their lived experiences throughout life and older age as well as in their physical, social and economic resources. Still, as individuals, adult people enjoy a range of civil, political, economic, social and cultural rights that are often denied in older age due to patronising and paternalistic ageist discrimination and harmful stereotypes (WHO, 2016).

Cities play a key role in facing demographic changes since more people than ever before will grow old in urban environments (UN, 2018), where most human experiences and activities are concentrated. Hence, they have a fundamental role in defining how to respond to our ageing (or greying) society. In 2007, the world passed a significant milestone when, for the first time in history, 50% of the world's population was living in urban areas (Brenner & Schmid, 2014). People are growing old in housing, streets, communities, towns, cities and mega-cities that are failing to respond appropriately to ageing populations with specific policies that remove all forms of discrimination based on older age (WHO, 2016). Moreover, climate change-related events (e.g. heat waves) and emergencies pose an increased risk to densely populated urban areas, as shown by the Covid-19 pandemic (Sobral et al., 2020). Older people's vulnerabilities further emphasise the need for policies and systems that respect and protect rights in older age to build more resilient communities and urban environments (Douglas et al., 2020; EY, 2020). At the same time, many opportunities and intrinsic advantages arise from urbanisation, which is driving the growth of cities across the world in ways that respect, protect and fulfil older adults' rights, according to the principle of age-friendly settings (WHO, 2007, 2016). The built environment plays a significant role in the construction of social relationships and experiences and can be appropriate for communities and people throughout the course of their lives. Places to rest, access to green spaces, well-designed and safe streets and pavements, accessible pedestrian crossings, walkways and cycling paths can all play an essential role in supporting social interaction and improving health (Ugolini et al., 2020). Pedestrian-friendly, accessible cities and urban environments encourage social connections and physical activity over the course of a person's life, particularly in later life, and can play a crucial role in developing physical, mental and cognitive function (Ekkel & de Vries, 2017; Gong et al., 2016; Ruiz-Euler et al., 2020; WEF, 2020). Early in the pandemic, many cities moved to create more space for people to walk and ride bicycles, not only to increase clean air, social inclusion and public health but also to provide more efficient ways to move people and goods in congested urban areas. The availability, affordability and accessibility of public transportation can impact people's ability to move around a city, visit friends and family, and access services, particularly in older age (Ekkel & de Vries, 2017; Paquet et al., 2013). Providing accessible information, planning transportation routes with appropriate destinations and providing specialised services where required are all critical. All around the world, hundreds of initiatives have sprouted to put walking, cycling and other urban transport innovations at the heart of recovery efforts. They demonstrate the global shift towards supporting more high-quality walking and cycling infrastructure and highlighting active mobility's role in ensuring that cities are welcoming and attractive to people from all walks of life (WEF, 2020).

In this context, in light of the Covid-19 outbreak, green urban areas assume the essential role of promoting quality of life, increasing the longevity and physical and psychological well-being of older people in cities and towns. Recent events related to the Covid-19 pandemic have highlighted the impact that housing quality has on both physical and mental health, especially for the elderly and other vulnerable groups: strict quarantine measures, as well as social distancing, false information and rumours can cause panic and fear among urban residents, affecting mental health (EC, 2020; Kamara et al., 2017). Moreover, extreme lockdown measures have created additional problems for older people who live alone and have to deal with social confinement and isolation from their families (Briguglio et al., 2020). Since many urban inhabitants do not have the opportunity to live in a house with outdoor spaces, parks, gardens and other local green areas are vital to citizens' everyday health (de Kleyn et al., 2020). Several scientific studies have identified and evaluated the benefits of such spaces (Chiesura, 2004; Sturm & Cohen, 2014), including for the elderly (Artmann et al., 2017; Sun et al., 2010; Wen et al., 2020). During the Covid-19–related isolation, urban green areas have provided places of solace and respite and allowed for physical exercise and relaxation. Therefore, urban green areas are considered a critical factor in defining the quality of urbanised contexts, especially during the Covid-19 pandemic.

Despite these benefits, not everyone has easy and safe access to green spaces (White et al., 2019). Due to the Covid-19 pandemic, cities need more open and accessible spaces to ensure that people both respect social distancing and are able to spend time in safe and secure green areas (Metha, 2020; Samuelsson, 2020; WEF, 2020). The rapid changes in modern society necessitate the continual adaptation of urban green areas and other features of the urban fabric. In line with the aim of this paper, urban green areas must adapt to the behavioural changes observed during quarantine, e.g. an increase in people walking to small urban gardens nearby or tree-lined streets (Ugolini et al., 2020) and to the needs of older people, whose preferences depend on the size, aesthetic quality, accessibility and maximal travel distance of a green space (Wen et al., 2020).

In the next few years, further challenges will drive urban environments and service design. The spread of the novel coronavirus has highlighted significant vulnerabilities related to the high density of people and activities in cities, which may pose challenges for appropriate social distancing appropriate social distancing (Desai, 2020; Stier et al., 2020). The coronavirus pandemic has rapidly changed Europe and the whole world. As Covid-19 will impact our ways of living and working for a long time, and considering how green and digital transitions influence, sustain or accelerate demographic paths, future strategic national and local projects will be essential in preparing adequate policies to face the combination of these challenging issues. Cities must be designed such that access to amenities can be provided while maintaining safe social distance, facilitating public health and safeguarding elderly people. These issues are closely related to the elderly's perception of their quality of life in urban environments, especially in the coexistence phase: the improvement of well-being must go hand in hand with the construction of more resilient communities in light of a planetary-scale pandemic. This issue is also significant for policymakers in managing territorial government practices.

4. Ten capital cities as case studies

This study presents an overview of green area distribution and potential usability by the elderly in urban environments, focusing on 10 European cities as case studies: Amsterdam, Brussels, Berlin, Copenhagen, Dublin, Lisbon, London, Madrid, Paris and Rome. This sample of capital cities reflects European demographic, social and economic structures in terms of their major differences and their heterogeneous territorial and historical features (ARUP, 2015; Mestheneos, 2011).

Studies have linked the engagement of older people in certain areas to the presence of specific geography within a city: routes, green spaces, public transport networks, the layout of building blocks, and dimensions and densities of certain elements (Ekkel & de Vries, 2017). Our research focuses on urban green areas (i.e.

parks, public gardens and nearby forests) due to their many beneficial effects, as described in previous sections.

Studies have revealed that in many countries people aged 65 and over are less physically active and have less access to nature-based recreation compared to younger groups (Lee & Maheswaran, 2011). Compared to other social groups, elderly people have specific preferences for some aspects of urban green spaces; for instance, they tend to search for calm and shaded areas where relaxing activities can take place, such as low-intensity sports, dancing, observing animals and plants, feeding animals and spending time socialising (Loukaitou-Sideris et al., 2016). Elderly people's access to nature-based areas should account for a variety of special factors, both objective and subjective: the distribution of parks or green spaces, the distance between greenery and their residences, cultural aspects and aesthetic preferences, infrastructure and mental status (Kamphuis et al., 2009; Kemperman & Timmermans, 2014; Ward Thompson & Aspinall, 2011). On the other hand, they dislike green areas with an absence of visitors or in an environment perceived as unsafe and unguarded (La Rosa et al., 2018). Among these aspects, Kemperman and Timmermans (2006) found that distance from a park was a major constraint for older adults, along with the trip to and from the park, with distance and heavy traffic acting as deterrents to park use.

For the sample of cities, the elderly population distribution was analysed and the urban green areas were located. Next, the extension and local distribution of green areas and the percentage of elderly population were compared. The next subsection presents the results of these analyses.

4.1 Elderly population distribution in the ten case studies

When analysing the elderly population structure and distribution, the total population, population density and percentage of young, medium and old elderly people were considered for each city. The 10 case studies were grouped into the following three clusters based on their surface extension:

- Big cities (London and Rome) had surface areas greater than 1,200 km^2;
- Medium-sized cities (Berlin and Madrid) had surface areas of 890 and 600 km^2, respectively; and
- Small cities (Amsterdam, Brussels, Copenhagen, Dublin, Lisbon and Paris) had surface areas smaller than 220 km^2.

City	Year	Total population	City surface	Population density	65–69	70–79	Over 80
		inh.[1]	km^2	inh./km^2	%	%	%
Amsterdam	2020	872,757	219	3,985	4.2%	5.8%	2.7%
Berlin	2019	3,669,491	892	4,113	5.0%	8.7%	5.4%
Brussels	2020	185,103	32	5,676	3.4%	4.5%	3.1%
Copenhagen	2020	632,340	88	7,185	3.3%	5.0%	2.1%
Dublin	2016	1,173,179	318	3,689	4.0%	5.4%	3.2%
Lisbon	2019	509,515	100	5,095	6.5%	12.0%	9.8%
London	2019	8,961,989	1,572	5,701	6.2%	6.1%	6.3%
Madrid	2019	3,266,126	604	5,407	4.7%	8.1%	7.3%
Paris	2017	2,152,423	105	20,499	4.0%	7.6%	5.1%
Rome	2020	2,837,332	1,287	2,203	5.5%	9.7%	7.5%

Tab.2: Population characteristics for the 10 selected cities (data from EUROSTAT, 2019)

[1] Inhabitants

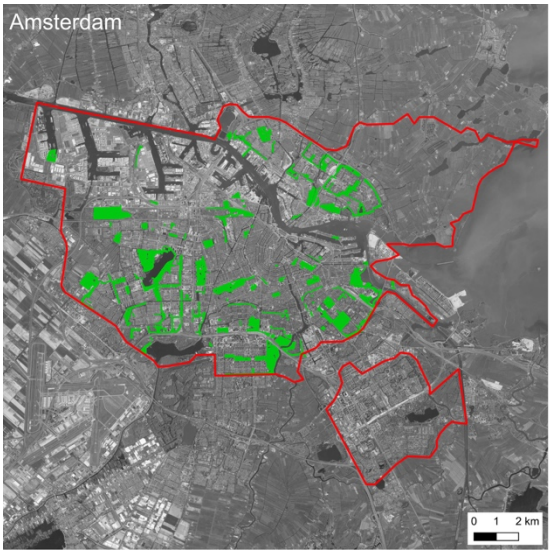
The cities with the highest percentages of elderly population are Lisbon, with 6.5% younger elderly (65-69), 12% medium elderly (70-74) and 9.8% older elderly (≥75), followed by London, with approximately 6.2% aged 65–69, 6.1% aged 70–79 and 6.3% over 80. Berlin and Rome have about 5% young elderly, around 9% medium elderly and 5.4% and 7.5% over 80, respectively. Amsterdam, Brussels, Copenhagen and Dublin have the lowest percentage of elderly residents (around 4% aged 65–69, 5% aged 70–79 and 3% aged 80 and older; EUROSTAT, 2019).

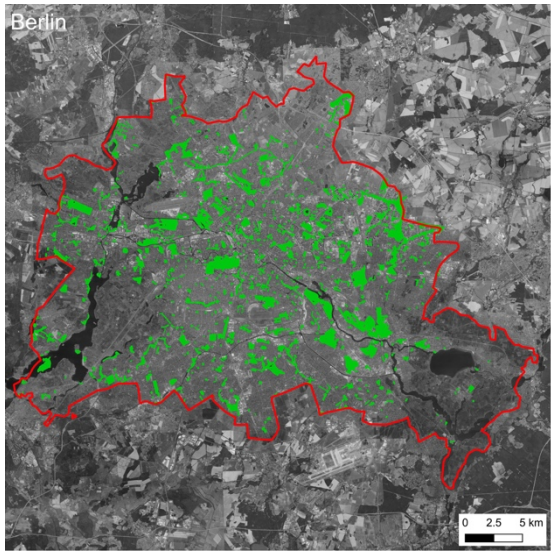
It is worth considering not only the elderly population in the selected case studies but also the distribution of population within cities, since urban structure influences how people live, move and gather (Gong et al., 2016). The population density index can explain the link between a city's population and dimensions. Paris and Copenhagen have very high population densities (20,499 and 7,185 inh./km^2, respectively) while Rome has the lowest (2,203 inh./km^2). Other cities' density values are about 5,000 inh./km^2.

In Lisbon and Madrid, the elderly population distribution is almost homogeneous, with a few variations: while there are higher concentrations in the centre of the city in Lisbon, the centres are slightly younger in Madrid. In Berlin, Brussels and Dublin, the suburbs are generally older than the city centres. In Dublin and Brussels, there is a ring around the centre, whilst in Dublin, older people are mostly located in the northern suburbs. Amsterdam and London have the highest percentages of elderly people in the suburbs but Paris also shows high concentrations in the centre and southwest (ARUP, 2015).

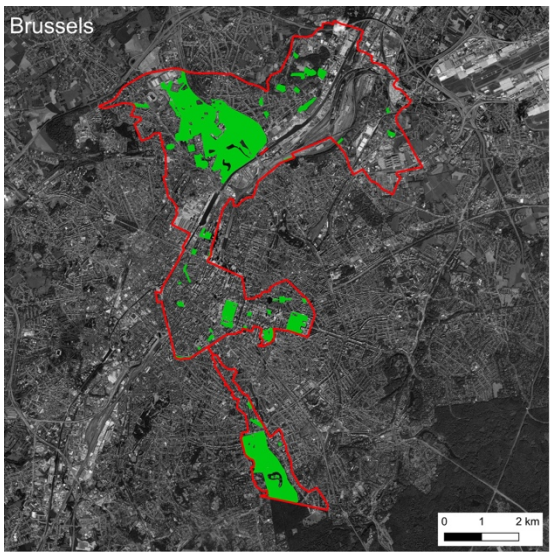
4.2 Urban green area distribution in the ten case studies

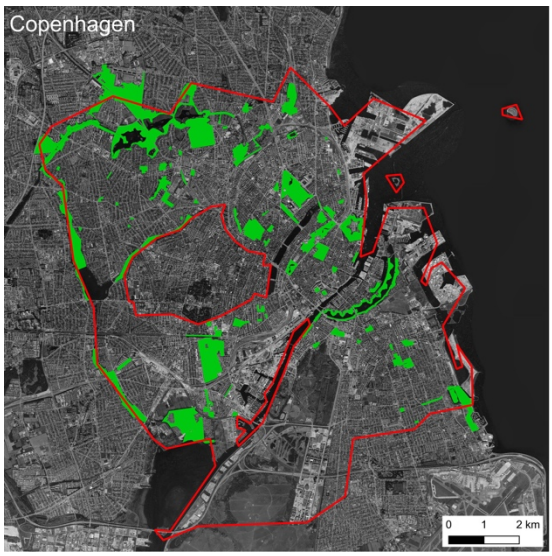
We propose a numerical and spatial evaluation of urban green areas in the 10 European cities. For this research, we used the latest available release (2018) of the Corine Land Cover (CLC) data. In the CLC database, we only selected the 'green urban areas' surfaces to evaluate the localisation and extension of these areas within the administrative boundaries of each city.[2] Based on the maps of each city (Fig. 4), it is possible to locate urban green areas and their extension. Comparing the urban green area spatial distribution between the two big cities in the sample highlights that a significant portion of Rome's urban green areas are located in the city centre, whereas in London these areas are uniformly distributed. The London scenario is an example of the adequate spatial distribution of green urban areas, considering the limited mobility capacity of older adults or other groups with similar mobility impairments.

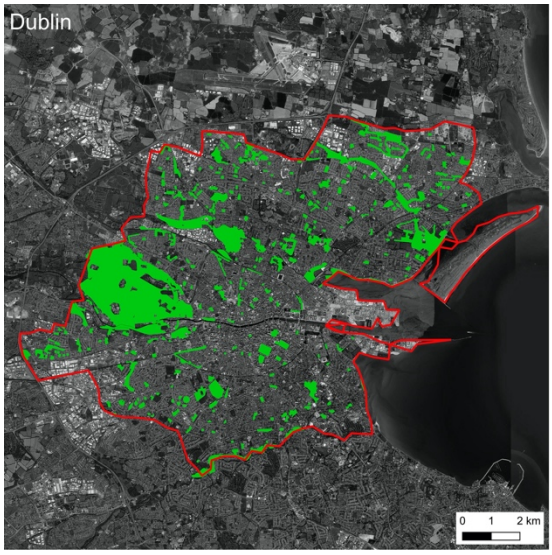


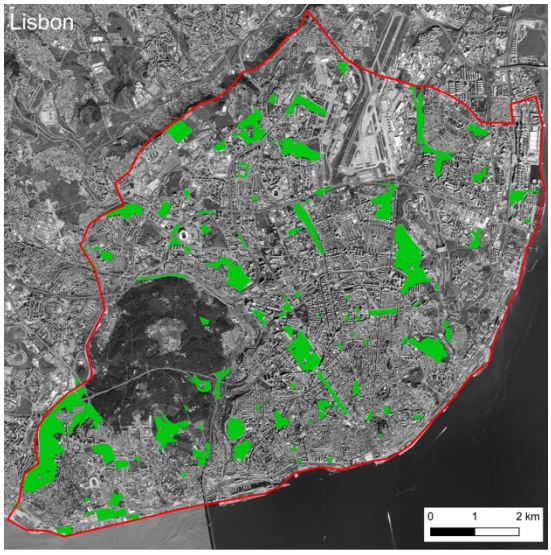


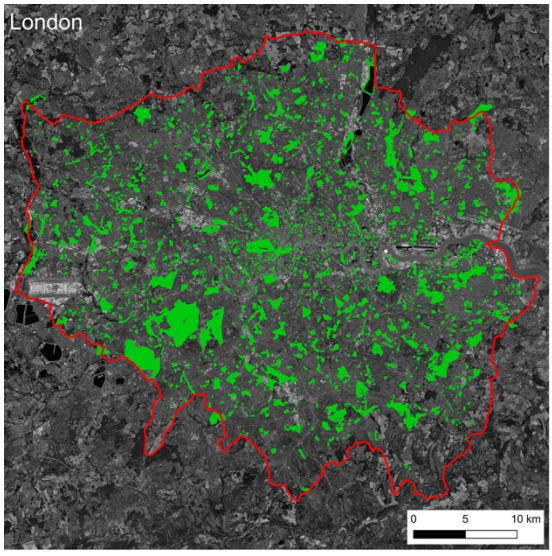
[2] CLC urban green area classifications are available at https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/html/index-clc-141.html.

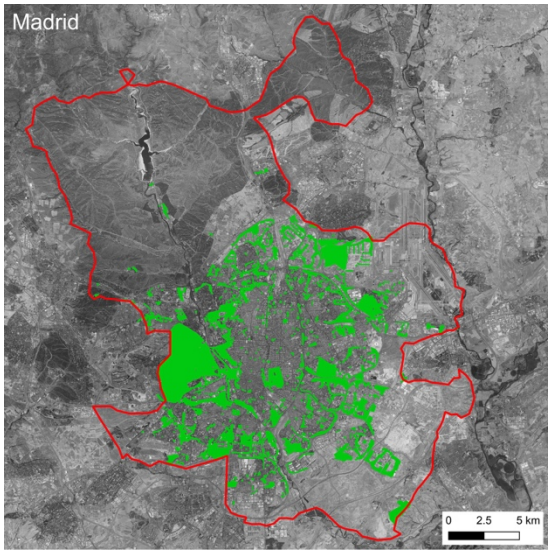

Brussels
0 1 2 km


Copenhagen
0 1 2 km


Dublin
0 1 2 km


Lisbon
0 1 2 km


London
0 5 10 km


Madrid
0 2.5 5 km

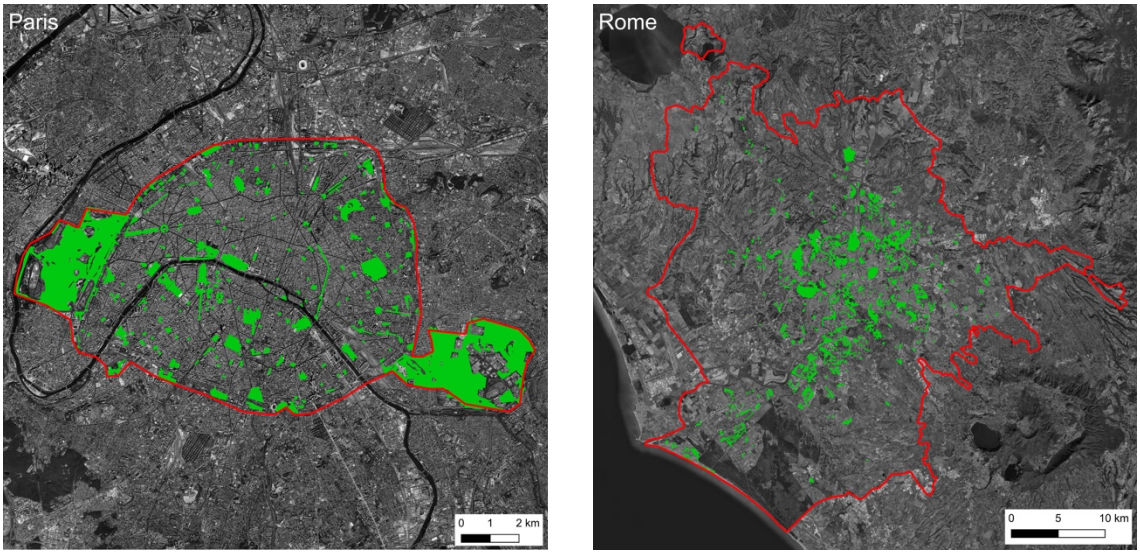


Fig.4 Urban green areas (green) in the 10 selected cities (Corine Land Cover, 2018)

City	Urban green areas	Percentage of urban green areas on city surface	Urban green area/inhabitants
	km^2	%	m^2/inh.
Amsterdam	10,770	5%	12.34
Berlin	69,846	8%	19.03
Brussels	5,083	16%	27.46
Copenhagen	8,550	10%	13.52
Dublin	15,229	13%	12.98
Lisbon	6,276	6%	12.32
London	153,302	10%	17.11
Madrid	58,073	10%	17.78
Paris	17,698	17%	8.22
Rome	35,494	3%	12.51

Tab.4 Urban green area surface in 10 selected cities (Corine Land Cover, 2018)

In the medium cities cluster, the distribution of green areas is mostly uniform. In Madrid, the most significant green spaces are outside the city centre, while in Berlin, the surface of the green spaces is relatively uniform for all municipalities.

In the small cities cluster, the dimensions and localisation of urban green areas varies significantly within the sample. Brussels, Dublin and Paris are characterised by some large green areas, while Amsterdam, Copenhagen and Lisbon show a medium extension of most urban green areas. The numerical data from the GIS analysis show that Paris has the greatest percentage of urban green space surface but the lowest square meters per inhabitant.

In general, if a green space is larger, it has better capacity and greater opportunity to attract people from more distant places (Wen et al., 2020). The EC's (2020) *Report on the quality of life in European cities, 2020* identified the satisfaction with green spaces rates for London, Copenhagen and Lisbon as 93%, 92% and 70%, respectively. Overall, people living in capital cities (74%) were less satisfied with the green spaces in their city than those living in non-capital cities (79%). Indeed, London has the greatest green area surface (more than 150,000 km^2) but the rate of urban area per inhabitant is only average (17.11%). The city with the highest rate of urban green areas is Brussels (27.46%). Brussels and Paris have the highest percentages of green

areas on the city surface (16% and 17%, respectively), followed by Dublin (13%) and London, Madrid and Copenhagen (10% each). The city with the lowest value for this indicator is Rome (3%).
Lisbon is particularly impressive as the city with the highest percentage of elderly people: although the percentage of green areas on the city surface is only 6%, citizens' satisfaction is very high (70%), perhaps due to the even distribution of green spaces throughout the city. While Paris has the highest rate of urban green area surface, it also has the greatest population density; accordingly, the green area surface per inhabitant is the lowest (8.2 m^2/inh.). The comparison of the spatial and numerical analyses demonstrates the importance of considering both of these factors in the urban planning process.

5. Discussion and conclusions

Demographic structure change is a complex issue that should be addressed by local and national authorities. High density of inhabitants and activities in a limited space represents one of the main challenges for urban areas, particularly in light of the Covid-19 pandemic. In developed countries, the ageing population will need to be supported with specific approaches and solutions. The novel coronavirus pandemic has raised some critical concerns related to safe and rapid access to urban services, activities and places, especially for those who have limited mobility. The Covid-19 health emergency has aggravated an unsatisfactory situation for the elderly and other weak population groups.
To address these issues, we conducted this preliminary study on the implications of Covid-19 for urban planning during the first phases of pandemic diffusion in Europe. The data on the spread of the pandemic evidences that urban areas are significantly affected by Covid-19. This overview for the European case studies showed that the practice of urban planning requires a combined audit that considers both the quantitative and spatial aspects of primary urban services. Our findings might benefit planners looking to make informed decisions on the distribution and the accessibility of urban services, like urban green areas, from the elderly perspective. With reference to the results of this study, new planning measures shall be implemented, taking into account the relation among green urban areas, elderly population and the spread of pandemic, both during the decision-making phase and the monitoring one. The issues proposed could be useful to the implementation of some urban planning Plan as the Services Plan, which aims at guaranteeing accessibility and availability to public services, or the Timings Plan, which has the objective to evaluate and coordinate the times of urban services, ensuring access for all citizens. These plans do not consider the number of services by itself, they take into account the distribution, the quality and the paths, too. Perhaps, in the light of this, one limitation of this study is related to the typology of data on urban green areas – specifically, our analysis suffers from the lack of availability of more recent and detailed data.
Our findings raised many topics which are worth pursuing further. The next steps of this research could be measuring the level of accessibility for each city in terms of older adults' distance from the nearest urban green area. Further analysis might be carried out, considering the distance of built-up/residential areas from urban green areas to better relate the percentage of the elderly, the size/distribution of the urban green areas and the quality/safety of the paths. Moreover, it could be interesting to apply the results of our study also to other urban services that affect elderly quality of life, or the level of well-being of other vulnerable groups, e.g. children and people with disabilities.

Authors Contribution

The authors conceived of the presented idea and developed the theory and performed the computations. For what concerns the manuscript, Carpentieri G. and Guida C. wrote paragraphs 1 and 5; Ottavia F. wrote paragraphs 3 and 4; Sabrina S. wrote paragraphs 2 and 3.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 409-425
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/6981
Received 11th June 2020, Accepted 3rd December 2020, Available online 31st December 2020

www.tema.unina.it

Transit oriented development: theory and implementation challenges in Ghana

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Abstract
Transit Oriented Development (TOD) encourages densification around transport nodes with a combination of work, educational facilities, commercial activities and other essential services. Implementing TOD in Ghana would, however, be faced with several challenges. The systematic review approach, which is based on published scholarly works was adopted. The paper aimed at exploring the significant characteristics, benefits, as well as the institutional and operational challenges of TOD in Accra. The paper identified the possible benefits of TOD in Accra to include a reduction in motorisation and congestion, promotion of walkability and other forms of non-motorised transport. It will also promote public transit ridership and improvement in the liveability of neighbourhoods. The challenges that would be associated with the implementation of TOD in Accra include the absence of a clear policy initiative of the concept in Ghanaian cities; inadequate budgetary support for strategic urban land use planning and development control; the existence of different ownership regimes within a sizeable stretch of land; and the existence of an ill-planned urban transportation system. Policy options suggested included a new housing policy that will encourage densification, mixed-income housing schemes with stronger government-private and sustainable financing schemes; and a planning regime that integrates transportation, land use and housing development.

Keywords
Ghana; Accra; Transit oriented development; Transportation; Corridor

How to cite item in APA format
Agyemang, K.K., Amoako-Sakyi, R., Antwi, K.B., Mensah, C., & Abane, A.M. (2020). Transit oriented development: theory and implementation challenges in Ghana. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 409-425. http://dx.doi.org/10.6092/1970-9870/6981

1. Background to the study

The Sustainable Development Goal 11 calls for sustainable, inclusive, safe and resilient human settlement. Strategies to achieve this include expanding public transport systems, improving upon accessibility and the development of sustainable human settlements. The New Urban Agenda also advocates for spatial development strategies that ensure accessible and well-connected, well-planned urban population densities, services and infrastructure, creation of inclusive and livable neighbourhoods, and controlling urban sprawl (United Nations, 2016).

Ghanaian cities, like others in sub-Saharan Africa (SSA), are facing a myriad of challenges that bother on congestion, pollution, and urban sprawl. In the Greater Accra region of Ghana, it has been estimated that between 1985 and 2014, the percentage share of urban land increased from 4.43 per cent to 14.46 per cent, representing an annual growth rate of 7.8 per cent (Osei et al., 2013). Several land use and spatial planning laws and legislative instruments have been introduced in the country to ensure sustainable urban development. These include the Local Governance Act 2016, Act 936 which defines local government structures of the country, Metropolitan/Municipal/District Assemblies (MMDAs) as planning authorities; Land use and Spatial Planning Act 2016, Act 925 which guides the preparation, implementation, enforcement, and monitoring of planning schemes; and the National Buildings Regulations 1996, LI 1630 which regulates the construction of new buildings and prescribes the procedure for the processing of building construction permits.

However, in the implementation of land use policies and laws, public regulatory agencies are faced with several challenges. This could partly be attributed to different regimes of land ownership in the country, insufficient resources for monitoring and enforcement of planning schemes, and the low level of political will to enforce planning regulations. In contemporary urban development thinking, there is emphasis on the need to curtail urban sprawl and traffic congestion. Suggested solutions include measures to help reduce the need to travel, the efficient use of non-motorised forms of transportation, and the promotion of the complete streets concept. This has led to the overarching need for Transit Oriented Development (TOD).

Transit Oriented Development focuses on the total development of transit stations and their broader precinct surroundings of neighbourhoods located within 10-minute walk from the stations. It promotes sustainable modes of transportation, such as public transit and non-motorised forms of transportation. It is a useful travel demand management tool as it assists in reducing the need to travel for services outside the TOD neighbourhood (The State of Queensland, 2010). Mirmoghtadaeez (2016) asserts that TOD could be an avenue to address urban transportation problems in countries faced with the challenge of increasing motorisation and vehicular pollution. In this regard, TOD should be well planned to ensure a reduction in the use of automobiles and hence traffic congestion. It should promote compact and increased density of people and mixed-use development around transit stations. This will help encourage walking and other non-motorised forms of transportation.

Concerning the importance of population densities, Masoumi and Shaygan (2016) in their study of densities within the pedestrian sheds around metro stations in Teheran, recognised the importance of densities in TOD planning.

It has also been argued that Transit Oriented Development could ensure equitable access to resources of the city by connecting underprivileged communities to more endowed communities with more resources and job opportunities. This calls for an examination of the prospects of using Transit Oriented Development as a strategy to help solve urban congestion, pollution and sprawl in Ghana.

The next section of the paper explains the concept of TOD with the authors proposing a conceptual framework for it. The paper delves into the argument for TOD in Ghana and the likely challenges that would be associated with its implementation. It concludes with policy recommendations for consideration.

1.2 Methodology

The systematic review approach, which is based on published scholarly works was adopted. This was necessitated by the broad nature of the study, which required gathering enough information and evidence about TOD and its application in the Ghanaian context. The systematic review approach as indicated by Mensah et al. (2016) and Victor (2008) deals with using a straightforward approach to search, appraise and synthesise available literature to satisfy the aim of a given topic under study. It often uses information from books, journals, conference papers, reports, among others. The use of systematic review allowed a wide range of published works (both theoretical and empirical) to be synthesised to answer a specific research question(s). It helps provide more accurate and reliable conclusions because the secondary materials or information utilised had already been tested in other studies (Victor, 2008; Akobeng, 2005). This helps to minimise bias and makes this approach more robust and comprehensive. The following steps or processes as prescribed by Perera and Mensah (2019), Bryman (2012) and Uman (2011), to make the systematic review approach more transparent and reproducible were followed in this study.

1. Defining the scope and purpose of the review: This stage focused on defining the scope and purpose of the review to make the review well-structured and get relevant secondary materials related to the study. In doing this, some questions were posed as follows: What does TOD entail? And how has it been implemented elsewhere? To further narrow the scope to focus on the study area, specifically, the following sub-questions were asked: How can TOD be implemented in Accra, Ghana? What challenges will the implementation of TOD face in Accra, Ghana?;
2. Identifying relevant publications on the topic under study: At this stage, several databases were searched. These included Scopus, Thomson Reuters, Science Direct, Social Science Research Network, Google Scholar, Directory of Open Access Journals (DOAJ), JSTOR, Ingenta Connect, and Web of Science. In addition to this, some search engines such as Google and Yahoo were used to search for more data. These efforts were further supplemented with the manual search for additional hard copy materials from the University of Cape Coast library. In all, over 200 publications were found at this stage;
3. Appraising the publications according to the purpose of the paper: The quality and credibility of the reviewed publication were assessed about the purpose of the study. In doing this Bowler et al. (2010) quality assessment criteria for publications were utilised. Much emphasis was given to publications from accredited institutions and peer-reviewed works. This reduced the number of publications to 103 for final inclusion in the study;
4. Synthesising the results: At this final stage, rigorous content analyses were conducted on the finally selected publications. This was done to tease out essential information on the topic under study and also to answer the research questions posed at the first stage. The findings from these analyses were afterwards organised and used to discuss various sections of this paper.

2. Theoretical and conceptual overview

2.1 Transit oriented development concept

The California Department of Transportation (2002) defines transit oriented development as "moderate-to-higher density development located within an easy walk (i.e. approximately half a mile) of a major transit stop, generally with a mix residential, employment and shopping opportunities designed for pedestrians without excluding auto" (p.3). Transit Oriented Development leads to the creation of an area where residents live very close (a walking distance) to a transit station that offers many services. It thus tends to reduce the number of trips, provides accessibility to job centres and other destinations, encourages non-motorised forms of

transportation and creates a pro-pedestrian neighborhood with increased transit ridership (State Highway Authority of Maryland, 2013; Cervero, 2008; Suzuki et al., 2009).

In his pioneering work on transit oriented development, Calthorpe (1993) argued for rethinking the American dream to include cities with neighbourhoods with mixed development, mixed-income, racial, different age cohorts, in effect inclusive neighbourhoods. The author argued for the introduction of transit oriented development to help address urban sprawl, promote non-motorised forms of transportation, make goods and services accessible in the community to help manage travel demand. Calthorpe introduced a model (Fig. 1) to help illustrate transit oriented development.

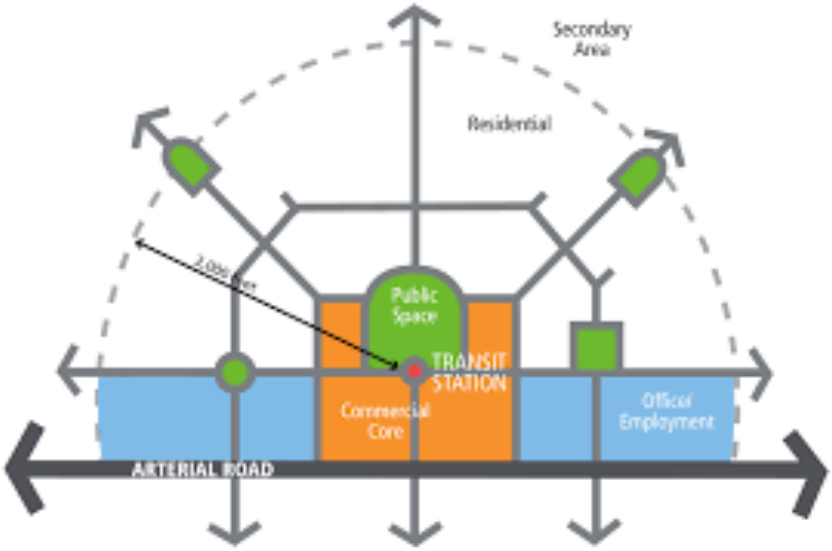


Fig.1 Transit Oriented Development design (Calthorpe, 1993)

Transit Oriented Development as a planning and design strategy aims at achieving compact, pedestrian and other forms of non-motorised transportation in a mixed-use neighbourhood that is well integrated with the transit stations. It survives on the basis that locating services, employment avenues, commercial and residential facilities around transit nodes encourages public transit ridership as well as the promotion of non-motorised transportation forms (The World Bank, 2017; Calthorpe, 2011; Institute for Transport and Development Policy, 2013). Centre for Transit Oriented Development in research concluded that the number of people in the United States who preferred living close to transit nodes has been increasing. The centre projected that by 2030, about a quarter of households would prefer to own or rent housing in higher-density zones near transit (LISA, 2009).

Centre for Transit Oriented Development (2009) advocates two dynamic steps that would assist in the creation of more livable transit oriented development systems. First is the proper co-ordination of transit and real estate development; and second is the need to pursue the goals of TOD beyond densification of estate development and, embracing conditions for livable neighbourhoods. Livability benefits outlined include employment opportunities, education and job training centres, affordable housing schemes for the working force and open spaces to facilitate recreation. In other words, there is an emphasis on enhancing the sustainability of the metropolis as a system.

Transit Oriented Development has been associated with the concept of "complete communities". A complete community is described as being endowed with opportunities for all residents, including quality housing, good educational facilities, commercial, healthcare and transportation as well as cultural oriented facilities. The community should also provide facilities and services that will make it children-friendly (The Centre for Transit Oriented Development, 2012). Transit Oriented Development, therefore, adopts the complete streets concept. Indeed, the North Carolina Department of Transportation (2012) explains that "Complete streets are designed

and operated to enable safe access for all users. Pedestrians, bicyclists, motorists and transit riders of all ages and abilities must be able to move along safely and across a complete street (p.10)."

Transit Oriented Development planning may also require considering not only a single station but also understanding the entire chain of stations along a transportation corridor or regional chain of TOD places. A good appreciation of the real estate market, main employment points and travel patterns in the area under consideration will be critical. At the regional level, a successful TOD project would warrant coordinating the policy and programs at different segments of government and harmonisation of an existing growth, housing development and jobs creating and development plans. It would also require coordinating and negotiating with relevant stakeholders such as local government and land management authorities as well as transit agencies (Centre for Transit Oriented Development, 2007).

At the corridor level, a transit corridor is defined as "the walkable areas around all the stations along a transit line. Different transit technologies will define different areas of influence". Corridor planning can include region-wide analysis of the potential impact of transit and can lead to a projection of areas where real estate developers may be attracted. In situations where there are existing lines already, these areas could benefit from TOD, if it incorporates urban revitalisation. Again, the poor and the vulnerable would benefit if it makes the necessary housing provisions for residents who are already threatened with displacement as a result of fluctuations in the prices of real estate as dictated by market forces (The Centre for Transit Oriented Development, 2010a).

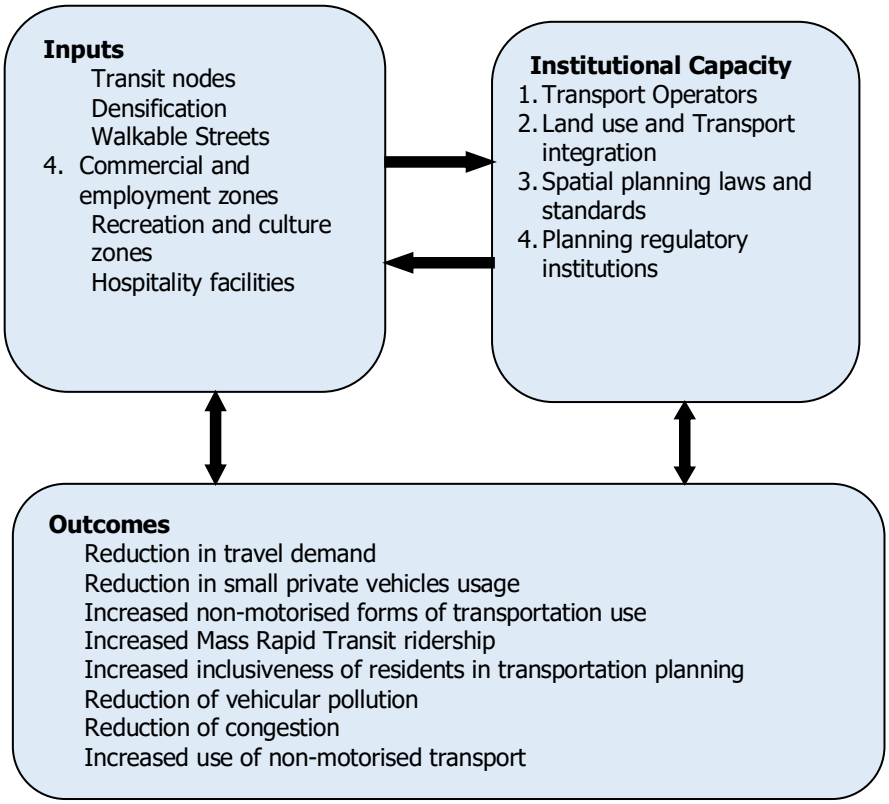


Fig.2 Framework for Transit Oriented Development

Transit Oriented Development planning promotes densification with a fair mix of human, job, and housing densities around significant transit stations outside the core of the city. This assists in the creation of polycentric centres, to complement the core, which is linked with transit to offset the one-way flow of traffic to the core during peak hours. (The World Bank, 2017).

There is also the micro area planning for Transit Oriented Development. Local Initiatives Support Corporation (2009) explains that station area plans are unique conceptual plans developed around a station. Although the

details of the plans would be station specific, the plans contain essential elements such as "zoning, design standards, parking requirements and information about transit access and bike and pedestrian circulation" (p.3).

A proposed conceptual framework has been suggested for Transit Oriented Development (Fig.2). The framework which operates on the systems thinking principles identifies several inputs that are very important for the development of TOD. Transit Oriented Development would require mixed-use development around transit nodes incorporating densification, commercial zones, recreation and cultural zones, walkable streets and tourism and hospitality facilities. There is the need for the requisite institutional capacity, which should include the right legal and regulatory framework, land use and transport integration and transport operators. The expected outcomes for the implementation of TOD should include a reduction in travel demand, reduction in small private vehicles usage, improved transit ridership and increased participation in transportation planning, among others.

2.2 TOD theory in practice

In Portland and Arlington in the United States, the planners followed a participatory approach to get community members to appreciate the need to focus on the type of city and region they prefer to live in rather than on the type of strategy. There was a focus on the advantages of densification and the benefits of making their respective cities more livable (The German Marshall Fund for the United States, 2013). The city of Portland achieved success in TOD by linking transportation and land use planning. It enabled the city to meet its goals on densification, compact development and commercial zones. The introduction of the Portland Streetcar assisted in the development of a transit oriented neighbourhood at the Pearl District of the city. Portland also exhibits an excellent example of private sector participation in the development of TOD. Partnership with Hoyt Street Properties assisted in the development of affordable dense housing facilities (Schematic Workshop Makers, 2009).

In China, Xu et al. (2017) explained that the objective of the introduction of TOD was not to curb low urban density and urban sprawl, as was the situation in the United States. The purpose of TOD in China was to help address the problems that were associated with high density by making public transit systems more efficient in such neighbourhoods. Lu et al. (2018) explained that there are some TOD new towns in the New Territories of Hong Kong with characteristics such as densification, pedestrian friendly neighbourhoods around transit stations and mixed-use. The authors, however, observed that individuals who lived close to the transit stations benefited more from walking than those living quite far away from the transit stations in the newly developed towns. One characteristic feature of TOD in Hong Kong's new territories is that adjoining land around TOD areas is predominantly rural.

The city of Bogota incorporated inclusive measures into transit oriented development planning by the introduction of Metrovivienda, an affordable housing scheme program, around transit stations. The Metrovivienda also improved access to social facilities such as education, health, green spaces and libraries. It assisted in providing affordable housing to low and middle-income families, reduced the cost of travelling as well as the need to travel (Suzuki et al., 2013).

Copenhagen used long term planning to shape urban development and growth with the use of the railway as the transport mode for transit oriented development. The construction of railway infrastructure along desired areas earmarked for urban growth triggered population growth and significant infrastructure along the railway corridors. This was combined with the creation of adequate public spaces that are pedestrian and community-friendly and bike routes (Suzuki et al., 2013).

The city of Denver, USA, made transit oriented development, more inclusive by addressing the challenges of low-income neighbourhoods. The city collaborated with the state authorities and philanthropic organisations in the creation of job avenues for low-income households. The city was able to get citizens participation

throughout the planning and implementation through open communication, commitment, and getting focused towards agreed goals (Living Cities and Institute for Sustainable Communities, 2011).

A careful analysis of the TOD examples given shows several characteristics that were common in all the cases. Transit Oriented Development promoted livability through increasing access to basic and commercial services, and a general pedestrian-friendly environment. There was also the introduction of affordable housing units in a mixed-use zoning environment with some level of densification. The participation of the private sector in the implementation of TOD was also evident. The importance of mass transportation in the implementation of TOD also came to bear with the introduction of intermodal and multimodal transport systems. In effect, all these factors served as travel demand management measures by helping to reduce the need to travel.

2.3 Accra: developing country city

Accra and Kumasi are the two major primate cities in Ghana. Although with an annual population growth rate of 2.2 per cent which was lower than the 5.5 per cent growth rate in Kumasi, Accra accounted for 16.6 per cent of the total urban population in Ghana (The World Bank, 2014). Accra city-region, as referred to in the National Spatial Development Framework has the highest net in-migration in the country, recording 153, 154 and 901,780 as net in-migration for 1984 and 2000 respectively. Data from the 2010 Population and Housing Census indicate that in-migration accounted for over one million of the total population of 4,010,054 (Ghana Statistical Service, 2014).

It is an essential economic hub in Ghana. The area accounts for 25 per cent of the nation's Gross Domestic Product and leads or is second concerning total non-primary sector economic activities (Government of Ghana, 2015a). The area is the most important destination of Foreign Direct Investment (FDI), accounting for 25 per cent of FDI (Government of Ghana, 2015b). All these factors have contributed to the attraction of population to Accra with its resultant land use and transportation challenges.

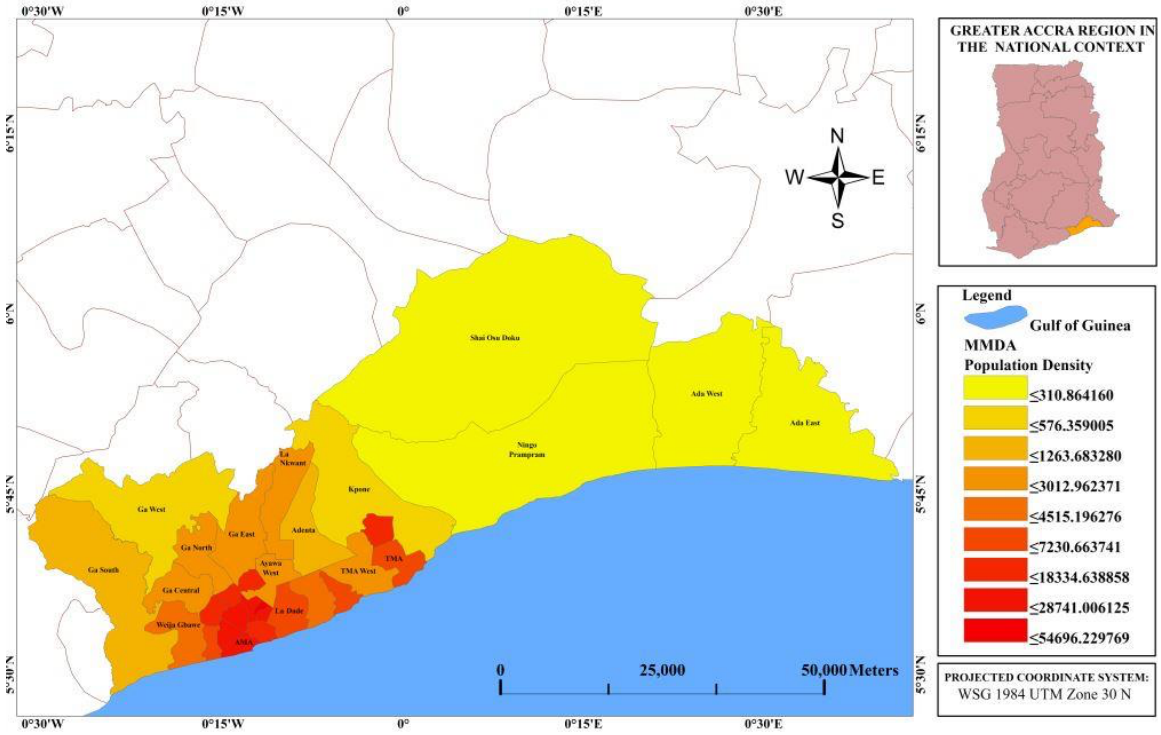


Fig.3 Greater Accra population density (GIS and Cartography Unit, Department of Geography and Regional Planning, UCC, 2020)

The influx of in-migrants has led to pressure on urban housing in the Greater Accra region. The resultant effect of the increasing population is inadequate affordable livable accommodation for the inhabitants of the city. About 8 per cent of the population dwell in uncompleted building structures, metal cargo containers and kiosks

(Ghana Statistical Service, 2014). The increasing population has also resulted in high population densities, especially in the inner-city areas. Figure 3 illustrates population density in the Greater Accra region. It could be seen that there are very high population densities of above 20,000 persons per square kilometre in the inner-city areas. Accra has a significant challenge concerning development monitoring and control. There are several unauthorised structures in waterways, reducing the ability of the city to deal with perennial flooding. Management of urban expansion has been a problem, with the city being allowed to grow "naturally" (Addae & Oppelt, 2019). The Ministry of Transport, Ghana, describes the urban expansion in Accra as characterised by sprawl of settlement with increasing population and vehicular ownership. Transit Oriented Development should also be recommended for Ghanaian cities because of the increasing rate of urban sprawl as identified by Osei et al. (2013), Ministry of Transport (2016) and Ministry of Local Government and Rural Development (2012). The figure below explains the extent of urban sprawl in Accra from 1999 to 2019 (Fig.4). The introduction of TOD will therefore be an avenue to reduce urban sprawl in Ghanaian cities. The Land cover maps (Fig.4) illustrates that the extend of urban sprawl has been increasing significantly between 2009 and 2019. Spatially, the city has been extending beyond the Greater Accra Region to other neighboring regions. This high rate of sprawl will lead a further increase in the extent of motorisation in the Accra city-region.

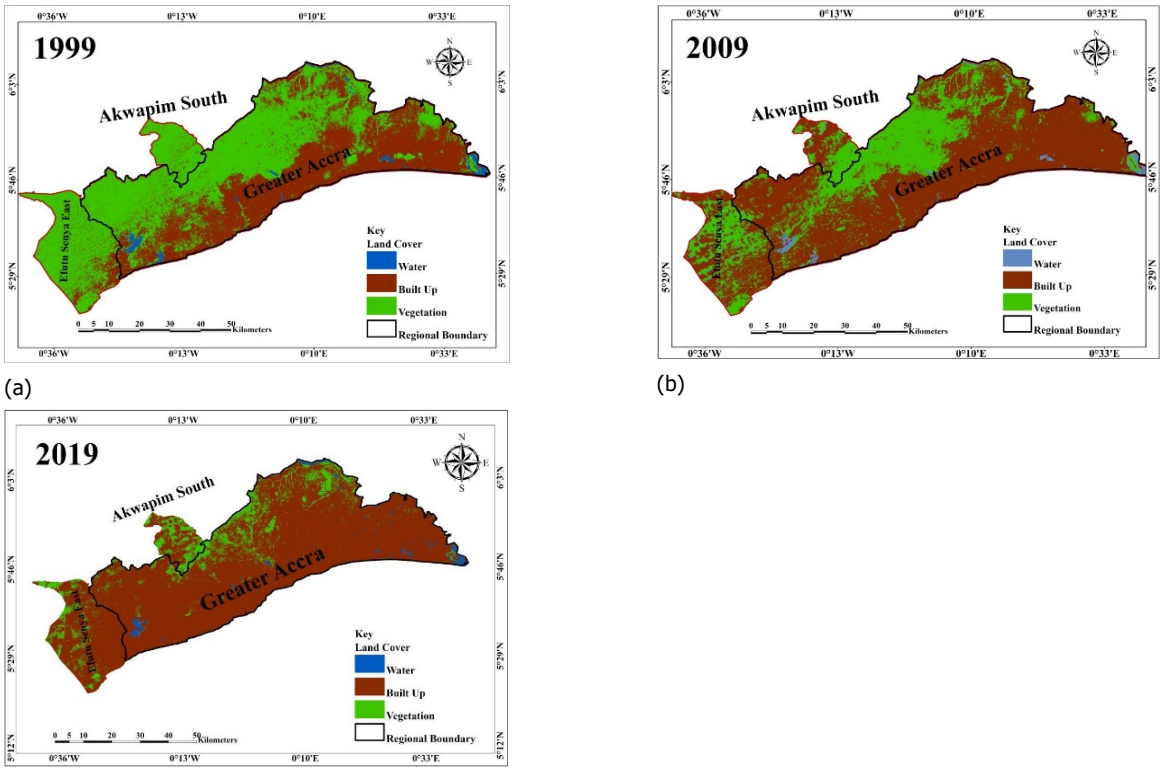


Fig.4 Land Cover Maps for 1999 (a), 2009hop (b) and 2019 (c) showing urban sprawl in Accra (GIS and Cartography Unit, Department of Geography and Regional Planning, UCC)

The high rate of sprawl would also imply that many people would have to stay at distances away from their workplaces and commute to work. Fig.5 illustrates the distances travelled by urban workers in Accra to work daily in 2007 and 2012 (Ghana Statistical Service, 2014). It could be seen that in 2007 more than 24 per cent journeyed for over 5 km to work and with over 18 per cent doing same for 2012.

A study by Agyemang (2019) indicates that commuters using their personal private small vehicles journey for several kilometres to work. Out of a sample of 430, it was realised that only 16.4 per cent journeyed for less than 10km to work. It surfaced that 30.70 per cent commuted for 10 to 14km; 22.79 per cent for 15 to 19 km; 10.00 per cent for 20 to 24 km; and 19.77 per cent journeying for over 25 km with their small private vehicles to work in inner Accra daily. This situation will contribute to traffic congestion, as shown in Fig.6.

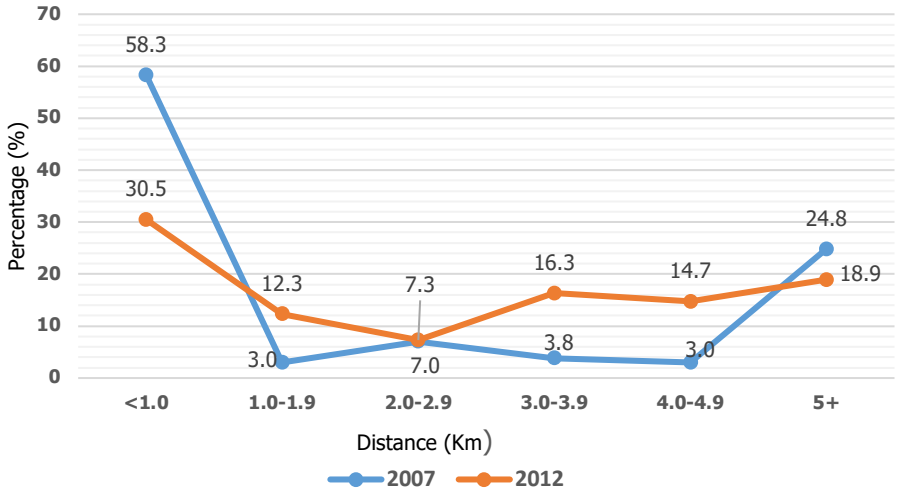


Fig.5 Average distance (Km) from residence to place of work in Greater Accra Region (Ghana Statistical Service, 2014)

The daily commuting from the hinterlands and other parts of the country to Ghanaian cities, especially Accra also calls for a second look at land use and transportation planning to incorporate some element of Transit Oriented Development. It has been estimated that outside the actual inhabitants of the city, there is additional daily inflow and outflow of commuters of between 2.5 million and 3.0 million to and from Accra for commercial and services purposes (Ministry of Transport, 2016; Ministry of Local Government and Rural Development, 2012).

The national transport policy document recognises the delicate relationship between transport and the quality of life of citizens. It explains that efficient transportation systems have positive impacts on the quality of life and business opportunities for the citizens (Ministry of Transport, 2008). Transit Oriented Development in Accra and other Ghanaian cities could be an avenue to help solve congestion in Ghanaian cities. Figure 6 shows traffic congestion at Kaneshie in Accra (Fig.6).

Fig.6 Traffic Congestion at Kaneshie, Accra (Bokpe, 2017)

Mass Rapid Transit (MRT) is not well developed in Ghana with the informal private sector, taking a very active role in urban transportation in Ghana (Abane, 1993; Abane, 2011). Frazier (2011) observed that the transportation network in Accra could be classified as failing, and one of the most dangerous globally. The dominant mode of public transportation in Ghanaian cities is some form of buses which account for 70 per cent of person trips in the cities and occupies less than 25 per cent of the road space in the cities. The more

significant contribution of road space is by Taxis and small private vehicles which occupy 70 per cent of road space in the cities but account for only 30 per cent of the person trips (Department of Urban Roads, 2015). The high risk of roads fatalities in the country calls for the introduction of TOD to help reduce travel demand in general, emphasis on mass transit and help reduce road fatalities eventually. Annual road crashes in the country was 11, 506 in 2010 and 10,887 in 2011 and increased to 14,914 in 2014 (Ministry of Transport, 2014).

Transit Oriented Development would, in a way assists in reducing the demand to travel by providing commercial services around transit nodes (The California Department of Transportation, 2002). It also incorporates the promotion of non-motorised forms of transportation (The World Bank, 2017; Calthorpe, 2011). It will assist in the re-organisation of the public transportation system in Ghanaian cities and contribute to a reduction in the CO_2 emissions (Global Environmental Facility, 2006).

2.4 Land use planning comparable to transit oriented development in Accra

A critical observation of the development of inner Accra reveals the city has been developed around five main transport terminals being, the Achimota, Kanashie, 37 Military Hospital, Tema station and Kwame Nkrumah Interchange terminals (Agyemang, 2019). These transport terminals have busy traditional market centres and business areas around them with residential facilities and business establishments. Figure 7 illustrates the area under review with the transit routes (Fig.7). It can be observed that, the area could be developed into a perfect city-scale transit oriented system that will "create a network of transit-oriented places and sites that integrate different functions and activity centres within easy access of transit" (The Centre for Transit Oriented Development, 2010b). The stations can also host multimodal transportation systems of Bus Rapid Transit and Commuter Rail Transit. An in-depth geospatial analysis of the individual stations under review reveals some attributes of TOD at the station scale.

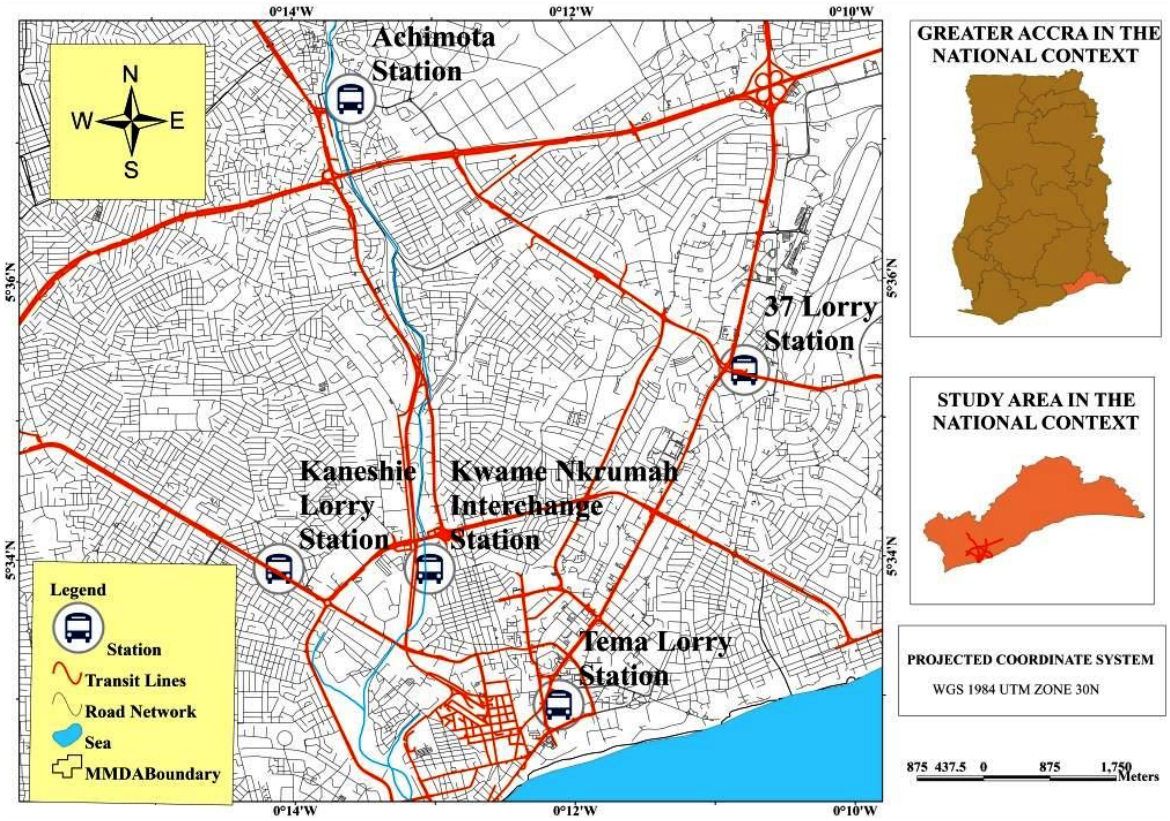
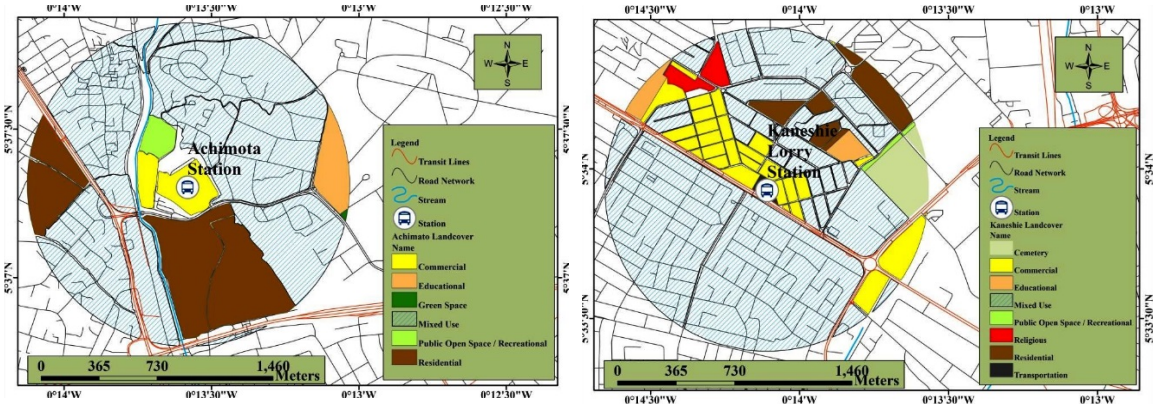


Fig.7 Major terminals and transit routes of inner Accra (GIS and Cartography Unit, Department of Geography and Regional Planning, UCC)



(a) (b)

Fig.8 Land use maps for Achimota (a) and Kaneshie (b) stations (GIS and Cartography Unit, Department of Geography and Regional Planning, UCC)

Using a radius of 1 km from the centre of the stations based on TOD standards, as explained in ITDP (2017), the characteristics of the land use pattern bear some semblance of TOD. Areas within walkable distances from the stations have land-use characteristics such as commercial, residential, mixed-use, educational, public open space/recreational as shown in Fig.8 for the Kaneshie and Achimota stations.

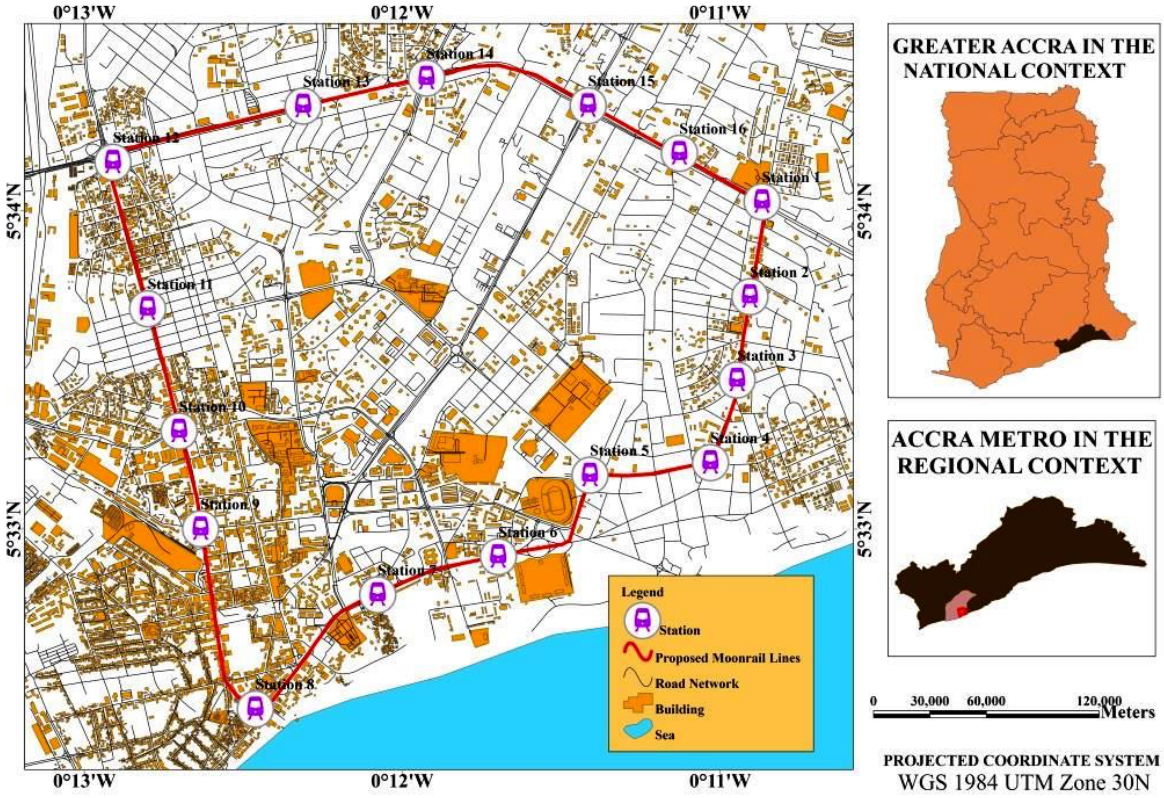


Fig.9 Proposed monorail routes and stations for Accra (GIS and Cartography Unit, Department of Geography and Regional Planning, UCC)

These areas, however, do not meet some of the essential standards for TOD. Institute for Transportation and Development Policy (2017) explains the standards for transit oriented development to include reduced land occupied by motorised transportation modes; safe and vibrant pedestrian realm; protected and shorter bicycling routes with secured parking; transit terminals accessible by foot; and affordable housing units.

One project that had some element of transit oriented development was the proposal to introduce monorail transportation system in the city of Accra by a private company, Intercontinental Commerce Corporation (ICC), of United States of America (USA) in 2010. The company planned the development of 16 stations along a proposed monorail corridor of 12.8 km in Accra (see Fig.9).

There was also a proposal to develop significant shopping malls at some of the monorail stations to serve neighbouring communities and transit riders. Some other stops were to have shops and food corners and coffee shops (Intercontinental Commerce Corporation, 2011). The proposed project however, did not have the full complement of a standard transit oriented system by lacking integration with bicycle routes and provision for the safe, walkable environment.

2.5 Challenges of adopting transit oriented development in Accra

Although the Ghana National Urban Policy Framework and Urban Policy Action Plan have policy initiatives on urban housing and transportation, there is no clear policy initiative on Transit Oriented Development in Ghanaian cities. This does not augur well for a discussion on TOD for Ghanaian cities (Ministry of Transport, 2012a; Ministry of Transport, 2012b). Transit oriented development projects are sometimes affected by upstream decisions made by policy and planning level decision-makers, operating many years ago before this era (Carlton & Fleissig, 2014). This makes current land use in most parts of the city, not incongruent with the standards for transit oriented development.

In Ghana, spatial planning faces a big challenge because of inadequate budgetary support for strategic urban land use planning and development control. This has resulted in urban sprawl in the major cities with its associated informal settlements and deficient urban infrastructure and services. There is also an ill-planned urban transportation system and its resultant traffic congestion (Ministry of Local Government and Rural Development, 2012).

Similarly, the Sector Medium Term Development Plan (SMTDP, 2014 to 2017) of both the Ministry of Transport and the Ministry of Roads and Highways failed to recognise the potential of TOD in transportation planning in the country. Unlike the Portland TOD project that benefited from the presence of a large tract of land under single ownership (Carlton & Fleissig, 2014), the existence of different ownership regimes within a sizeable stretch of land in Ghana could serve as a challenge for the development of a sustainable Transit Oriented Development.

Transit oriented development has been noted for swelling the value of land around transit nodes. Unbridled gentrification pushes out low-income occupants of the area under TOD planning. To offset this problem city authority could provide incentives to estate developers at TOD enclaves to incorporate the development of affordable real estate schemes to render TOD as a socially inclusive program (The World Bank, 2015).

Looking at the promotion of Transit Oriented Development in cities, Bertaud (2002) argues that urban structures exhibit resilient qualities and are not easily altered. Some cities have already developed a spatial pattern that did not pay much attention to transit and which would be difficult to reverse. Again, it is argued that predominantly monocentric cities with medium to high density would be better off by focusing on appropriate regulations and infrastructure investment which will probably favour an increasing use of public transport. On the other hand, in cities with predominantly polycentric structure and low density, the convenient transportation measure may be to focus on pollution and congestion reduction.

3. Discussion and policy implications

Transit Oriented Development should not lead to excessive gentrification and replacement of current residents with new residents who can afford prices of property that have been skyrocketed under gentrification. This was achieved in Pearl area TOD by moderating construction cost and pricing of housing to avoid gentrification eliminating original community members due to high prices of housing (Portland Development Commission, cited in Carlton & Fleissig, 2014)

Centre for Transit Oriented Development (2009) outlines the benefits of TOD to include livability. Livability from the context of the centre should include the creation of employment avenues, education and job training centres, affordable housing schemes for the working force and open spaces to facilitate recreation. Transit

Oriented Development should be pursued to include the goal of breaking the monocentric pattern of Ghana's cities to further serve as a travel demand management measure to reduce vehicular pollution and congestion. Complete streets, as explained by the North Carolina Department of Transportation (2012) to mean streets designed and managed to ensure the safety of all users, will also be a challenge. It will call for the redesigning of most neighbourhood streets in the country which will come at a tremendous financial cost to municipalities. This could, however, be carried out in stages with priority given to streets with heavy vehicular activities and noted for vehicular-pedestrians accidents.

Affordable housing as a requirement for a better TOD system will further be a challenge in the country. The real estate industry in the country is under the control of the private sector who are focused on the provision of housing schemes for the higher and middle-income population segments of the country. A shift in policy for housing promotion that will incorporate Public-Private Partnership (PPP) will be desirable. This would require proper participatory planning with the participation of the private sector and other relevant stakeholders in the transport and real estate value chain. The adoption of Public-Private-Partnership in the development of housing schemes assisted in the attainment of the mixed-use and densification in the Pearl area TOD (Carlton & Fleissig, 2014).

The development of Mass Rapid Transit (MRT) routes could complement the introduction of Transit Oriented Development neighbourhoods in the city. In the development of a new suburb and schemes for selected settlements around new outer ring roads, Transit Oriented Development could be employed with MRT systems linking the newly developed community with other suburbs in the city. A new housing policy that will encourage densification, mixed-income housing schemes, promote stronger government-private, and sustainable financing schemes will augur well for the development of TOD in Ghana. Financing schemes could include declaring TOD zones as tax exclusive with special tax incentives to housing developers who would be prepared to develop mixed-income and mixed-use and densification-focused housing schemes in designated TOD zones.

Proper community engagement and participation is very important for the success of Transit-Oriented Projects. The Centre for Community Innovation (2009) explains that one barrier to the development of TOD is the opposition from residents of the proposed area to accept some of the components of the project especially the high-density neighbourhood and mixed-income housing. This is usually borne out of the idea of Not-In-My-Backyard (NIMBY). Planners could offset this problem by sustainably engaging the community and key stakeholders and effectively explaining the perceived benefits of the project to the overall development of the community and the nation at large.

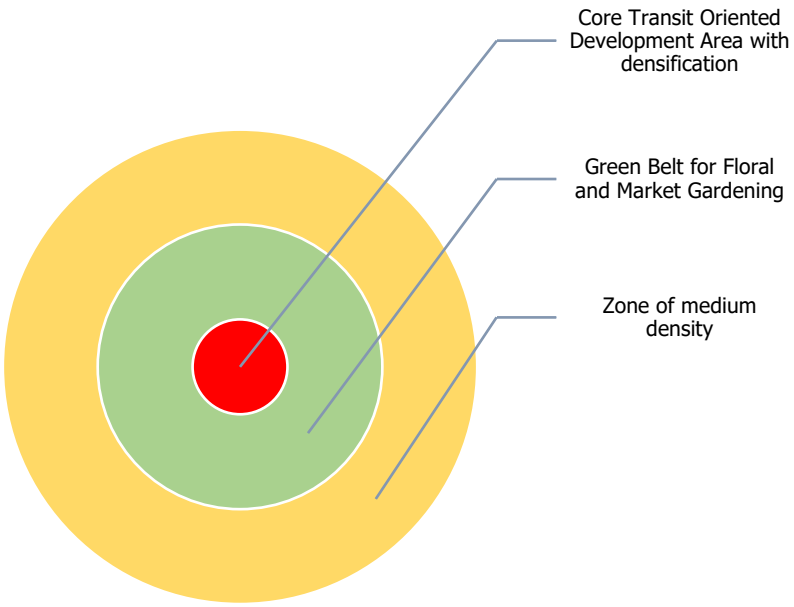


Fig.10 Transit Oriented Area with Green belt and Medium Density Zone (Authors' Construct adapted from Calthorpe, 1993)

To cater for the concerns of some middle and upper-middle-income class who may not be in favour of densification, we propose that transit oriented developed could be modified to include a green belt around the original TOD zone. This zone could serve as inner-city agricultural and nature reserve belt for floral and market gardening. This belt could be followed by a belt medium density neighbourhood to cater for the middle class and other citizens who may not be in tune with the high density of the original TOD zone but could walk, ride a bicycle or drive and park at a parking zone within the TOD area and join public transit or rapid mass transit (Fig.10).

The issue of fragmentation of land ownership has been as identified as a challenge to the development of TOD in the country. It is therefore recommended that city authorities/government could identify owners of land in a proposed TOD zone, pay the economical price and legally acquire to re-sell to developers for Transit Oriented Development. Additionally, a planning regime that integrates transportation, land use and housing development is indispensable. Under the development of an efficient transportation system to assist in sustainable TOD in Ghana, modal integration would ensure intermodal and multimodal transportation system development. The development of central transport nodes that incorporates stations for different transportation modes will assist in the easy transfer of passengers from one mode to another and increase the options that passengers have concerning different transport modes.

Transit Oriented Development implementation may be associated with some challenges for Ghanaian cities, the benefits that are associated with the implementation of TOD necessitate that city authorities and policymakers follow the winds of change in current urban transportation planning and commit resources for further research and the development of TOD systems to help promote liveable and sustainable cities.

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Image Sources

Fig.1: Calthorpe, 1993

Fig.2: Authors

Fig.3: GIS and Cartography Unit, Department of Geography and Regional Planning, UCC

Fig.4: GIS and Cartography Unit, Department of Geography and Regional Planning, UCC

Fig.5: Ghana Statistical Service, 2014

Fig.6: Bokpe, 2017

Fig.7: GIS and Cartography Unit, Department of Geography and Regional Planning, UCC

Fig.8: GIS and Cartography Unit, Department of Geography and Regional Planning, UCC

Fig.9: GIS and Cartography Unit, Department of Geography and Regional Planning, UCC

Fig.10: Authors

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TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 427-444
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/7146
Received 3rd September 2020, Accepted 1st November 2020, Available online 31st December 2020

Spatial policy in cities during the Covid-19 pandemic in Poland

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Abstract
The 'geographic' aim of the study is to find the regularity of the increase in the number of infections in larger cities and their surroundings. The goal related to the science of public policy is to determine the implemented and potential effects related to spatial policy in Polish cities. The geographic part of this publication uses the available data on the development of the number of identified (recorded) infections. The part of the paper related to the accomplishment of the goal covering the sphere of public policy is primarily of an overview nature. It contains the characteristics of the spatial management system in Poland (including tools affecting the broadest impact on urban space) and the introduced and potential changes caused by the pandemic.

Keywords
Spatial policy in Poland; Covid-19; Cities

How to cite item in APA format
Śleszyński, P., Nowak, M. & Blaszke, M. (2020). Spatial policy in cities during the Covid-19 pandemic in Poland. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 427-444. http://dx.doi.org/10.6092/1970-9870/7146

1. Introduction

The spread of any infectious disease in the human population has its very important conditions related to the subject of geography studies (Cliff & Haggett, 1989; Wilson, 2010; Meade, 2014). A specific feature of every infectious disease is its spread, i.e. local transmission. Since the SARS-CoV-2 coronavirus is transmitted from person to person by airborne droplets, the development of the pandemic is closely related to social contact models. These in turn depend especially on the natural environment (e.g. climate, orography, hydrography), settlement structure and population density, level of social development (hygiene, epidemiological awareness), lifestyles (including especially models of socio-economic mobility), and finally on the attempts to reduce the virus and disease by state and local government services (Skydsgaard, 2010; Amin, 2020). In each of these conditions, successive cause-effect relationships can be found, in which, from the point of view of geography, the key is the physical, geodetic space and relations between the elements occurring in it.

The spread of an infectious disease is a complicated and complex process, nevertheless, science provides many studies on the regularities of this diffusion, which often allows for an effective limitation of the epidemic growth in a given area (Sattenspiel & Lloyd, 2009). Particularly important are issues of spatial development, i.e. settlement structure, population density, urban forms, communication network (Darch et al., 2018; Carozzi, 2020; Cordes & Castro, 2020; Hamidi et al*.,* 2020). The type of land use and functions and their spatial organization affect population flows, creating a greater or lesser probability of social contacts (Badr et al*.,* 2020; Tammes, 2020).

Although research on the spread of infectious diseases has a very long tradition (Panum, 1846), knowledge of the causes of diffusion and dispersion is still unsatisfactory. Although the fundamental role of social contacts is known, models of human communication on the microscale are less well recognized. So far, this has not been facilitated by the lack of appropriate source data, e.g. on the exact paths of human movement in space and time. However, the development of telemetric tools, e.g. related to the location of cell phones, gives hope for progress in this area as well (Franch-Prado et al., 2020). For example, research is being conducted on land use to indicate their social function (Pei et al., 2014), day and night mobility (Yuan & Raubal, 2012; Śleszyński & Niedzielski, 2018), and the relationship between the type of spatial structures and the intensity of human activity is being sought (Yue et al., 2017). Determining the actual population and their behavior in a given area also results from the needs of spatial planning, including forecasting the optimal infrastructure, especially transport, as well as water and sewage, service networks and others. All in all, the development of telemetric tools indicates promising possibilities of using spatial planning data to improve epidemiological safety.

One of the basic methods is limiting the social contacts, including those related to the prohibition of free movement, and the solutions vary greatly between countries (Chinazzi et al., 2020). If such measures are taken relatively early and consistently, the infection curve becomes more flattened over time and the relevant services have more time to prepare for combat. However, limiting the activity in the long run threatens with serious economic losses in many economic branches (Ascani et al., 2020; Napierała et al., 2020). Therefore, it is crucial to skillfully balance the strength of the introduced restrictions in social contacts against the real epidemiological and general health risks of the population. Moreover, these limitations, both in the short-term and long-term scope, determine the spatial policy. Already at the present stage, there is a discussion to what extent the SAR-CoV-2 pandemic will modify the dimensions of spatial policy, including environmental, transport or public space development issues.

The 'geographic' aim of the study is to find the regularity of the increase in the number of infections in larger cities and their surroundings. Cities, as centers with a high population density and activity, in general, should be primarily exposed to a rapid increase in the incidence, as shown by evidence from around the world in the case of the SARS-CoV-2 pandemic (Cordes & Castro, 2020; Du et al., 2020). Preliminary results in Poland show that this does not have to be the case, or at least it does not apply to the largest agglomerations in the first place (Jarynowski et al., 2020; Raciborski et al., 2002; Śleszyński, 2020), although the associations with

mobility are emphasized in these studies. The intensity of all detected infections in Poland in August 2020 was not uniform and was concentrated in the southern part of the country (Fig.1).

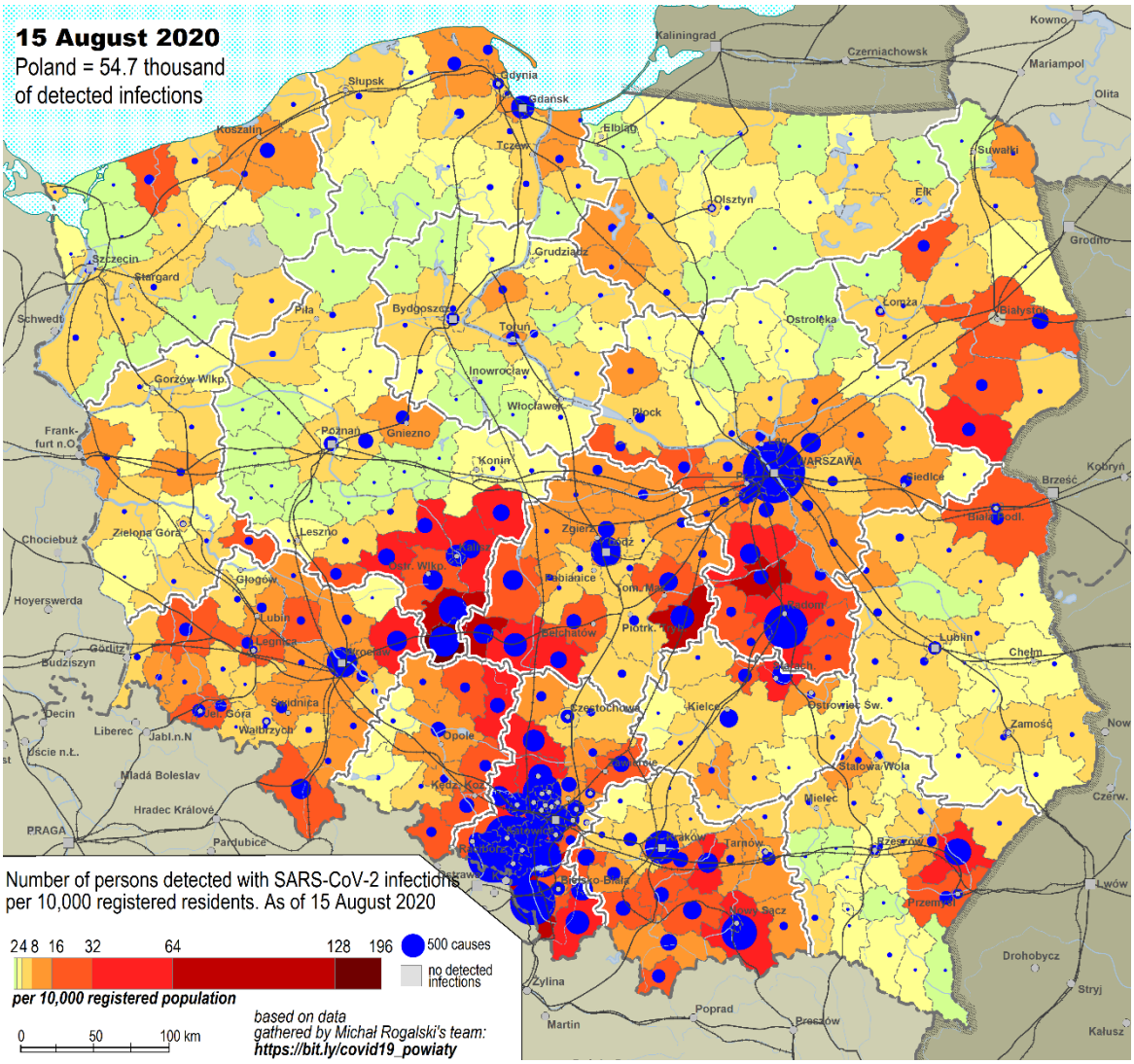

Fig.1 Spatial structure of detected SARS-CoV-2 coronavirus infections in Poland in August 2020

Meanwhile, the goal related to the science of public policy is to determine the implemented and potential effects related to spatial policy in Polish cities. It is a separate, vital context of urban development issues. By March 2020, numerous dilemmas and problems in this area were diagnosed, which were directly translated into the tools of spatial policy. The outbreak of the pandemic contributed to the emergence of new problems and new challenges. In the first place, they come down to typically procedural issues (related to work on individual tools of spatial policy), but they are related to a broader context of issues, including new dilemmas. Regardless of the above, regarding the discussions (especially in world literature) on changes in spatial planning, the direction and scope of potential changes, also in Polish spatial policy tools, should be considered.

2. Methods

The geographic part of this publication uses the available data on the development of the number of identified (recorded) infections. In Poland, in mid-August 2020, the only such database is the information available on the website, collected every day by social effort according to poviats by a team led by M. Rogalski (2020). Until then (mid-August 2020), official data on cases, entered through the National Register of Patients with Covid-19 (Regulation of the Minister of Health, 2020), had not been made publicly available.

It should be emphasized here that data on infections do not represent the entire infected population, since the detection of any disease depends on its correct diagnosis in the population. For Covid-19, it depends primarily on the tests performed. These are in turn performed in those populations where there is a greater likelihood of infection. Due to the transmission of the coronavirus by airborne droplets, tests in Poland were performed mainly in places exposed to more frequent occurrence, i.e. in health and social care facilities (e.g. hospitals, nursing homes) and in these communities (families, workplaces and other concentrations of the population) where infection has already been identified. In contrast, most infected people go through it asymptomatically. Meanwhile, based on screening tests carried out in various places in the country (Krakow, Upper Silesia) (Uniwersytet Jagielloński w Krakowie, 2020), it can be assumed that in Poland only 5-10% of cases are detectable and that in June 2020, already a few percent of the Polish population "encountered" the coronavirus (Lipiec, 2020).

Infection analysis had to be adapted to the available data. The mentioned set of M. Rogalski et al. (2020) by county was used. A poviat is the second level of territorial-administrative division, between a voivodeship and a municipality. There are 380 units, 66 of which are cities with county rights. Bearing in mind the great functional diversity of poviats and the aims of the article, related to urbanization, the division into 6 categories has been proposed (Fig.2):

- 1a: core areas over 250 thousand inhabitants (30 poviats, 23% of the country's population);
- 1b: core areas below 250 thousand inhabitants (28 poviats, 7% of the country's population);
- 2: mixed areas (land poviats with larger city or highly urbanized) (39 poviats, 14% of the country's population);
- 3: land poviats being external zones of types 1a and 1b, mainly "bagel" poviats (68 poviats, 21% of the country's population);
- 4: other more densely populated poviats (over 70 people per 1 km^2) (101 poviats, 20% of the country's population);
- 5: other sparsely populated poviats (less than 70 people per 1 km^2) (105 poviats, 15% of the country's population).

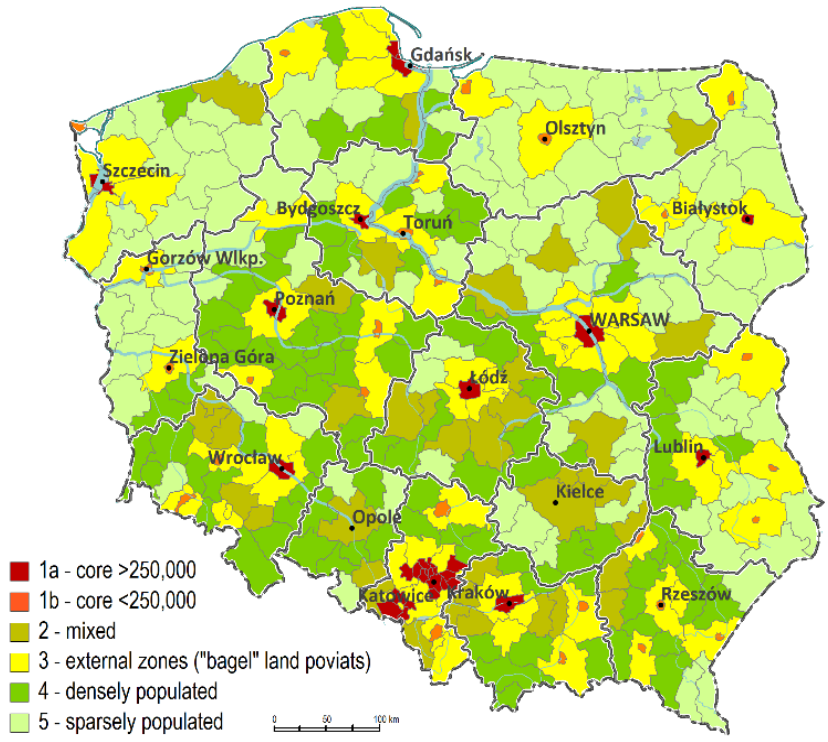

Fig.2 Classification of poviats (counties) used in the analysis

The analysis used aggregation to functional areas of cities (1a+1b), as this type of area, based on everyday functional and spatial relationships (commuting to work, education, personal services, trade, etc.), seems to be the most appropriate field of reference for research on the spread of infectious diseases. In this way, a database was created containing 80 functional areas, consisting of 166 poviats (the largest functional area — Katowice — contained 19 poviats). Due to data availability, it has been divided into six types:
The database designed in this way aggregated data (from the aforementioned M. Rogalski team) from the first 165 days of the pandemic, i.e. for the period March 4 - August 15, 2020.
The part of the paper related to the accomplishment of the goal covering the sphere of public policy is primarily of an overview nature. It contains the characteristics of the spatial management system in Poland (including tools affecting the broadest impact on urban space) and the introduced and potential changes caused by the pandemic. The temporary legal changes related to counteracting the pandemic and their place in the spatial management system are also synthetically characterized. In this respect, reference was also made to the wider, international discussion on the changes introduced by the Covid-19 pandemic, determining changes in urban policy (and, consequently, spatial policy). Face – to – face interviews were also conducted in selected Polish cities.

3. SARS — CoV-2 pandemic in Polish cities and their functional areas

Poland, as a relatively large country, considering European conditions (area 312.7 thousand sq. km, population above 38 million), is administratively divided into 16 voivodeships (corresponding to the NUTS2 regional level and having government and local government administration and management), 380 poviats (self-government) and 2,477 communes (self-government). Among 380 poviats, there are 66 cities with poviat rights, 18 of which are voivodeship capitals (in two voivodeships, they are bipolar systems). However, in communes, i.e., at the local level (LAU2), critical spatial policy actions are taken. The smallest population in cities with poviat status (and urban communes simultaneously) is 36,000 (Sopot), while the largest is 1,791,000 (Warsaw). When it comes to the organization of epidemiological services, the primary institution is the State Sanitary Inspectorate (PIS, familiar name — sanepid) — a specialized entity that performs public health tasks by performing control and supervision over hygiene conditions in various areas of life. The inspection also collects, among others, epidemiological data. PIS has central and local structures. The latter are voivodeship (NUTS2) and poviat (NUTS4) sanitary and epidemiological stations. Besides, there are specialized (border) units. Development of the number of infections in functional areas of larger cities relating to other areas (i.e. before the holiday increase in infections) is presented in Fig.3. Until about May 10, the increase in infections was fairly even in all types of poviats. After that date, there was a fairly rapid increase in infections in the largest cities and agglomerations (over 250,000 inhabitants). As for the smaller cores (below 250,000 inhabitants), the increases compared to the other types were relatively small, very similar to poviats with the lowest population density. The remaining three types (mixed poviats, outer zones of urban poviat towns and more densely populated poviats) showed quite similar increase, especially for types 3 and 4. Such results are not unambiguous and suggest that the increase in infections in Poland was not relating to the degree of urbanization. Nevertheless, if types 1-4 and 5-6 are added together, it turns out that in the functional areas of cities on August 15, the incidence rate per 10,000 population was 16.7, and on the remaining — 11.7. Thus, in the functional areas of cities, the cumulative incidence was over 40% higher.
As shown by more detailed data, this picture was influenced by a higher infectivity rate in the southern part of the country (Fig.4). Particularly high increases occurred in the agglomerations of the Silesia and Lower Poland voivodeships.

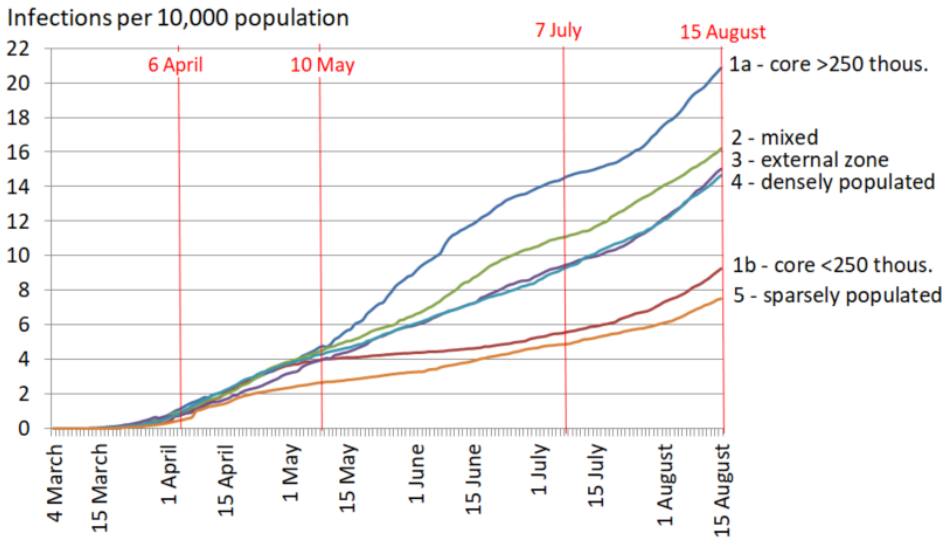

Fig.3 Detected coronavirus infections in Poland in the period March 4 - August 15, 2020 by poviat types

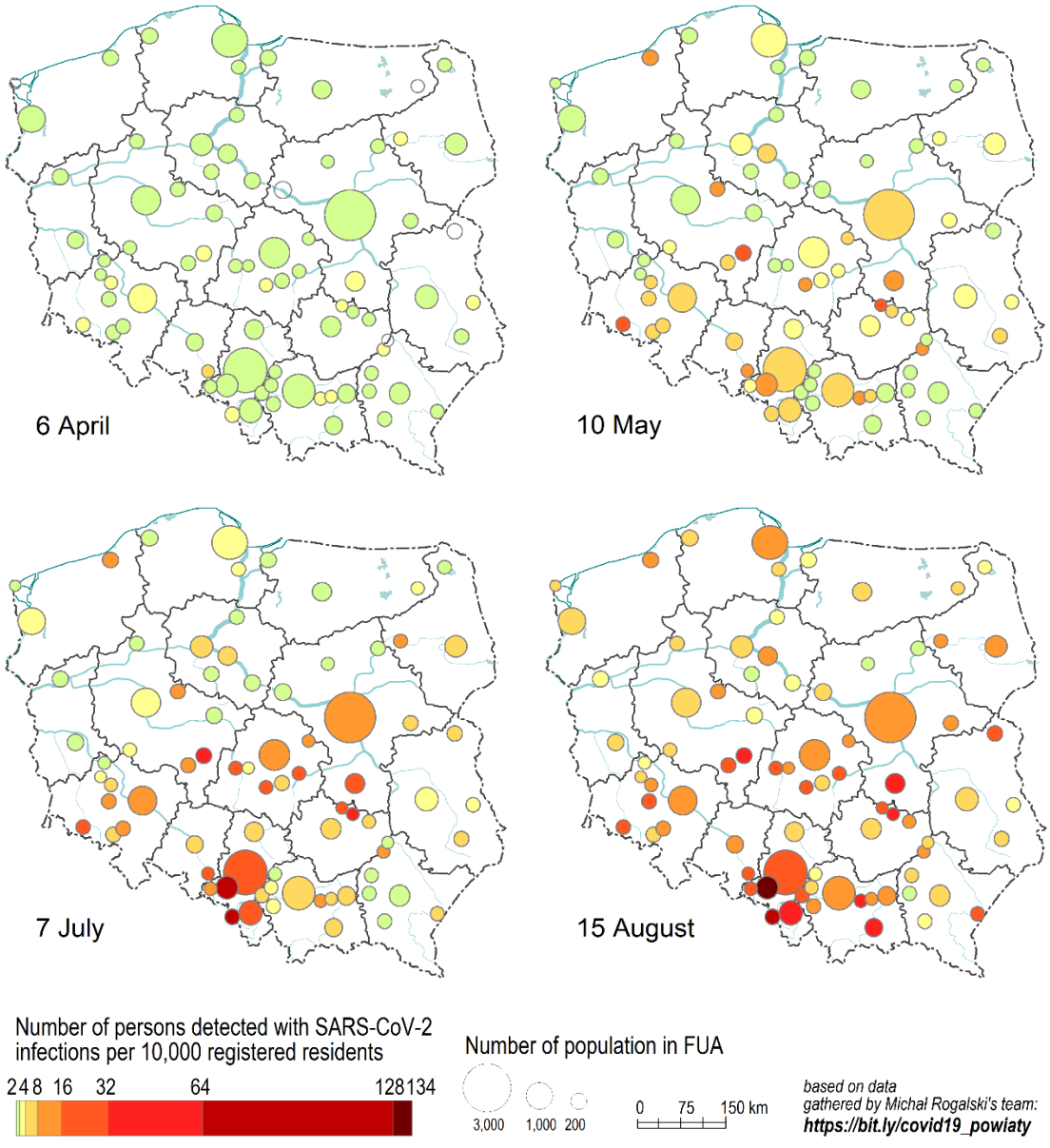

Fig.4 Spatial structure of detected SARS-CoV-2 coronavirus infections in functional urban areas in Poland in August 2020 in selected time periods

Tab.1 presents data for 18 selected functional urban areas — FUA (over 30 infections per 10,000 inhabitants on August 15 or over 500,000 inhabitants). They concentrated 58% of all identified infections (80 FUA's concentrated 73% of all infections). FUA with the highest infection rates are especially Rybnik (133.5 cases per 10,000 population), followed by Cieszyn (89.3), Nowy Sącz (43.4) and Kalisz (42.7). Apart from the Rybnik agglomeration (over half a million inhabitants), these are rather smaller groups. It is worth noting that in virtually all agglomerations, there was a fairly rapid increase in the number of detected infections during the holiday season (July 7 - August 15), but it was generally slower than in the entire country (52%). In Nowy Sącz FUA, this increase was record-breaking (more than fivefold increase in infections) and in FUA's of Bochnia, Krakow and Tri-city, the increase was greater than 100%. It should probably be associated with the transmission of infections through tourist mobility.

No*	Name of functional urban areas	Number of population (thous.)	Number of infections detected (cumulative)				Total infections on 15 August		
			April 6	**May 10**	**July 7**	**August 15**	**domestic share (%)**	**per 10,000 inh.**	**increase between July 7 - August 15 (%)**
1	Rybnik	525	55	694	5,282	7,008	12.2	133.5	32.7
2	Cieszyn	178	51	135	1,207	1,591	2.8	89.3	31.8
3	Nowy Sącz	300	19	52	213	1,303	2.3	43.4	511.7
4	Kalisz	183	46	517	702	784	1.4	42.7	11.7
5	Starachowice	90	7	44	330	368	0.6	40.9	11.5
6	Radom	364	132	533	1,106	1,444	2.5	39.6	30.6
7	Bielsko-Biała	601	27	409	1,493	2,312	4.0	38.5	54.9
8	Bochnia	107	30	139	152	393	0.7	36.9	158.6
9	Sieradz	118	3	16	278	369	0.6	31.3	32.7
10	Katowice	2,406	266	1,577	5,330	7,330	12.8	30.5	37.5
23	Warsaw	3070	454	1,364	2,628	4,262	7.4	13.9	62.2
29	Wrocław	930	246	582	838	1,101	1.9	11.8	31.4
30	Cracow	1,308	197	557	722	1,543	2.7	11.8	113.7
32	Łódź	1,071	142	419	911	1,155	2.0	10.8	26.8
40	Tri-city	1,309	114	435	509	1,100	1.9	8.4	116.1
51	Lublin	566	83	132	198	293	0.5	5.2	48.0
53	Poznań	930	54	176	274	456	0.8	4.9	66.4
58	Szczecin	767	37	133	196	341	0.6	4.4	74.0

* order of infection rates per 10,000 population on August 15, 2020

Tab.1 Infection rate development characteristics in selected functional urban areas in Poland. Source: based on data collected and made available in M. Rogalski's team (2020)

4. Spatial management system and conditions of urban development in Poland

For many years, problems related to the malfunctioning system of spatial management have been the subject of discussion in the Polish literature. To a very large extent, they relate to the development of urban and suburban areas, which is closely related to the course of transformation processes in the countries of Central and Eastern Europe after 1989 (Węcławowicz, 2002; Parysek, 2010). The most serious of them are issues of ineffective management, spatial conflicts, poor quality of settlement, numerous dysfunctions in spatial development and a general lack of spatial order (Markowski, 2010; Parysek & Mierzejewska 2016; Lorens 2017; Komornicki et al. 2018). Recently, attention has been paid in particular to the serious economic (i.e. *de facto* financial) costs of spatial chaos related to the burden on the budgets of households, enterprises or municipalities (Lityński & Hołuj, 2017; Śleszyński et al., 2020), including the area of settlement locations (Krzysztofik et al., 2017; Lorens, 2017; Karwińska et al., 2018; Mantey & Sudra 2019), real estate market (Krajewska & Pawłowski, 2019), inefficiencies in transport (Niedzielski & Śleszyński, 2008; Niedzielski et al.,

2020), as well as environmental and landscape protection (Chmielewski et al., 2018; Giedych, 2018; Szulczewska et al., 2014). It is also associated with the insufficient effectiveness of spatial policy tools (Nowak 2017a). Public authorities (both at the national and, for example, local level) have a problem both with introducing regulations that clearly protect the values of the area related to spatial order, as well as with enforcing the partial ones that are binding. These issues are reflected (to a different extent) also in other countries (Gitundu, 2020; Ida & Ono, 2019; Nadin et al., 2018; Roca et al., 2004; Tan et al. 2010; Acheampong, 2019; Blaas, 2019; Kyvelou & Gourgiotis, 2019.; Sharifi & Yamagata, 2018; Wang, 2019; Kovács et al., 2019). This confirms the thesis about the universal nature of these problems.

In 2020, there were 944 cities in Poland, including the smallest ones with only about 0.5 thousand residents. All of them were local governments of the third (last) administrative and territorial level (after the voivodeship and poviat) and similarly the third and last level of spatial planning (after national and regional) [1]. At the same time, from this quite numerous group, nearly 1,000 cities, there were 302 urban communes and 642 urban-rural communes. The latter consisted of the city and the surrounding countryside. Although the key document of planning the law in Poland, i.e. the Spatial Planning and Development Act of March 27, 2003 (Journal of Laws of 2003 No. 80, item 717), formally mentions the hierarchy of this planning, in practice, most investments and location decisions and more broadly related to spatial development, are the responsibility of local governments.

Thus, according to the aforementioned Act, in Poland, the tools of spatial policy that determine the direction and scope of urban space development to the greatest extent (adopted at the local level) include:

- studies of conditions and directions of spatial development;
- local spatial development plans.

Studies of the conditions and directions of spatial development are (by definition) directional acts and each commune must pass them obligatorily. These acts determine the future spatial activities in the city, including, among others: directions of changes in the spatial structure, directions and indicators for land development and use (including areas intended for development and excluded from development), areas and principles of environmental protection as well as areas and rules of cultural heritage protection (Nowak, 2020). The studies also contain binding guidelines for local spatial development plans. This second tool of spatial policy, unlike studies, is not obligatory — its adoption in a given area depends on the discretion of the authorities of a given commune.

However, if the local plan is adopted, it will already have binding effects, i.e. contain specific prohibitions addressed directly to property owners and investors. Local plans define in a binding manner the purpose of a given area and the detailed principles of its development and development indicators (such as, e.g. building height, building intensity, or building line). Local plans (valid for over 30% of Poland) may or may not introduce the spatial order. In practice, local plans are also adopted that enable the implementation of buildings isolated from the needs and possibilities of a given area (which, especially through oversupply of construction land, contributes to the deepening of spatial chaos) (Izdebski et al., 2018; Śleszyński et al., 2020).

Moreover, in areas where the local plan has not been adopted, investors may apply for a decision on development conditions. According to the legislator's intentions, it is to be an equivalent of a local plan. Nevertheless, the decision is issued on an individual scale, at the investor's specific request (for whom the protection of spatial order throughout the city is not a priority). Decision on development conditions and land development, of which over 90 %are decisions on development conditions (since 2003, over 2 milion such decisions have been issued in Poland) is not related to other tools of spatial policy, in particular, from the formal and legal point of view, there is no relationship between it and the study of the conditions and directions of spatial development. This leads to the deepening of problems related to spatial chaos (Nowak, 2015; Nowak,

[1] The poviat level in Poland does not have extensive, systemic spatial planning tools, while only quasi-control functions related to issuing the building permits, see Nowak 2020.

2017b). The above issues are very broadly translated into the issues of urban development and urban policy. Urban issues are discussed in detail in Polish literature on the subject (Węcławowicz, 2002; Markowski & Marszał, 2006; Nowak, 2010; Borsa, 2016; Grabkowska, 2011; Sagan & Grabkowska, 2012; Sagan & Grabkowska, 2013; Smętkowski et al., 2008; Szlachta, 2013; Krukowska & Lackowska, 2016; Lorens & Ledwoń, 2018).

5. The Covid-19 pandemic and new context of the discussion on spatial policy in Poland

As the spread of infectious diseases, as stated at the beginning, has a number of significant geographical conditions on various territorial scales, it is worth pointing to them in the broad environmental, settlement and demographic context of Poland. These are the following issues:

a. conducive to the expansion (diffusion) of the virus or posing a particular threat to it:

- several large concentrations of population with the highest population density, where there is a high intensity of commuting (areas in various parts of the Upper Silesian and Rybnik conurbations, as well as the Warsaw, Tri-City, Kraków, Wrocław, Szczecin and Poznań agglomerations);
- high percentage of the elderly population in the centers of large and medium-sized cities, as well as in rural areas, e.g. in the north-eastern part of the country;
- large share of multi-family block buildings in medium and large cities with urban and architectural solutions that are not conducive to maintaining the social distance.

b. unfavorable for virus expansion (diffusion):

- moderate population density in most of the country's territory;
- relatively low, as for developed countries, development of urbanization processes (resulting from the so-called "urbanization delay");
- tendency to disperse buildings;
- high density of the river network and a general shortage of bridges on larger rivers (it was clearly visible during the expansion of infections in late spring in southern Podlasie, when the Bug was the barrier);
- spatial mobility lower than in highly developed countries.

In the literature on the subject, the impact of the pandemic on spatial policy has already been discussed and recognized as a long-term issue (Boschetto, 2020). The factor determining the situation of cities and, consequently, their spatial policy may be, among others, diagnosed problems with food supplies (Benton, 2020). There are also discussions about the typically urban features of a pandemic, but there are problems with their unambiguous separation (Gargiulo et al., 2020). Lai, Leone & Zoppi (2020) indicated several levels in this regard. They distinguished, among others, future spatial contexts in cities, within which physical distance and minimization of social relations are recommended. This limits the formula of functioning many key places in the space, usually associated with public space (but not only). It also makes it necessary to apply (or implement more broadly than before) a few postulates. Among them, the concept of the city-garden was distinguished (see also Sofo & Sofo, 2020), development of urban agriculture, as well as creation of a framework for alternative means of transport (bicycles, scooters, etc.).

Numerous publications (Falchetta & Noussan, 2020; Helm, 2020; Murgante et al., 2020,) emphasize the further need to protect the environment, which is directly translated into spatial policy. Angiello (2020) reminds in this context that the quality of environmental protection influences the degree of Covid-19 spread. The author carries out a broader analysis of the current spatial needs, paying attention to the requirement of the more extensive use of green areas and the development of bicycle infrastructure, and the necessity to reorganize cities so that its movement is as short as possible. Zecca et al. (2020) discussed the latter topic was greater detail paying wider attention to the role of space-time in urban spatial planning, especially in the present

circumstances (also Guida & Caglioni, 2020). At the present stage, diagnoses and directions of activities are formulated in a fragmented manner, however, in the analyzed context, such proposals as strengthening the use of the concept of green infrastructure (Ronchi et al., 2020), implementation of sustainable mobility (UNECE, 2020), modernization (to avoid the overcrowding and excess of services) of transport (Gaglione, 2020), modernization of public facilities, including stadiums, cinemas, places of prayer, as well as deepening social participation (Acuto, 2020; Santoro et al., 2020). Fasolino et al. (2020) emphasize the need for in-depth integration of spatial policy issues and such thematic spheres as medicine, environmental protection, science, psychology and urban sociology. This will allow a wider multifunctionality of the space. Cotella & Brovarone (2020), in turn, reflect on the redefinition of rural areas' role and the possible possibilities and effects of a broader settlement of these areas (which may be the consequences of changes taking place in cities due to the pandemic).

The above discussions are an essential point of reference when discussing the determinants of spatial policy in Poland resulting from the Covid-19 pandemic. In connection with the pandemic, in the sphere of urban spatial policy (regarding the use of spatial policy tools), procedural dilemmas and issues related to the future optimal content of spatial policy tools appeared. The thematic issues related to the former include:

- social participation during a pandemic — and in particular whether (and to what extent) it is possible to computerize the participation (whether it is legal and — more importantly, whether it will not lead to the exclusion of some potential participants);
- speed of adopting/issuing specific resolutions/administrative decisions with direct effects in the sphere of spatial policy. This applies to both the deadlines for issuing specific decisions (decisions on development conditions), as well as the issue of proceeding in the event of a pandemic of projects of local spatial development plans, studies of conditions and directions of spatial development, and even resolutions on determining the location of housing investments (based on the so-called special housing acts);
- contacts between individual public administration bodies during work on specific tools of spatial policy. This applies in particular to the inactivity of some bodies agreeing/issuing opinions on the content of individual projects. In practice, these bodies did not express their position, which was tantamount to tacit approval of the project. In the event of a pandemic, this could block further work on a local plan or study.

The above-mentioned problems have also met with the reaction of the central government, in particular reflected in special acts containing a number of regulations counteracting the effects of the Covid-19 pandemic, the so-called "Anti-crisis shields"2. These broad, extensive "special acts" covered a number of different areas, to some extent also those related to the sphere of spatial policy. Synthetically speaking, the most important changes in this area consisted in:

- "suspension" of deadlines related to administrative proceedings and those related to other activities undertaken by public administration bodies (which also included activities of spatial policy entities);
- excluding from this suspension some activities related to the sphere of spatial policy.

As a result of procedural changes, in part ad hoc, and in part — relating to the entire spatial management system, new dilemmas have emerged. Generally speaking, they involve introducing a new dilemma to previous discussions. It consists in answering the question of what is more important (under the conditions of a pandemic, but also in other circumstances): protection of key values in the spatial development system, or

[2] See the Act of March 31, 2020 on amending the Act on special solutions related to the prevention, prevention and combating of Covid-19, other infectious diseases and the crisis situations caused by them, and certain other acts (Dz. U. 2020, pos. 568), Act of April 16, 2020 on specific support instruments in connection with the spread of SARS-CoV-2 virus (Dz.U. 2020, pos. 695), Act of May 14, 2020 amending certain acts in the field of protective measures in connection with the spread of SARS-CoV-2 virus (Dz.U. 2020, pos. 875), Act of June 19, 2020 on interest subsidies for bank loans granted to provide financial liquidity to entrepreneurs affected by Covid-19 and amending certain other acts (Dz. U. 2020, pos. 1086).

the speed of implementation of planning procedures (consisting in, for example, ensuring, e.g. at the expense of, full social participation), quick adoption of the local spatial development plan enabling the implementation of investments important from the economic perspective, including the economic crisis. Public authorities have so far given priority to the second of the indicated goals, i.e. the speed of planning procedures.

However, as indicated previously, procedural issues should be considered less important than the attempt to provide a broader response in the sphere of spatial policy to the new situation related to the Covid-19 pandemic. One can wonder to what extent the new situation will force a change in the specific content of spatial policy tools. The first stage should be the obligatory analysis of new spatial conditions and their relationship with the tools of spatial policy (especially studies of conditions and directions of spatial development), obligatory for each commune on a national scale. The analysis in cities should cover at least the following thematic areas:

- new conditions related to the protection of health and guaranteeing the public safety;
- conditions for further integration of development planning;
- deepening the protection of the environment and nature, referring to the degree of implementation of the concept of green infrastructure and the needs (and possible scope) of supporting the development of urban agriculture;
- the scope of necessary changes, especially in the development of public spaces;
- the scope of adapting urban space to possible modification of urban transport.

Most of the indicated issues were also analyzed in the Polish literature on the subject before the pandemic (Kudłacz, 2015; Markowski & Drzazga, 2015; Nowakowska, 2015; Mantey & Kępkowicz, 2018; Szulczewska, 2018; Kojder et al., 2020). It should also be pointed out that the analysis of the indicated problems cannot be tantamount to the necessity to implement the far-reaching changes in each case. Despite the fact that — as indicated above — the literature indicates that the effects of a pandemic will be irreversible in many respects, city authorities need to adapt spatial measures. However, the issues related to the integrated development policy and protection of the environment and nature (in particular the implementation of green infrastructure) are certainly not of such a temporary nature. Creating a framework for an integrated development planning system depends to a large extent on the central authorities (and in Poland, it is implemented to a small extent, which requires a change).

Regarding the protection of environment and nature, the spatial policy tools in force in Poland are in many respects limited, but even in the present conditions, it is possible to implement green infrastructure more widely. It can be concluded that most of such changes in the spatial policy tools themselves do not require implementation overnight, and thus gross simplification of procedures. The problem may be, at most, incidental situations, in which the lack of agreement between the commune authorities and the authorities agreeing certain actions — as it happens now — may prolong. Similarly, one has to consider the undermining of spatial policy tools before administrative courts. These problems, however, relate to local spatial development plans, while the discussion on the directions of changes in the spatial policy and the adaptation of the above-mentioned postulates (specified in local analyses) will relate primarily to studies of the conditions and directions of spatial development.

Referring to previous studies (Śleszyński et al., 2020), it can be indicated that the circumstances related to the pandemic may contribute to the deepening of the costs associated with spatial chaos, examples of which may be the subsequent costs associated with the more frequent pandemic (e.g. in the period immediately after the so-called lockdown) using cars instead of public transport, or the new situation on the real estate market.

At the current stage, it is not possible to obtain comprehensive data on detailed actions (or omissions) related to spatial policy in the context of Covid-19 in all Polish cities. However, face-to-face interviews were conducted

in five cities (voivodeship capitals): Gdańsk and Szczecin (northern part of Poland), Łódź and Toruń (central part of Poland) and Wrocław (south-western part of Poland). The information obtained shows that:

- in some cities, no major challenges and new spatial problems were identified at the administration level. In the area of local spatial development plans, only the need to suspend work on new plans was noted (especially after the stage of making them available to the public, in the context of public consultations - e.g. Gdańsk);
- in a different model of activities, work on local plans continued. In this situation, attempts were made to ensure safety during public consultations. At the same time, new spatial challenges were diagnosed, as evidenced by the commencement of work on changing the existing study of conditions and directions of spatial development (the case of Wrocław).

In the context of the decision on development conditions, some cities did not notice any changes in this regard during the pandemic. However, the situation is varied. It is worth mentioning the example of the city of Łódź, which has detailed information on the number of decisions on development conditions in the subsequent months of 2020. For example, in February there were 205 decisions issued, in March 185 decisions, in April 132 decisions, and in May 209 decisions. At the same time, in the period from March to June inclusive, the number of applications for decisions on development conditions decreased (as compared to earlier and later periods), and the number of cases concerning decisions on development conditions, not examined in the basic period, started to increase.

The dilemmas and the problem related to the Covid-19 pandemic fit more broadly in the European discussion on the directions of spatial policy changes. As indicated above, public authorities' actions in the first months of the pandemic directed towards procedural considerations. Partial reflection concerned only the optimal formula of social participation in spatial planning. It does not change the fact of the developed needs for changes that Polish cities also face. As indicated above, the problem that has already been noticed (and that can be deepened due to the pandemic) is spatial chaos and its very high costs (especially relating to other European countries).

Nevertheless, the directions of changes postulated in the latest literature on the subject may contribute to the reduction of these costs: both in the sphere of environmental protection (green areas, green infrastructure), transport (not only bicycle infrastructure but the increasingly emphasized postulate of more careful consideration of space-time in the spatial policy) and modernization of public facilities. Specific barriers and doubts may appear when discussing the broader development of rural areas. Without denying such a need, one should point out that it may worsen the spatial chaos and increase its Polish reality costs. More comprehensive operations (within which the discussion with new functions/development of rural areas' functions will combine with the context of protection of spatial order and integration of development policies) may block these negative tendencies.

The example of Poland and solutions applied by the public authorities illustrate one more issue. In the current situation, the introduced solutions' quality depends on the moment of their introduction. The legal regulations that entered into force in spring 2020 (and one can assume that the same will apply to the legal rules introduced in autumn 2020) directly respond to the crisis. Their makeshift and the perspective limited to a few subjectively selected issues are noticeable in such a case. On the other hand, however, there is a need to introduce some postulated actions. In this context, the optimal solution seems to be the institutions of informal spatial planning (which individual countries can apply only with an adequate level of social capital).

6. Summary

The conducted analyses confirmed the large scale of problems caused by the Covid-19 pandemic in Polish cities and their functional areas. As far as local spatial policies are concerned, it should be clearly emphasized that new challenges and problems appear to an ever-greater extent. At the present stage, the necessary scope

of changes in the existing studies of the conditions and directions of spatial development and local spatial development plans is still debatable, but there is no doubt that such a reflection should be undertaken (this is reflected in the positions of some municipal authorities, e.g. Wrocław). In the literature on the subject, a wide range of issues has been distinguished in this context. The specific chaos presented in the article, related to procedural dilemmas (and different approaches to these problems in individual cities) is an additional argument in favor of the thesis that a broader reflection in this respect is necessary.

It should also be emphasized that the impact of the pandemic on spatial planning in Poland will be strictly conditioned not only by the specificity of Polish law in this area, but also by the effects caused by long-term negligence in spatial management. What will hinder the optimization of spatial structures in terms of epidemiological safety is the spatial chaos, observed especially in suburban zones. On the one hand, it affects mobility and models of social relations, and on the other hand, it affects ineffective spatial organization of medical services.

The authors see the need (along with access to further data) to continue the analyses. They should cover both the actions of municipal authorities in specific periods of a pandemic (and their direct translation into the use of spatial policy tools), as well as the degree of inclusion of new problems and thematic contexts in local spatial policies.

Also in Poland, there is a need for a broader focus on environmental protection in cities, modification of the transport formula (including public transport), improvement of the development of open spaces, as well as the reflection on urban and rural functions in the context of a pandemic, diagnosed in the literature on the subject. Besides, there is a postulate to increase the resilience of cities (e.g., by shaping the health functions of spatial policy tools, including local plans) and a broader approach to the context of space-time (especially when it comes to the context of moving around the city). In Polish reality, these changes must be coordinated with the concept of reducing the spatial chaos (the lack of such coordination may, in at least some cases, lead to maintaining or even deepening this chaos). Wider use of informal instruments in spatial planning also seems of crucial importance. There is no doubt that (probably not only in the Polish realities) quick legal changes prepared during the crisis do not guarantee the achievement of essential effects from the spatial management system's perspective.

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Image Sources

Fig.1: based on data collected and made available in M. Rogalski's team (2020)

Fig.2: based on data collected in IGIPZ PAN

Fig.3: based on data collected and made available in M. Rogalski's team (2020)

Fig.4: based on data collected and made available in M. Rogalski's team (2020)

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TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 445-457
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/7197
Received 18th September 2020, Accepted 8th December 2020, Available online 31st December 2020

www.tema.unina.it

The contribution of a tramway to pedestrian vitality

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Abstract
Pedestrian movement in the public environment is important in supporting local public life, commerce and physical activity. Countering the decline in the presence of people on the streets is a major focus of urban planning in a wide variety of urban contexts. This research investigates the contribution of a tramway to local pedestrian movement, using the Hong Kong Tramways (HKT) as a case. Flow counts were collected in a field study of the tram corridor that enabled regression analysis. Pedestrian flow was positively related to the following, in descending order of importance: feeder street pedestrian flow, tram alighting rates and irregular crossing rates. These factors cumulatively account for 41% of pedestrian volume on tram corridor segments. Pedestrian flow is negatively related to the degree of barrier fencing and block size. The tram is also used to transit between walking segments, effectively enlarging the individual walking environment. The findings suggest spatial planning measures associated with higher pedestrian flow.

Keywords
Pedestrians; Tramway; Vitality

How to cite item in APA format
Zacharias, J. (2020). The contribution of a tramway to pedestrian vitality. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 445-457. http://dx.doi.org/10.6092/1970-9870/7197

1. Introduction

The choice of the form of mass public transit to serve an urban corridor remains a topic of debate in urban planning and transport planning. Although the faster travel speeds of heavy underground rail are often highlighted in the worldwide efforts to shift urban mobility from private to public modes, slower surface modes are often seen as urban development generators (Olesen and Lassen, 2016). Contemporary light rail projects are typically strategic urban projects, where measured efficiencies may take a second place to the experiential and regenerative properties of the infrastructure. The iconic and representational aspects of new tramway projects have captured the political imagination, supported by strong public preference for the mode over motor alternatives (Hensher et al., 2015). Technological advances in surface rail systems and new awareness of the important issues of comfort and reliability have complicated the choice of mode previously centred on carrying capacity and time (Denant-Boemont & Mills, 1999).

In the contemporary context of a renewed interest in surface rail as well as controversy concerning its contribution to non-motorized transport and local revitalization, we need a longer timeline to see how a tramway system may contribute to land use change and new urban activity structures. While unique in many respects, the Hong Kong tramway provides an interesting case of a century-old system and an extensive network of served streets in areas with variations in land use mix.

Firstly, we consider definitions of vitality and then what is shown to support it, including urban rail. Street vitality is strongly associated with liveability, and according to some authors, to sustainability (Miller et al., 2013). Jacobs (1961) suggested that vitality was represented by the abundance of human activities in space. She prescribed a specific blueprint for fostering street vitality, including diversity of land uses, small blocks and the presence of older building stock. All three were found to be positively associated with walking in Seoul, Korea (Sung & Lee, 2015). The second of these is examined in the present study. The qualities of the urban street, emphasized by Jacobs and others, would appear to have significant sway in how the local street is perceived and used, as in the case of a Polish city (Kotus & Rzeszewski, 2013). Seniors are particularly sensitive to the issues of layout and design of the walking environment (Gaglione et al., 2019), which prompts the inclusion of such factors in the present study.

At the same time street vitality as pedestrian flow is geography-bound because of increasing complexity of movement systems in cities. In this emerging context, it makes sense to expect that land use outcomes would depend on the specific characteristics of the rail system. Underground metro has a different accessibility map than that of tram, because tram stations are more closely spaced and are directly connected at the same level to their surrounding environment. It should follow that pedestrian flows are related to interaction with the transit system and its flow of passengers to and from the street, which is investigated in the present study. The metro station and supportive land use structure is an often-cited example of transit-oriented development (TOD) with its guiding principles of density, a diversity of land uses, station accessibility in support of the metro station, and a central role for public transport in urban mobility (Calthorpe, 1993; Cervero, 2008; Renne, 2009). In theory the concentration of movements at more widely spaced metro stations is supportive of more intensive development in a smaller area where the distance between stations is not walkable for the majority. New public transit systems introduced in an existing city centre have been shown to modify shopping patterns (Davies & Bennison, 1977). In that study, the redistribution of public transit stations led to a redistribution of pedestrian movement and related changes in shop turnover, independently of other changes in land use. It is then expected that the location of public transit stations is relevant to local flow level, part of the focus of the present study. The literature on the overall effects of tramway systems on walking provides some evidence that there is a measurable shift from motorized modes. For example, urban traffic decreased significantly in Zaragoza, Spain following the implementation of a tramway (Ortego et al., 2017). In another before-after study of the implementation of a surface rail system, it was seen that a higher proportion of local residents accessed transit on foot after the line opened (Brown et al., 2016). There was also higher frequency of walking

for a wide variety of purposes. The built environment constitutes an important influence on the propensity to walk in the vicinity of a rail corridor. For example, in Minneapolis, USA, it was seen that the presence of commercial uses was strongly associated with walking rates around the rail corridor (Schoner & Cao, 2014), a finding that we consider in the present study. Discontinuities between the surrounding road network and the transit corridor resulted in less walking for all purposes. While Hong Kong does not exhibit this kind of discontinuity, the density of its street network does deserve examination for its contribution to street vitality. In general, studies on contemporary tramway projects support the idea that pedestrianism accompanies surface rail. When such effects are experienced over a long time, we might expect land use change and other signs of street vitality, including the increased presence of pedestrians.

In a uniform movement network, with uniform land use and population density distributions, we could expect variations in local pedestrian flow to be small. In theory, a tramline makes a direct contribution to local pedestrian flow by offering individuals the opportunity to substantially enlarge the traversable environment by using the tram to link walking segments. To the extent such a phenomenon occurs, it would directly contribute to local pedestrian flow and overall flow levels. Increased walking rates were observed in smaller urban blocks (Appleyard, 1981; Moran et al., 2016), in facilitating more links among street segments. In theory, higher interaction rates that accompany smaller networks may induce longer walks and a larger traversed environment. While it is widely claimed that a tramline can make a direct contribution to local pedestrian vitality, we lack empirical studies to show how or if it works.

Other explanations for local pedestrian vitality include the claim that qualities and experiences are influential as preferences are acted out in the real environment. It is widely held that fine-scaled urban design is highly relevant in the pedestrian experience (Sternberg, 2000), and qualities may also impact on who elects to be in particular urban spaces (Ozuduru et al, 2014). The positive effects of space design alone are thought to be associated with social vitality (Jones et al., 2016), the response to a new opportunity for experience and encounter offered by the environment of focus. In the present study we do not investigate the effect of urban spatial qualities of tram streets on pedestrian preferences, although it is clear that the tram streets are distinctly different from streets for motorized modes.

The vitality of local streets may be supported variously by bottom-up initiatives from entrepreneurs and local organizations (Ozuduru et al, 2014), but may also respond positively to an array of policy initiatives on the part of local government, particularly in support of a liveable and pleasant walking setting. In Hong Kong, the transport authority has been concerned with safety and security for pedestrians and efficiency for motor traffic. The implementation of fences on pavements started in the 1970s and accelerated in recent years to an estimated 1,500 km of fences today. According to the Transport Department that identifies the need for such facilities, they are intended to keep pedestrians off the traffic lanes in places with high pedestrian flows (DeWolf, 2018). They are thought to reduce irregular street crossing although this effect, alongside other effects of street fencing, remains to be confirmed.

Pedestrian circulation and the associated commercial activities are highly sensitive to minor features of the walking environment. Shopping linkage, or the series of temporally linked stops made in a shopping itinerary, are also sensitive to network arrangements. The efficiencies in shopping linkage, uncovered in shopping centre designs and implemented in the shopping centre development era, had negative impacts on traditional commercial streets in cities throughout the developed world (Bromley & Thomas, 1989; Thomas & Bromley, 2003). Shopping centres offer the efficiencies of bringing many more retailing units close together in space and eliminating the 'dead' zone that often occurs on linear retailing streets as a consequence of an uncontrolled mix of land uses, or the interposition of major barriers and parks (Reimers & Clulow, 2004). Urban motorization led to the introduction of many physical features intended to control pedestrian movement including designated pavements, curbs, signal-controlled intersections and fences. Qualities of these features of the walking environment have been shown to have impact on the number of walking trips in the local environment

(Tian & Ewing, 2017). Stated preference studies also reveal pedestrian preference for wider, uncrowded pavements with trees and the presence of commercial activity (Liu et al., 2020). In spite of these recent findings, empirical study of the specific effects on walking rate of certain street design features remains a gap in the literature.

2. Aims and hypotheses

This study is intended to uncover the quantitative contribution of a tramway to street-level pedestrian volume, independent of other contributing factors. The contributing factors of local physical planning and land use are also examined for their contribution to pedestrian flow. In general, we would like to know how management of the transport environment, including environmental design, contribute to local street vitality. The tramway contribution to local pedestrian movement is separated from that generated by the immediate local environment by seeking answers to the following questions:

1. Is the presence of a tram station positively related to pedestrian flow at the station location block? There is direct access from the tram station to the target block;
2. Is the alighting rate positively related to pedestrian flow?;
3. What part of the target block pedestrian volume can be explained by the coterminous contribution to pedestrian flow of streets directly connected to the corridor? The tram corridor is a major commercial artery in the local area.

The relatively high ridership volumes on the tram and their short headway allow for the possibility that the tram is a significant contributor to local pedestrian flow, but it is necessary to quantify this relationship to understand the size of the contribution. The proximity of station to footpath, never more than a single traffic lane, would appear to strengthen the link to local pedestrian traffic, while close spacing of stations allows riders to disembark close to intended areas for visit. It is also possible, however, that alighting tram passengers are returning home or accessing locations off the tramway corridor and so making no contribution to pedestrian flow. Several local physical characteristics are considered as well, in keeping with the theory that urban design may be salient in pedestrian flows.

4. Following the literature, is smaller block size positively related to pedestrian flow? Small block size is thought to promote linkage;
5. Is the degree of barriering to cross-movement, through the use of fences, negatively related to pedestrian flow? Limiting the path choice in this way is thought to reduce footpath attractiveness;
6. Is the irregular (non-compliant) crossing rate, which increases the de facto level of choice, positively related to pedestrian movement?

In general, it is suggested that increasing the options available to pedestrians increases their willingness to use that local environment and to access those additional opportunities. Areas of greater internal linkage would then likely attract more visitors by diversifying and expanding the area of pedestrian activity, while external linkages also expand the pedestrian catchment.

3. The Hong Kong Tramways system

The tramway is intimately associated with the urban development of Hong Kong Island, forming the spine of the east-west development of Hong Kong from 1904 when the tramway first opened. In 2017, the year of the present study, the HKT spanned 13 km on Hong Kong Island with a total track length of 30 km. There were 120 stations in use, with approximately 250 m between stations. It is positioned on the centreline of a connected series of wider streets at the lowest elevation where the land is flat. Today, the tramway is paralleled by the Mass Transit Railway (MTR) that runs under the tramway streets for nearly all its length. Buses also travel on the same corridor but typically offer access to distant locations with few intermediate stops. Light buses operate using parts of the corridor, linking more distant housing estates with central

locations. In this way, the tramway corridor is a multiple mode system that is also characterized by street-front commercial activity and strong pedestrian movement. In 2013, average daily ridership was 198,000 (Transport Department, 2014) (Fig.1), declining to 180,000 in 2019 after extensions to the MTR.

Fig.1. Tramway-street arrangements involve several channels in a narrow right-of-way

HKT operates within densely built-up districts across Hong Kong Island. The westernmost district is Kennedytown, a moderate-income residential community now undergoing some gentrification (Fig.2). To its east is Sai Ying Pun, with its seafood markets, middle-income residential uses and hotels. Sheung Wan is the western edge of the Central Business District (CBD), a mixed area of shops and services, with serviced and rental apartments. Cross-border bus and ferry services are concentrated here. Central and Admiralty are the CBD, devoted to offices, hotels and high-end shopping. The MTR stations in these two areas are hubs for connections to Kowloon and Island South. They are also directly connected at the underground level to certain shopping centres. Immediately above the CBD is the higher income Mid-Levels residential area, with restaurants, bars and specialized shops. To the east is Wan Chai with the Convention Centre, hotels and public services. HKT then runs through Causeway Bay, the most intensely visited shopping district in Hong Kong, but also a densely inhabited residential area. Further east are North Point, Fortress Hill, Quarry Bay and Sai Wan Shan, all middle-income residential areas with Quarry Bay also housing an office cluster. The entire area served by HKT is built at high density in residential or office blocks. The tramway corridor itself has streetfront commercial uses its entire length except for those short sections where it runs adjacent to public open space. HKT lost its right-of-way in a large proportion of the tramway corridor in 1974, when the company was sold to Wharf Holdings Ltd. The system is operated by RATP Dev Transdev Asia since 2010. The tram now shares road space with motor vehicles and also no longer has priority signalling at intersections. On the other hand, operating speeds have increased in recent years. Passengers can check for tram arrivals in real time with an app. In practical terms, one can usually see approaching trams in the distance because they are double-decked and run in the centre of the street. Headways at peak travel time are about 1.5 minutes.

The HKT has a flat fare of 2.6HKD, a concession fare for seniors of 1.3HKD and a children's fare of 1.2HKD. The fee is relatively low in relation to MTR and especially taxi alternatives. In a parallel study, it was found that the lower price of the HKT had no impact on the choice to use the service (Yang & Zacharias, 2017). In that study it was also found that travel time, waiting time and walking distance to the station are the three aspects of the tramway service that gained the highest scores on an importance scale. These priorities are also revealed as the most important service factors in the rail services of Algiers (Baouini et al., 2018). The tramway service was favoured for somewhat shorter trips than the MTR, with 25% of trips under 5 km. In

general, it was seen that the tramway users were somewhat different demographically from MTR users, although not in terms of income.

The tramway system operates on the same network in 2020 as it did in 2017, when this study was conducted. It also operated continuously during the civil unrest of 2019, unlike the MTR, which closed some or all of its operations during street demonstrations. The operator has also proposed a major expansion of the HKT network into new development on the former airport site, but a final decision has yet to be made.

4. Methods and Materials

This study measures the tramway's contribution to pedestrian vitality by relating statistically local pedestrian flow on the tramway corridor to contributions from flows at tram stations and from neighbouring environments. Physical environment characteristics are also included in a regression model as explanatory variables.

The dependent variable is pedestrian volume on the sidewalks, measured in persons per minute at a mid-block cordon on sidewalks parallel with the tramline. Repeated counts were taken for 49 counting cordons. Blocks were coded for the presence of a tram station for either direction or both (1) or none (0).

Simultaneous 5-minute counts of passengers in transit on trams passing the target block were taken, along with the number alighting and boarding on blocks with transit stations. Note that the passenger count is easily accomplished because the double-decked tram car has large windows and is relatively narrow. The contributing pedestrian flows from streets intersecting with the tram corridor are also taken at a mid-block cordon.

Individuals crossing at designated crosswalks and those crossing the street elsewhere were also counted in the same timeframe. The relationship between local pedestrian flow and crossing rate is associational but may reveal the importance of crossing facilities in local pedestrian flow.

Barriers to movement across the corridor are also included for each of the 49 counting positions. The presence of fences along sidewalks to prevent unregulated street crossing were coded as an index representing the proportion of the sidewalk that is fenced, for a maximum of 3.0 when there are continuous fences on both sidewalks and a third one lining the tramway.

Block length was also measured with the hypothesis, based on the literature, that longer blocks would have lesser pedestrian flow.

The tramway system was sampled according to evident physical characteristics and dominant land uses. The areas presumed to have significant differences in terms of travel and local behaviour are the following:

1. des Voeux Road in Sai Wan area characterized by dominant residential and local commercial uses at the street;
2. Sheung Wan area with a mix of employment, residences, central shopping facilities and the Sheung Wan transport hub;
3. Central with offices, hotels and high-end shopping centres;
4. Admiralty area, also with office use, commercial activities and institutional uses;
5. Fortress Hill to North Point residential areas with some employment and traditional street-level commercial activity.

The main tramway corridor and the sub-areas are shown in Fig.2.

These land use segments of the tramway corridor were also used to gauge their impact on pedestrian flow, with the hypothesis that higher intensity land use – essentially high-rise office development and shopping centres – would produce higher pedestrian flow on the tramway corridor.

The total length of the studied tramway corridor has 134 tramway stops, separated for each direction and 49 survey units, defined by major street crossings. There are 31 survey units with at least one tram station in one or both directions. Pedestrian cordon counts are taken 2-5 times with simultaneous boarding and alighting

counts when applicable. At the same time, the passenger count on the tram is taken from snapshots of the sideview seen from the footpath.

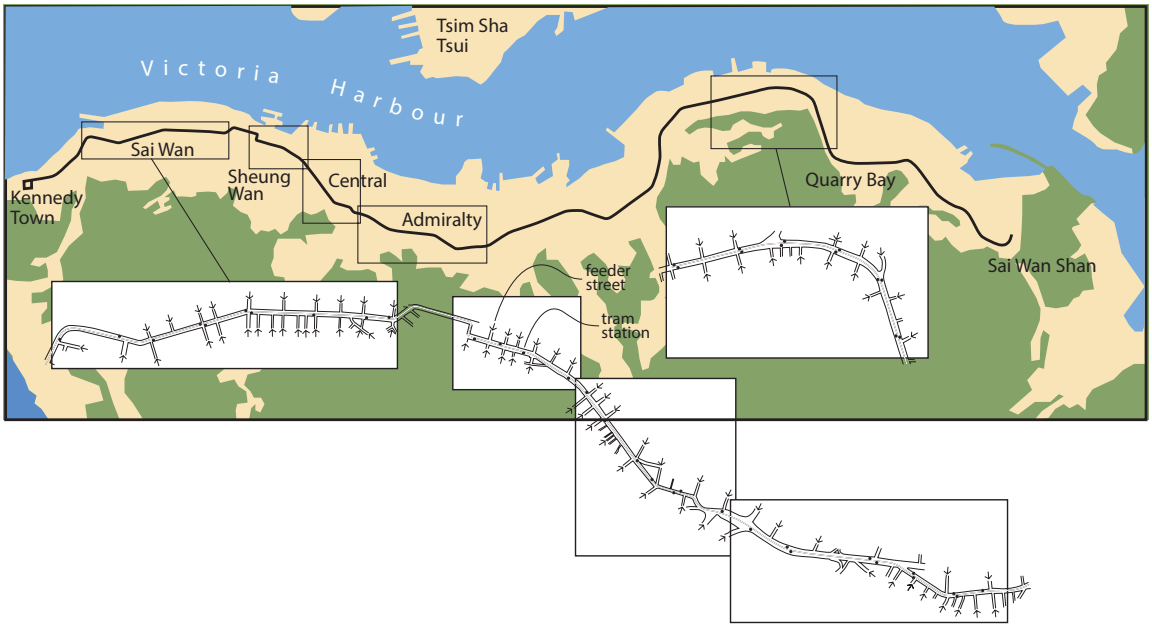

Fig.2 The main tramway corridor on Hong Kong Island with study areas

Five research assistants undertook the field study in June and July 2017. All local censuses were undertaken within a fixed time frame of about one hour so that the various counts could be statistically related. All data were entered in a database and analyzed using SPSS 22. A hierarchical linear regression is performed so that we can observe the specific contribution of each explanatory variable.

4. Results

Tab.1 presents the descriptive results from the field survey. The two sides of the tramway corridor streets were counted separately in this analysis, but the feeder street counts are combined for the two sides of the street.

Variable	Counts [N°]	Mean rate [p/min]	Standard Deviation
Street pedestrian volume (north side)	198	12.1	9.9
Street pedestrian volume (south side)	197	18.5	13.9
Feeder pedestrian volume	708	6.1	6.2
Tram alight	928	2.8	3.3
Tram board	456	2.1	3.0
Passengers in tram	578	22.9	21.8
Pedestrian crossing rate	70	30.9	36.7
Irregular crossing rate	49	3.1	3.4

Tab.1 Street and tram pedestrian counts (n) and rates

Streets of the tram corridor have much higher pedestrian flows overall than do the feeder streets from surrounding local areas (Tab.1), supporting the thesis that arrival in the area for walking is by tram for many individuals. The total numbers of individuals riding, alighting and boarding the tram are also not small in

relation to the flows of pedestrians on the streets. We could expect from these figures that if an effect of tram-riding on street vitality does exist, it would be detectable.

The explanatory variables are entered in a combined linear regression model following calculation of possible collinearity using VIF, reported in Tab.2. There is negligeable collinearity. Pedestrian flow is significantly related to disembarking and boarding tram passengers, the flow of pedestrians from the surrounding areas into the tram corridor, the volume of pedestrian crossing traffic at lighted intersections and the irregular crossing rate in the local environment. All of these factors contribute positively to pedestrian volume on the sidewalk. The disembarking rate at a station associated with a street segment contributes some 20% of the variance in pedestrian flow on the sidewalk. Non-compliant street crossing, although constrained by the presence of fences on one or both sides of the street, is also positively associated with pedestrian volume (9%). While it might be thought that jaywalking is simply a by-product of large pedestrian numbers, it makes an independent contribution to the flow on the footpath. For example, the crossing volume at lighted intersections and according to traffic rules, explains only 1% of the variation in pedestrian volume.

In all, these six independent variables explain about 41% of the variance in pedestrian volume on the sidewalks. This might be considered large in relation to other possible explanatory variables, such as the presence of major shopping facilities or office towers, instead of residential blocks and local retailing uses.

Variable	B	SEE	Stand. B	R^2	F	VIF
I: Alighting rate	3.636**	0.411	0.407	0.165	78.085**	1.35
II: I, Boarding rate	0.083	0.205	0.019	0.166	39.041**	1.02
III: II, Feeder ped. vol.	1.683**	0.159	0.456	0.350	70.472**	1.21
IV: III, Crosswalk vol.	0.060	0.039	0.072	0.354	53.645**	1.39
V: IV, Jaywalk vol.	2.127	0.434**	0.205	0.392	50.238**	1.14
VI: V, Barrier fence level	-3.700	1.085	-0.142**	0.409	44.946**	1.15

Note: *<.05; **<.01

Tab.2 Hierarchical regression model for street pedestrian vitality with 6 explanatory variables

When the tramway corridor is segmented according to land use mix, as indicated above in Methods and Materials, it is found that these categories make no contribution to pedestrian flow. In other words, land use defined in broad categories is not significant in its contribution to street vitality in this case. In particular, areas with a higher concentration of workplaces do not generate higher use of the tram.

The question of whether block length is a factor in street pedestrian vitality is examined. Short blocks provide more frequent opportunities to access the target street. For each of the count segments, block length was measured as the distance between intersection midpoints. With 396 counts on the 49 corridor segments, the correlation between block length and pedestrian flow is $r=-0.287$ ($p<.01$; two-sided). As expected, in keeping with the literature, shorter blocks are associated with stronger pedestrian flow.

The flows of pedestrians from MTR station exits at or adjacent to the tramway corridor could be used to compare with tram-disembarking passengers. Over the same study segments of the tramway, 5-minute counts were also taken of pedestrians exiting MTR exits and moving in the direction or directly into the tramway corridor streets (figure 3). It will be seen that the egress rate from MTR stations is much more variable than from tram stations. The 24 MTR exits contribute 344 persons/minute to the corridor while the tramway contributes 244/minute. The contributions of pedestrians from the MTR are at a very limited number of points

– 25% of exiting passengers are at a single exit in Central, while 49% are at 4 of the 24 exits. This people flow suggests a more nodal form of development, with integrated high-density, mixed use development above stations (Zacharias & He, 2018). The MTR also generates pedestrian movement into the local street environment although a certain proportion of pedestrians exiting the station remain in the connected centre above, before returning to the MTR. Point generators may be much larger in the MTR system with a different distribution in the street environment than seen in the tram streets. These distinctions suggest the largely autonomous roles of each of the transport systems, with their different purposes and with little linkage between them.

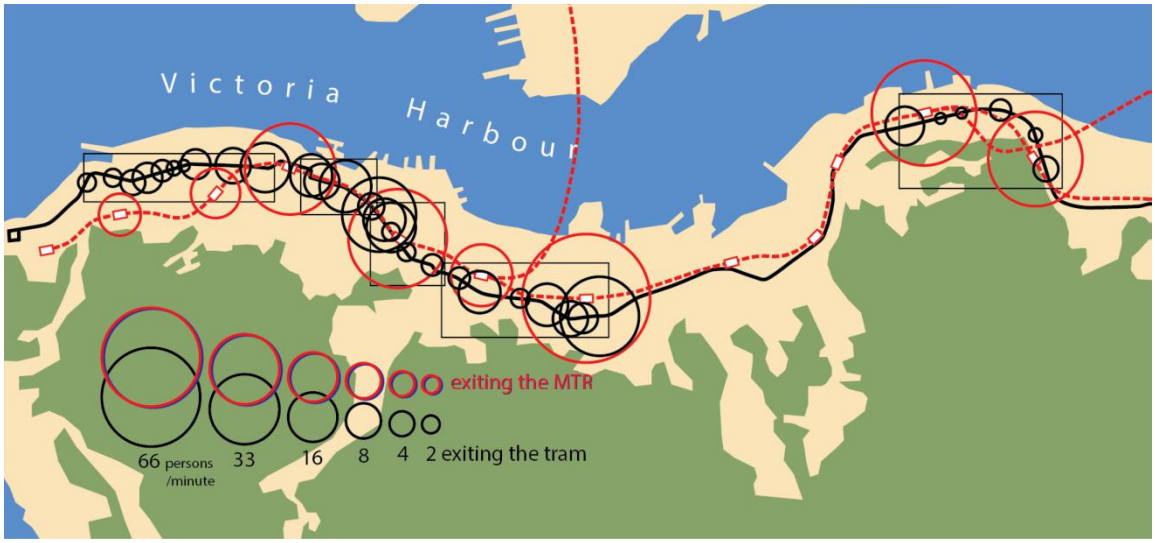

Fig.3. Disembarking tram rates sampled across store operating hours and metro station exit rates in the same time frame

5. Discussion

The 198,000 average daily riders on 30 km of track amount to 6,600 boardings per kilometre. For order of magnitude, the most heavily used urban surface rail systems in the U.S. are the Massachusetts Bay Transportation Association regional line (3,310 km) and the Muni Metro of San Francisco (2,760 km) (APTA, 2018). The building and population densities are much greater in Hong Kong than in those American systems, but a state-of-the-art underground metro follows the alignment of the HKT, which could be expected to take a high proportion of travellers on the corridor. The tramline streets also carry buses, light buses and taxis although these modes carry far fewer passengers than do the HKT or MTR. The tram corridor is a multi-modal transport corridor with a relatively stable distribution of users across modes. While destination and distance are undoubtedly important factors in the distribution of users, the tram is most integrated with local street functions and at the scale of blocks. Station spacing is at smaller intervals than in most urban surface rail systems but this spacing has a role in sustaining continuity in urban streetlife.

This connection between tram and street is demonstrated in the relationship among people flows. The contribution of local area population and activities to pedestrian flow on the tramway corridor streets is about 27%. Without any motorized transport, that figure should approach 100%, largely because of the severe constraint of typical walking distance. The contribution of the tramway to street pedestrian flow, measured as disembarking passengers, is about 20% of the total. The mean pedestrian flow for all locations and all times within the tramway corridor is 30.6 persons/minute while the tramway carries 22.9 persons/minute. This latter flow is much higher than the combined passenger flow in taxis, light buses, buses and private vehicles. Many bus routes use the tram corridor for only part of the route, light buses pass with less frequency and cars carry relatively few individuals.

The physical organization of the tramway corridor is significant in the pedestrian environment. Fences were introduced in Hong Kong by the Transport Department as a measure in favour of traffic separation, a

fundamental principle in Hong Kong's urban planning model (Bristow, 1989), that includes overhead walkways and underground pedestrian corridors. The fences are placed at the outer edge of the footpath. Some of the dedicated tramway tracks are also now bound by fences, to discourage pedestrians from accessing the stations at the ground and directing them to bridges with staircases leading down to the station platforms. The bridges are not well used with people preferring to access stations directly from the footpath. For most of the length, the fences are discontinuous, to respect the pre-existing structure of land uses and, in some cases, movement. The fence is clearly negatively related to pedestrian flow ($r=-.289$; $p<.01$). Irregular crossing is positively related to pedestrian flow, although we do not know whether more pedestrians are generating more jaywalkers or whether the practice of jaywalking raises desirability of walking in a particular segment of the corridor. On the other hand, irregular crossing is negatively related to fences ($r=-.272$; $p<.01$), such that there is a latent desire to jaywalk. Accessing the tram station almost always involves crossing one or more traffic lanes without a pedestrian signal, while crossing the entire width of the street is mandated at signalled intersections only. For the pedestrian using the tram, the regulatory environment could be considered somewhat ambiguous at least in the real environment of small dimensions and close, physical relations. Street space has been more clearly demarcated in an apparent attempt to separate movement streams. The original operating concept of the tramway was to allow free movement of individuals from the spaces near buildings to the tramway.

The tramway extends the walking environment by offering an accessible means to go at faster than walking pace to a distant locale, which is evidently what is occurring. Numbers alighting (average=2.1; sd=3.0) and boarding (2.8; sd=3.3) at a station are a small proportion of passengers on the tram (22.9; sd=21.8). At these rates, the majority of passengers are travelling several stations in their use of the tram corridor. Passengers board from origins in the local environment but are typically travelling beyond walking distance to access other parts of the tram corridor. Without the tram, these passengers would have little option but to walk or detour to the MTR, which will also typically involve a much longer walk within underground corridors and via stairs, escalators and lift to the station platform. Such complex travel involving vertical movement is a major disincentive to walk among the elderly (Gaglione et al., 2019). Alternatively, they might restrict their walks to a very local area, as suggested by the much lower pedestrian flow on blocks without a tram station. The apparent hop-on-hop-off nature of the tram deserves further investigation as an indication of the role of such transport systems in an urban corridor. In the Hong Kong environment, the tram is an extension of the walking network because of the density of stations, ease of access and opportunities offered. The significance of network characteristics at the very local scale in walking rates that is revealed in other studies (Zecca et al., 2020) is also salient here. These studies suggest more attention should be devoted to localized conditions of walking, in addition to the traditional study of citywide walking networks.

A major question for Hong Kong concerns the vitality of its street environment, particularly in light of new developments that emphasize linkage between the MTR and concentrated facilities attached to the stations. This form of nodal development is an innovation that should be assessed for its impact on the traditional, street-oriented public environment of Hong Kong. To encourage the development of the north side of the tramway corridor, more pedestrian crossings would clearly help, based on the present study. The fences removed for constructing street barricades during street demonstrations were temporarily replaced with poles strung with plastic chain that was removed by activists almost immediately, presumably to maintain free crossing movement. The design and management of the tramway corridor clearly deserves re-examination, to balance local community needs, street vitality, access to public transport, pedestrian safety and an efficient, road-based transport system. The present study could serve as a source for gauging the effects of a new street design.

It is almost a convention in public transport planning to simplify systems and concentrate resources on the most efficient carriers, when efficiency is measured as throughput and time. Underground rail systems are

planned in consideration of walking distance, where it is almost always more time-efficient to walk when the destination is within the distance between a station and a third one on the same line. Thus, it is unlikely that the metro will be used to expand the walking environment by linking two areas distant from each other. The effects on local street vitality of the MTR require further study. In the present work, the contributions of the MTR to movement within the major tramway corridor are much less than the contribution of the tram itself. It may be, however, that the large pedestrian volumes generated by certain metro stations also contribute to a different pattern of street-oriented public activity. These effects need to be understood as part of a plan to integrate public transport with local land use. This study also suggests further investigation of combined transport corridors – heavy underground rail paralleled by bus, tram, bicycling and walking systems – so we can better understand the synergies between these systems and their complementary implementation.

This study concerned the iconic Hong Kong tramway, but the methods are adaptable to other tramway systems. In the contemporary city, we are much concerned with the integration of areas with sharply different social and economic profiles. How the tram serves to link such areas and create a common public environment for everyone in the city seems an important extension of the present effort on measuring the tram effect on street vitality.

6. Conclusion

In Hong Kong, the tramway is an integral part of the local commercial street network. Blocks supported by tram stops have significantly higher pedestrian flow than blocks without. The tram contribution to street vitality, measured in terms of pedestrian presence in the tramway corridor, is about 20% of the total, while the ability to cross the street, facilitated to some extent by the tram station at the middle of the street, contributes an additional 10%. Together, tramway-related factors account for more in street vitality than the flow of pedestrian traffic emanating from surrounding areas into the tramway corridor. In all, the five variables of the model – passengers alighting and boarding the tram, pedestrian volume on feeder streets, crossing rates – collectively account for 41% of the variance in pedestrian volume.

The pedestrian flow on the south side of the corridor is about 30% higher than on the north side. Most of the inhabited areas surrounding the tram corridor are to the south. It is also clear that disincentives to crossing, including fences, reduce street vitality on the north side of the tramway streets. Local improvement in crossing conditions, in particular providing more crosswalks, removing fences or allowing jaywalking would have a positive effect on north side vitality.

Although there has been discussion about the long-term viability of the Hong Kong tramway, it should now be clear that the question is not only a matter of the operations of this historic system. The character and liveliness of the vicinity of the tramway corridor are supported by the tramway operations by facilitating movement between local areas and extending walking distance. In this way, the tramway makes a direct contribution to active transport.

Acknowledgements

Masters programme students at the College of Architecture and Landscape at Peking University collected the field data. The study was funded by the State Administration for Foreign Expert Affairs of China and hosted by the Faculty of Architecture, University of Hong Kong.

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Image Sources

Fig.1: Photos taken by the author

Fig.2 and 3: Figures prepared by the author

Author's Profile

John Zacharias

The author's interests lie in the space between the planned environment and human behaviours. How plans and designs condition behaviours but also how behaviours transform space are central investigations in the research. Environmental perception is a second strain of research, which interfaces with behaviour when we examine the study concerns cognitions relating to actions. The studies on these topics published in international journals are typically conducted in real environments at a variety of urban scales.

TeMA Journal of
Land Use, Mobility and Environment

TeMA 2 (2020)
print ISSN 1970-9889, e-ISSN 1970-9870

www.tema.unina.it

REVIEW NOTES

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

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

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

TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 459-463
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/7178
Received 14th September 2020, Available online 31st December 2020

www.tema.unina.it

REVIEW NOTE – Urban Planning Literature Review

After recovery: new urban challenges

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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 five parts: Urban planning Literature Review; Town Planning International Rules and Legislation Overview; Urban Practices, Projects, and Innovative Approach; Framework of Scientific News and Events; Economy, Business and Land Use. Each of these sections 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 the global scientific panorama, on selected topics and issues.
The contribution discusses, with interesting scientific works, the significant impacts of Covid-19 pandemic on our lives and urban systems. Infections due to Sars-Cov-2 had and still have serious social, economic and health consequences, that each country around the world is currently experiencing. Moreover, myriad other challenges – especially climate change – are on the horizon and cities have to pivot to resilience, focus on their most vulnerable citizens and adopt a zero-tolerance for inequality.

Keywords
Resilience; Emergency; Covid-19

How to cite item in APA format
Guida, C.. (2020). REVIEW NOTE – Urban Planning Literature Review. After recovery. New urban challenges. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 459-463. http://dx.doi.org/10.6092/1970-9870/7178

1. Introduction

In 1920, a world-wearied by the First World War and sickened by the 1918 flu pandemic desperately sought to move past the struggles and tragedies and start to rebuild lives. People were looking forward to "returning to normalcy," and today, exactly one hundred years later people all over the world find themselves in a similar position. The Covid-19 crisis and the political, economic and social disruptions it has caused have exposed the inadequacies of our current urban and economic systems. Amid global concern for lives, livelihoods and the planet, leaders find themselves at a historic crossroads for shaping the recovery and, at the same time, have a window of opportunity to reset economies and societies on a new trajectory of more inclusive and sustainable growth.

In line with the last issues and "Covid-19 vs City-20" Special issue of TeMA Journal (Gargiulo et al., 2020; Guida, 2020), I dedicated this section of Review Notes to scientific manuscripts and journals in the field of urban planning, whose main topic is the improvement of urban resilience to face the social, economical and healthy crisis due to the outbreak of a novel coronavirus and its consequent disease.

the corona pandemic hardest hit people living in cities, which now find themselves deeply affected by economic and social crisis. Poverty and inequalities are rapidly rising in cities, with new groups of people at risk of poverty – the 'new urban poor'. Addressing this crisis requires unprecedented bold actions by working together in solidarity between all levels of government to build a fair, inclusive and sustainable recovery for cities all over the world, leaving no one behind (Carpentieri, 2020). The future of cities has been the centre of debates in the last months all around the world. The reorganisation of public space, social and economic activity to new priorities in such a short period, has forced local governments to think different.

While a global pandemic has been considered a looming risk for decades (World Bank, 2020), Covid-19 violetly shacked the fragile ground of society, health systems, economies and governments worldwide. Amid extraordinary challenges and uncertainties, policymakers are under pressure to make decisions on managing the immediate impact of the pandemic and its consequences, considering that recent decisions will shape the state of the world for years to come.

Now, more than twelve months and 1,400,009 deaths into the Covid-19 pandemic make people longing for an end. Scientific communities are trying to answer this question and agree that we will maybe two different "ends", each with a separate timeline.

The first is an *epidemiological endpoint,* when herd immunity is achieved. It will occur when the proportion of society immune to Covid-19 is sufficient to prevent widespread, ongoing transmission. Many countries are hoping that a vaccine will do the bulk of the work needed to achieve herd immunity and researches predict that, by the end of 2020, the first commercial doses will be available. When this endpoint is reached, the public-health-emergency interventions, as limits and restrictions, deployed in 2020 will no longer be needed. While regular revaccinations may be needed, perhaps similar to annual flu shots, the threat of widespread transmission will be gone.

The second endpoint will occur when almost all aspects of social and economic life can resume without fear of ongoing mortality (when a mortality rate is no longer higher than a country's historical average) or long-term health consequences related to Covid-19. The process will be enabled by multidisciplinary tools and approaches, such as, from the healthcare side, vaccination of the highest-risk populations, improved therapeutics, continued strengthening of public-health responses, and increasing the social, economic and environmental resilience of urban areas. Among the main issues, tourism, public space, mobility and transport, green and smart economy and climate resilience need to be designed according to a new normality, opening a world of possibilities for structural changes where people and their health will be in the centre of urban transformation.

In fact, the next normal will not look exactly like the old—it might be different in surprising ways, with unexpected contours, and getting there will be gradual—but the transition will enable many familiar scenes,

such as air travel, bustling shops, humming factories, full restaurants, and public transit operating at capacity, to resume. These different temporal endpoints mean that Covid-19 will likely persist for years. Even with the most sophisticated testing and contact tracing, cities will suffer waves of infectious outbreaks until immunity takes hold or antiviral therapies and vaccines are developed. Nevertheless, cities cannot, and will not, stay locked down indefinitely, in order to avoid spiralling food prices, rising unemployment, economic disintegration and social and political unrest will follow.

Hence, both the epidemiological and normalcy ends to the Covid-19 pandemic are essential. The transition to the next normal will mark an important social and economic milestone, while herd immunity will be a more definitive end to the pandemic. At the same time, only strategic and integrated interventions can make this goal reachable in a short period, and this achievement will need joint actions of policymakers, stakeholders and citizens (Bottero, 2017). Increasing the resilience of health management, social, economic structures of cities is our chance to do more than undo the effects of the pandemic crisis and anticipate the new normalcy endpoint.

The next paragraph aims at focusing on how cities have been and still are vitally important as parts of the global human ecosystem, despite the pressure and disruption inflicted on urban centres and their citizens by the Covid-19 pandemic.

2. Post-pandemic challenges for urban environments

Shortly after the coronavirus overwhelmed Wuhan in early 2020, the pandemic's centre of gravity shifted westward from Seoul to Milan, Madrid and New York. Around the world, cities are just spreaders of infection but also key to containing it. The eventual "restart" of most economies depends on the condition of the biggest cities because they are engines of growth and productivity. Cities are dual-edged, as they are both parts of the problem and a potential solution to sick the "new normalcy" endpoint.

They intensify the spread and transmission of infectious disease through high dense human contacts. Today, about 4 billion people live in cities, more than half of the world's population. According to some researchers, around 600 cities generate two-thirds of global GDP. Since they are hubs for transnational commerce and mobility, densely populated and hyper-connected cities can amplify pandemic risk. Scholars have found that pandemics often emerge from the edge of cities. Viral outbreaks are frequently incubated and transmitted via peri-urban communities and transportation corridors at the outskirts of cities before they spread into their cores. It is not just cities, but also their local and global supply chains, travel networks, airports and specific neighbourhoods that are sources of contagion.

At the same time, cities play a central role in preparing for, mitigating and adapting to pandemics. That is nothing new, since many of the norms and rules for cities to manage infectious disease were first discussed at a global sanitary conference in 1851 (Howard-Jones, 1975). Today, cities' preparedness to Covid-19 pandemic varies a lot, according to the their level of development and the socio-economic determinants of their populations: cities with a high concentration of urban poor and deep inequalities are potentially more vulnerable than those that are better resourced, less crowded, and more inclusive, while cities that are open, transparent, collaborative and adopt comprehensive responses are better equipped to manage pandemics than those that are not. Even though many acceptable practices have been applied it is still too early to declare a success (Patel, & Shah, 2020) for the response of some cities, such as Taipei and Singapore, that could count on good investigative capacities, health systems lessons learned by past pandemics (Bouffanais, & Lim).

City networks have an opportunity to exert global leadership in shaping preparedness and response. There is an opening, then, for international coalitions of city leaders – including the C40, UCLG, Metropolis, the U20, the Mayors Migration Council and the Global Parliament of Mayors – to advocate for a seat at the decision-making table. City coalitions such as Eurocities and the U.S. Conference of Mayors are already powerful advocates for devolution and together with international networks can help give direction about practical ways

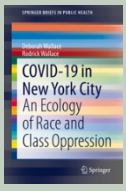
to reduce inequalities and secure the rights and needs of people living in situations of concentrated disadvantage. Cities have always exhibited a remarkable capacity to evolve in the wake of crises and served as testbeds for innovation. There is no doubt that the Covid-19 pandemic will trigger enduring changes to the built-space, city plans, building codes and the rules governing city life everywhere. Large built-up areas and bustling street life will likely give way to fewer retail stores, open green spaces, and more flexible work options. Public transport, cycling, pedestrian and other forms of micro-mobility could be prioritised over cars.
Moreover, Covid-19 is neither the first nor the last pandemic cities will face. Myriad other challenges – especially climate change – are looming menacingly on the horizon. In the end, cities that pivot to resilience, focus on their most vulnerable and adopt a zero-tolerance for inequality will be the ones that survive and thrive in the 21st century. In the light of these challenges, the following books and journal aim at defining future scenarios for our cities, as both places of infection and potential solutions to Covid-19 pandemic effects.

Journal of Urban Management

Editor-in-Chief: Shih-Kung Lai
Publisher: Elsevier
First publication year: 2012
ISSN code: 2226-5856

The Journal of Urban Management agrees that cities are complex systems and that only plans for urban development cannot deal with the issues directly derived from rapid urbanisation. Hence, the Journal has two aims: integrate the studies across fields in urban planning and management, and provide a more holistic perspective on problem-solving. The Journal explores innovative management skills for taming thorny problems that arise with global urbanisation and provides a platform to deal with urban affairs whose solutions must be looked at from an interdisciplinary perspective. It collects scientific articles in theoretical work and applications that are targeted at urban management worldwide, including developing and developed countries. Hence, it covers studies and research in planning, administering, regulating, and governing (PARG) urban complexity. The urban phenomena that are of interest cut across ecological, physical, economic, political, and social settings, with the belief that these settings interact with each other and should be treated as a whole. In the light of Covid-19 pandemic, interesting papers have been published on Journal of Urban Management. As stated in the Editorial Preface of the last issue of Journal of Urban Management, as the Covid-19 spreads worldwide, different viewpoints about the effects of the disease on the world pervade. Covid-19 pandemic is a complicated matter and based on the ideas derived from complexity theory, and we should be able to take practical actions fighting this virus on a scientific basis. Journal of Urban Management offers interesting insights on urban dynamics to face Sars-Cov-2 pandemic focusing, for example, on concepts of immediate resilience and adaption, the usability of public spaces to respect the social distance. In summary, given the uncertain duration and periodicity of the occurrence of Covid-19, the papers of the last issue of Journal of Urban Management attempt to critically review the built environmental think-tank that would be adaptive, predictive and responsive towards a "new" normal or future.

Covid-19 in New York City. An Ecology of Race and Class Oppression



Authors/Editors: Deborah Wallace, Rodrick Wallace
Publisher: Springer
Publication year: 2020
ISBN code: 978-3-030-59623-1

This book offers an engaging social epidemiological study of Covid-19 spread in New York City (NYC), the primary epicentre of the United States, due to the rapid, extreme rise of NYC case and mortality rates. Decades of public policies destructive of poor neighbourhoods of color heavily determined the spread within the City. Premature mortality rates revealed the "weathering" of policy-targeted communities: accelerated ageing due to chronic stress. Sars-Cov-2 attacks the elderly more severely than those under the age of 60. Communities with high proportions of prematurely aged residents proved fertile ground for Covid-19 illness and mortality. The very public policies that created swaths of white wealth across much of Manhattan and parts of Brooklyn destroyed the human diversity needed to ride out crises. The book is divided into five chapters; the first deals with premature death rate geography in New York City, and its implications during the outbreak of Covid-19 pandemic; the second chapter is about markers of Covid-19 in NYC, at the ZIP Code Level; the third offers an overview of Covid-19 infections in the broader area, N.Y. Metro Region; the fourth examines pandemic control from upstream, finding analogies with firefighting and fire prevention; the fifth chapter focuses on the implications of the Covid-19 pandemic's explosion in the New York Metropolitan Region from the perspective of both historical trajectory and ideas of 'ecosystem resilience' transitions.

The Arup Profile: Issue 2

Authors/Editors: Josef Hargrave
Publisher: Arup
Publication year: 2020
Website: https://www.arup.com/perspectives/publications/magazines-and-periodicals/the-arup-profile/arup-profile-issue-2

The Arup Profile: Issue 2 is the last issue edited by Arup Foresight team. Arup is an independent firm of designers, planners, engineers, architects, consultants and technical specialists, working across every aspect of the built environment. As Covid-19 has caused an unprecedented change to our lives, it has also impacted homes and offices, transit, energy and even food supply. This disruption also coincides with another crucial challenge we are facing with persistent carbon emissions and environmental degradation. Despite the twin crises, the main question that Arup is trying to answer is: how can we adequately respond and catalyse new opportunities and shape a sustainable future? The second issue of The Arup Profile invites technicians, researchers and policymakers to imagine and question our world as we adjust to the new normal and begin to consider ideas to build back better. Each contribution explores stories and ideas that consider everyday life in a post-pandemic world, to using hydrogen to accelerate the energy transition and strengthening food security in cities through urban agriculture. The issue also shares about the continuing work made by Arup engineers and consultants in enhancing the resilience of rail, healthcare and industry, and in designing decentralised commercial hubs as we begin to consider the future of the CBD. The Issue invites readers to imagine and question our world in a post-pandemic era and an opportunity to consider how we can design and build a better, more resilient future. Moreover, the Issues offer interesting insight, 'Beyond the curve'. It collects illustrations that were informed by a series of internal workshops, more comprehensive research and expert interviews to consider the implications of Covid-19 on the built environment. Each implication is supported by case studies from around the world captured on our insight platform, Arup Inspire, as well as expert opinions from Arup practitioners working across the built environment. The issue concerns new ideas to improve resilience and health security of homes, neighbourhoods, transit networks, offices and retail.

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TeMA Journal of
Land Use, Mobility and Environment

Call for Paper

TeMA vol. 14 (2021) The city challenges and external agents. Methods, Tools and Best Practices

Cities need to modify and/or adapt their urban form, the distribution and location of services and learn how to handle the increasing complexity to face the most pressing challenges of this century. On these topics and the ones born during the last year, the scientific community is working in order to minimise negative effects on the environment, social and economic issues and people's health.

For these reasons, the three issues of the 14th volume will collect articles concerning the six topics addressed in 2020 and also a seventh concerning the effects on the urban areas related to the spread Covid-19 pandemic.

In particular, TeMA Journal intends to propose articles that deal the effects of climate change, the ageing of the population, the reduction of energy consumption from fossil fuels, immigration flows from disadvantaged regions, innovation technology, the optimisation of land use and the impacts, in the short and long period, connected to the Covid-19 pandemic, with innovative methods, tools, techniques and practices.

For this reason, authors interested in submitting manuscripts addressing the issues may consider the following deadlines:

- First issue: 10th January 2021;
- Second issue: 10th April 2021;
- Third issue: 10th September 2021.

TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 465-470
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/7241
Received 6th October 2020, Available online 31st December 2020

www.tema.unina.it

REVIEW NOTE – Town Planning International Rules and Legislation

Strategies and guidelines for urban sustainability: the explosion of micromobility from Covid-19

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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 written by young researchers. 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. In particular: the Town Planning International Rules and Legislation Overview section aims at presenting the latest updates in the territorial and urban legislative sphere.
Urban patterns and their intrinsic relationships have completely changed since Covid-19. In particular, the mobility subsystem has undergone a significant change, inducing users to use "soft" such as micromobility. Micromobility is now on the rise, especially in large cities, but at the same time the lack of dedicated routes pushes researchers and technicians in the area to find solutions capable of providing rules to users.
This section examines the legislative decrees issued by the Italian government to promote a sustainable mode of travel for cities such as micromobility.

Keywords
Urban sustainability; Soft mobility; Micromobility; Covid-19.

How to cite item in APA format
Gaglione, F. (2020). Strategies and guidelines for urban sustainability: the explosion of micromobility from Covid-19. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 465-470. http://dx.doi.org/10.6092/1970-9870/7241

1. Introduction

The resurgence of infections from Covid-19 and the need to respect social distancing is questioning the processes and habits of mobility companies and people. Among the many consequences that the epidemiological emergency is entailing, inevitable impacts will affect the actors involved in the field of mobility. Companies, investors, citizens and the public sector will have to rethink and reshape the mobility habits of all of us, both in terms of reducing the number of trips and changing modal preferences, favouring forms that guarantee the safety of users. One of the effects of the Covid-19 emergency falls precisely on mobility in urban and metropolitan areas which has inevitably undergone significant change. In the Review Note of previous issue of TeMA, the different forms of organization of local public transport were examined in terms of management costs, sanitation of vehicles, increases in rides in order to avoid gatherings in the reopening phase after the lockdown to reach urban services (Gaglione, 2020). Six months later, the uncontrolled spread of the Coronavirus has led users to use "soft" forms of mobility but also sustainable for cities such as micromobility. Confined spaces, crowding and proximity to strangers, the need to cling to supports, touched by strangers are among the main reasons that would push users to abandon metro, trams and buses, certainly posing a new research question in the scientific field on how to define the role of new forms of transport and travel solutions in relation to the achievement of urban services. The spread of modes of travel through micromobility can alleviate the challenge that large cities face today and offer a path towards more sustainable urban transport, given the difficulty in forecasting the end date of Covid-19 pandemic. The mobility of the urban system is already very complex and depends on several factors, on the movement behaviour of users (bus, bicycle, on foot, on the subway), on accessibility, and therefore, on the capability of a place to be reached and the forms of organization and structure of the transport offer offered. The rapid urbanization also foreseen by the World Health Organization to expand by more than 1.5% per year until 2030 (WHO, 2010) entails having to meet a greater demand for travel in terms of access to urban places and services, but generates also consequences such as increased traffic congestion, atmospheric and acoustic pollution on urban systems. This phenomenon implies that inevitably cities will have to implement measures aimed at spreading alternative modes of transport to the motorized one, which is still the mode of travel widely used by the population even for short journeys. Micromobility, with electric scooters and e-bikes, which are now on the rise, especially in large cities, especially where there are dedicated infrastructures and also numerous sharing mobility services. The emergence of micro-mobility companies has been well documented in recent years with companies like Ofo and Mobike in China and Citi Bike. In 2018, this micro-mobility trend was re-energized with the emergence of the shared and dockless electric scooter (e-scooter for short), pioneered by Lime and Bird in the US. Micro-mobility as a concept developed in research work on the new mobility paradigm (Sheller, 2011), and was subsequently revisited by other researchers (Brunner et al., 2018). It is an increasingly term used in the scientific literature concerning urban mobility (e.g. Clewlow, 2019, McKenzie, 2019), but often giving it a vague definition. In general, micro-mobility refers to shorter distance journeys for personal transportation using small, light vehicles or devices, especially two-wheeled motor vehicles. Important research conducted by INIRIX Research in 2019 showed that in 25 cities in the United States it could be replaced by micro-mobility solutions, while this figure rises to 67% of car journeys in five cities in the United Kingdom. The data were based on the proportion of existing vehicles traveling three miles or less, based on estimates of distance travelled by the National Association of City Transportation Officials.

INRIX also analysed over 30 million car journeys in the UK, revealing a much higher percentage of short distance vehicle travel than in US cities. This is due to a high-density population and shorter distances between destinations, making UK cities more attractive for micro-mobility solutions to replace cars. Following this research, in the cities of the Kingdom, the United States and France, such modes of travel have been encouraged and widespread, although the forms of organizations to allow the usability of a movement of this type still remain a research question today. In Italian cities, it was born after the period of the lockdown,

public transport with reduced capacity and the consequent increase in traffic due to the use of the private vehicle have led to the search for alternative means of getting around daily routes. The research commissioned by Arval entitled "The Italian scenario of urban mobility: a look to the future" has highlighted above all the growing interest in micro-mobility which, according to what emerged, is at the top of the wishes of Italians). The e-bike would have been identified as the ideal tool for commuting from home to work which, according to the research, in 75 percent does not exceed a distance of 15 kilometres. The choice of vehicle is also affected by factors related to the environment, agility and the absence of fatigue, while the lack of dedicated routes, the cost and the risk of theft represent the greatest resistance to purchase, pushing researchers and technicians of the territory to find solutions capable of providing rules to users. In short, just look at our cities to understand that bicycles, owned or increasingly shared, and electric scooters are changing urban mobility. However, the current body of micro-mobility literature does not yet include adequate studies on electric scooters. Cities have not yet reached a consensus on how to run e-scooter business in their jurisdictions based on the experience of others, however the sheer amount of travel data has outpaced the analytical capacity of these private companies. As a result, they can only make limited contributions to planning practice (Freed, 2018). The rise in micro-mobility cities, in particular electric ones, raises a new question in the scientific field and leads to rethinking the forms of reorganization of urban mobility that are combined within a new system of urban life rules (Coppola & De Fabiis, 2020; Masoumi & Shaygan,2016), in particular of having to think about the creation of dedicated lanes, parking services for such electric vehicles and which do not generate conflicts between pedestrians and vehicles. Furthermore, the fear of getting infected, the limits imposed only on proven work needs and for the achievement of essential services has indirectly induced a cultural overturning of users on how to move even in the city, especially where the use of micromobility was a difficult progress to achieve, also thanks to the incentives that the government has allocated for their purchase. In this direction, the content of this review aims to examine the regulatory documents on electric scooters, in particular, where they can circulate and how they can be used in Italian territorial contexts.

Law 17 july 2020, n.77 (Decreto Rilancio)

The Legislative Decree May 19, 2020, no. 34, containing "Urgent measures on health, support for work and the economy, as well as social policies related to the epidemiological emergency from Covid-19" (the so-called "Decreto Rilancio") was published in the Official Gazette no. 128 dated 19 May 2020. Recently converted into law n. 77 of 17/07/2020, with amendments, of the decree-law of 19 May 2020 and published on the Official Gazette n.180 of 18-07-2020. The text contains hundreds of heterogeneous provisions ranging, among others, from construction to culture, from taxation to school, from health to mobility, to businesses, etc. In this review, the emphasis is on the mobility system and the measures implemented in the previous issue to restart the local public transport system while in this section on sustainable mobility in particular micromobility. With the relaunch decree, the government allocated a 120-million-euro fund to guarantee the mobility bonus or bicycle bonus equal to 60% of the purchase for vehicles such as scooters, segways, hoverboards and monowheels. Art. 205 regulates the possibility of obtaining the contribution for all adults, without the provision of income requirements. The mobility bonus is single and can be used only once per person.
The beneficiary must be resident in the regional capitals, metropolitan cities, provincial capitals or municipalities with a population greater than 50,000 inhabitants. Moreover, the facilitation is also designed for the disposal of vehicular traffic in generally congested areas resulting in high rates of noise pollution. The decree grants the use of the bonus retroactively, that is from 4 May last. Therefore, those who have purchased one of the aforementioned vehicles can still have the refund provided if the residence coincides with the above requirements. But there is no need to rush the purchase as there is time until 31 December 2020. The bicycle bonus or mobility bonus consists of a refund or discount of 60% of the price with a maximum of 500 euros. This means that on a purchase, for example, of a scooter, whose average price can be around 300 euros, you can get a discount of 180 euros.
The measure implemented by the Ministry of the Environment in conjunction with the Ministry of Infrastructure and Transport aims to encourage sustainable forms of transport that guarantee the right to mobility of people in urban areas in the face of the limitations to local public transport operated by entities premises to deal with the epidemiological emergency from Covid-19.

To obtain the grant, simply keep the supporting document of the expense (invoice) and, as soon as it is online, access the web application that is being prepared by the Ministry of the Environment using SPID credentials (Public System of Digital Identity) and also accessible from its institutional website. The system will need to indicate the vehicle or service they intend to purchase and the platform will generate the electronic shopping voucher to be delivered to authorized suppliers, together with the balance to be paid for, to collect the goods or enjoy the identified service.
These provisions will remain in force only until 31st December 2020. In 2021, however, the provisions of the Climate decree will become effective again, which provides for a fund to be paid by the Ministry of the Environment equal to an additional 180 million euros for residents in the Municipalities affected by the Community infringement for Italy's non-compliance with the obligations provided for by the Community directive on air quality

Law 28 February 2020, n.8 (Decreto Milleproroghe)

The mobility bonus was the prelude on the one hand to incentivize micro-mobility, but at the same time to rethink the system of rules for the circulation of vehicles falling within the category of micro-mobility, in particular with Law 8 of 28 February 2020, published in the Official Gazette no. 51 of 29 February 2020 and in force from 1 March 2020, converted the decree law n.162 (decree Milleproroghe) with some modifications.
In order to provide a complete picture on the subject, it is necessary to outline the regulatory changes concerning the definition and circulation on the national (and provincial) territory of electric scooters. The first law dedicated to the "diffusion of electric micro-mobility" is governed by the law of 12/30/2018 n. 145, commonly known as the 2019 budget law aimed at promoting technologically advanced and sustainable modes of travel. In detail, in art. 1 co. 102, authorizes in the cities "the experimentation of the circulation on the road of vehicles for personal mobility with mainly electric propulsion", including in this category also electric scooters. However, nothing else is specified about the concrete methods of circulation, nor about the characteristics of these technological tools, a task that simultaneously relies on the regulatory authority of the Ministry of Infrastructure and Transport. Only with the decree dd. June 4, 2019, called "Testing of the road circulation of devices for electric micro-mobility", the technical characteristics required for the types of electrical devices admitted to the experiment were defined. Of greatest interest is art. 3 of the decree, which makes the circulation of any type of electric micro-mobility device subject to a specific provision by the Municipalities. The reason for this provision, to be considered deductible from the legislation itself, lies precisely in the fact that it is a real phase of preparation and study of the advantages and disadvantages of these new tools and that each Municipality, still completely in the process of experimentation at national level, has the right (and therefore not the obligation) to adopt and implement these new forms of travel. To condition this municipal approval, and therefore further aggravate the expectations of those who wish to take advantage of the scooters, even in the form of business, art. 4 provides that the Municipalities, before issuing the approval provision (whatever it may be), must map the set of possible paths for the circulation of electronic devices, which are also subject to technical prerogatives of use specified in general terms in the same source legislation since the decree itself explicitly admits for the first time the rental services of shared devices, even in free-floating mode (so-called free-floating). By free flouting we mean that set of electric scooters under a common brand that stop and are available in various parts in the perimeter of the predefined experimentation area and that can be taken and used by booking and / or unlocking with a specific application on smartphone, with rates that can be based on the kilometres travelled or on the duration of the rental itself, resulting in a new organization of the characteristics of the built environment in relation to this type of urban mobility. The issue of the recent law 8 of 28 February 2020 introduces some changes with respect to the laws set out above. In particular, it introduced art. 33-bis which defines provisions on the circulation of devices for electric micro-mobility and atypical vehicles by amending art. I paragraph 75 of the law of 27 December 2019 n. 160. Which equated electric scooters with cycles with certain characteristics defined by the ministerial decree of the Minister of Transport Infrastructure. This law introduces the extension of testing of these vehicles, extending it until July 27, 2022 to allow the collection of information and allow evaluations for future regulation to both local technicians and researchers, providing possible solutions for their better usability within the city. It also introduces the characteristics of the electric knob and the documentary obligations: (i) the maximum circulation speed is 25 Km / h: previously the limit was 20 Km/h. The vehicle can circulate on urban roads with a limit of 50 km/h and traffic allowed for normal cycles (bicycles), but it can never exceed the speed of 25 km/h and obviously, if present, the obligation to circulate on the cycle paths. (ii) It cannot circulate on extra-urban roads if there is no cycle path and, in this case, it must compulsorily circulate in it respecting the speed limits. Furthermore, in pedestrian areas, unless otherwise indicated, it is allowed to circulate with the scooter as long as it does not exceed 6 km/h. This implies that the electric scooter must allow the setting of at least 2 predefined speed limiter levels. (25 Km/h and 6 Km/h). (iii) It must have a bell for acoustic signals that follows the construction, assembly and technical standards exactly identical to those for cycles. It must have white or yellow lights at the front, red light and red reflectors at the rear. In the absence of which from half an hour after sunset until dawn and during the day if the weather conditions require them, it will not be usable but only conductive or transportable by hand.
With regard to drivers, the law does not provide for driving licenses or licenses, however, imposing the completion of the 14th year of age and some behaviours, first, compliance with the speed limits indicated above. You must proceed in a

single row in all cases where it is required by road traffic conditions and never side by side in a number greater than 2. Minors, based on the different characteristics of greater danger of electric scooters, must wear a protective helmet. Your arms must remain free and always hold the handlebars except for any indications for turning manoeuvres. When it is necessary to turn on the lighting of the electric scooter, you will also have to wear a high visibility reflective vest or shoulder straps
Finally, other people, animals or objects cannot be transported. Not even towing or being towed by other vehicles.
The ministerial decree provides that an atypical electric propulsion device may be conducted only in some urban areas previously authorized for experimentation. Also indicating that this type of vehicle can be driven only if adults or minors in possession of an AM, A1 or B1 driving license.
The device must strictly comply with the technical characteristics set by the ministerial decree and must not circulate in the areas of the built environment and dedicated infrastructures that in many cities still struggle to be present. In case of violation, an administrative sanction will be incurred which will range from € 100 to € 400.
If the electric scooter does not comply with the characteristics indicated above, it will be verified whether it falls into one of the categories of existing vehicles based on the provisions of the Highway Code that are described in the next sheet.

Highway code

The highway code regulates the rule set out in Article 1, paragraph 75-ter for electric scooters, prevails over art. 142 of the highway code since it appears to be a special and specific provision for this medium. Therefore, if caught going with a speed exceeding 25 Km/h and higher than the limit imposed for the road you are traveling on, the sanction provided for in Article 1 paragraph 75-ter mentioned above will be applied. Instead, the penalty will be the one applicable by art. 142 highway code if the speed will be less than 25 Km/h but higher than the limit in force on the carriageway. The sanctions of the latter article will also be applied if the imposed limits are exceeded and you are traveling on a cycle path.
As for the use of the helmet, it must be "suitable" and approved by following all the indications and standards already in force for helmets used with cycles. However, being equated to a velocipede, for everything that is not specifically governed by the new rules, the current highway code for cycles will be applied, in particular Article 182 of the highway code which governs their circulation. Furthermore, the highway code defines how such vehicles must circulate within the urban system as follows: (i) Art.143: you must circulate keeping as close as possible to the right edge of the carriageway, so as not to hinder other vehicles. Furthermore, it is not allowed to circulate on the sidewalk and if required, it must be transported or conducted by hand. (ii) Art.154: As for bicycles, the direction must be indicated in case of turning with the arm. (ii) Art.173: You can use your mobile phone or any other electronic device only with the aid of a headset. This is to ensure that the hands are always free and used for the management of the vehicle.
If the electric scooter does not comply with the characteristics indicated above, it will be verified whether it falls into one of the categories of existing vehicles based on the provisions of the Highway Code and integrated by the rules of Regulation (EU) 168/2013.
The examination of these documents shows that the effects of the coronavirus has induced a change in the lifestyles and behaviours of users in moving by promoting cutting-edge modes of travel both from a technological and sustainable point of view for cities such as the spread of micromobility. At the same time, modes of movement of this type are still being tested and it is still difficult to define one's own role within the urban system. Furthermore, the challenge is still highly demanding, especially in cities where sharing mobility services are not dated, the need to define the forms of organization. The cities have not yet reached a consensus on how to manage this mode of movement in their jurisdictions which, as can also be seen from these legislative documents, are being tested and validated on the basis of the experience and best practices of other cities. The spread of these ways of moving beyond Covid-19 has positive environmental impacts for the reduction of polluting emissions and congestion of vehicular traffic. Furthermore, the overall improvement in air quality facilitates a policy of re-appropriation of places relieved by vehicular pressure.

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TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 471-477
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/7251
Received 15th November 2020, Available online 31st December 2020

www.tema.unina.it

REVIEW NOTES – Urban practices

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

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

Keywords
Covid-19; Urban policies; Milan; Paris; Brussels

How to cite item in APA format
Angiello G. (2020). Toward greener and pandemic-proof cities: EU cities policy responses to Covid-19 outbreak. *Tema. Journal of Land Use, Mobility and Environment*, *12* (3), 471-477. http://dx.doi.org/10.6092/1970-9870/7251

1. Introduction

In December 2019, in the Wuhan province of China, a new form of Coronavirus (Covid-19) emerged. Since then, the virus has been spreading globally and, as of 05 November 2020, more than 200 Countries around the world have reported 71,9 million confirmed cases and a death toll of 1,61 million deaths (Template: Covid-19 pandemic data). The Covid-19 pandemic triggered both third and first world economies, causing severe disruption to society and business, especially in urban areas (OECD, 2020a).

2. Toward greener and pandemic-proof urban areas?

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

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

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

3.1 Milan

With 1.4 million inhabitants, Milan is the second largest city in Italy. As the capital city of the Lombardy, one of the wealthiest EU regions, Milan is considered a leading alpha global city, with strengths in the fields of the finance, commerce, art, design, fashion, media services, research and tourism. The city has experience a sustained urban growth over the past few decades, characterized by the implementation of large-scale urban renovation projects and the development of an efficient and modern public transportation network, coupled with a well-developed shared-mobility eco-system.

On February 21st 2020, the first Italian Covid-19 case was registered in Codogno, a small town about 50 kilometers south of Milan. Since then, the virus has spread over the Lombardy region, making Lombardy and its capital the focal point of the virus outbreak in Italy. The pandemic has severely hit the city's dynamic economy and social life, reversing the long-standing growth trends that have characterized its economy, with consulting services,

finance, constructions and horeca being the most affected economic sectors. In order to provide a response to the social and economic challenges posed by the pandemic, on May 4th 2020, the city Council launched *Milan 2020*, the city's adaptation strategy to the Covid pandemic. The document was first released as a draft in early April 2020, open to observations and contributions through an online participatory process. Central to the adaptation strategy is the idea that the pandemic is generating long-lasting radical changes in citizens lifestyle and business operations and that these changes will require a strong reorganization of the city's physical and organizational assets. Therefore, city's reorganization should not merely provide a short-term operational response, but should also set the condition for improving city's readiness and resilience to current and future critical situations that could occur in the mid and long term. The first part of plan provides an analysis of the social and economic impacts of the virus outbreak. This part serves as the plan knowledge-base to set a future vision of the city. The vision encompass five main guiding principles in the fields of governance, economic development, public services, workforce and sustainability. Based on such principles, several planning and revitalization interventions are defined. One of the most important line of intervention concerns with the reallocation of the uses of roads and public spaces with the main objective to increase soft mobility supply and develop areas that allow commercial, recreational, cultural, and sporting developments, while respecting the appropriate physical distances. In this respect, the adaptation strategy envisions the development of 35 km of new bicycle lanes, the re-development of city's pedestrian paths, with new and widened pavements, and the extension of Limited Traffic Zones and pedestrian areas. On the land use side, interventions have been target at strengthening public services with attention to proximity, ensuring access within a 15-mininutes walk to essential services, balancing the differences between neighborhoods, enhancing specificities, and trying to reduce inter-district travel. Accordingly, the Municipality of Milan is cooperating with the Lombardy Region to create local services, starting from popular neighborhoods, with high population density and characterized by an older population. Other strategic lines of intervention included the adaptation of the city's *Time and Hours Plan* to a different schedule for public services especially for social and educational services and productive activities, in order to avoid overlaps in entry and exit times, regulate the demand for mobility and facilitate physical distancing, identifying timeslots reserved for the most vulnerable groups. A further line of intervention concerned with the simplification, expansion and acceleration of digital services available to the citizens in order to reduce the needs to travel and contain physical contacts between public servants and city users. Finally, the plan intends to support both business and household economic recovery by providing e.g. microenterprises financing services, social rental services and facilitated access to credit. A dedicated section of the strategy is also devoted to skills redevelopment, targeting individuals that have lost their jobs due to the current crises.

3.2 Paris

Paris is the capital and most populous city of France, with an estimated population of 2,148,271 residents. Paris is one of Europe's major centers of finance, diplomacy, commerce, fashion, science and arts. While its historic center is one of the most popular destinations in Europe, the recent expansion of its outskirt areas has been characterized by a poorly regulated development, coupled with inadequate infrastructure provision and consequent social and economic exclusion.
Paris has been strongly affected by the virus outbreak, with tourism, leisure and mobility being the economic sectors suffering the most. At the same time, the pandemic was an eye-opener to city administration and an occasion to put forward an ambitious strategy started in 2014 and aimed to decarbonize city's economy and make Paris a healthier city. Since 2014, the year of the first election of Mayor Hidalgo, Paris went through a series of policies that banned the most polluting vehicles from entry to the city, freed the quayside of the Seine from cars, and regained the space of the streets for more trees and pedestrian space. This process of pedestrianization of the city was fostered during the Hidalgo campaign for re-election 2020, *Paris en Commun*. This campaign manifesto has been relaunched as a post-COVID strategy, introducing the concept of a "15 minutes city", in which citizens' basic needs, such as work, shopping, health, or culture, should be available within 15 minutes of their home. To meet this aim the city has implementing a coordinated mix of land use planning and urban design measures such as the relocation of schools, health centers and other public facilities, the renovation of urban public spaces and the expansion of the city's network of public housing into wealthier areas. This urban design measures have been coupled with soft mobility measures aimed at making cycling and walking an attractive mode of transportation. In this regards, the most evident measure proposed is the extension of the urban bike network that connects the city center to the suburbs. This network was already under examination before the COVID pandemic, but its design has been accelerated and proposed as an emergency measure in order to allow more people to commute using the bike across Greater Paris. In total, more than 50 kilometres of lanes - normally used by cars - have been reserved for bicycles. Among them are the Avenue de la Porte d'Orléans, Avenue du Général-Leclerc (on the southern section), the Étoile tunnel and Porte Maillot. In addition, 30 streets have been designated pedestrian-only, in particular around schools, to avoid large groups of people gathering on sidewalks.
Beside these structural interventions focused on the urban built environment, the city has put in place several measures in the social welfare domain. In this respect, Paris developed a plan to support businesses, low-income families, cultural actors and associations, providing different forms of aids such as direct economic support, rent relief support, food aids, municipal taxes relief programs and discounts on the purchase of public transport subscriptions. The city also acted as

"enabler" for private citizens and NGOs that want to help other citizens in need by creating an online platform that is helping people in need to connect with citizens willing to assist them. Finally, as for many other EU cities the Council of Paris has re-designed its city's time-plan, rescheduling the opening hours of public services in order to reduce congestion and mass gathering.

3.3 Brussels

Brussels - officially the Brussels-Capital Region - is a region of Belgium comprising 19 municipalities, including the City of Brussels and has an urban population of 1.2 million inhabitants. It grew from a small rural settlement on the river Senne to become the de facto capital of the European Union, as it hosts a number of principal EU institutions, including the European Parliament, the Commission and other administrative, legislative and executive EU institutions and agencies. As one of the top financial centers of Western Europe, it's economy is largely service-oriented and dominated by regional and world headquarters of international companies though it still does have a number of notable craft industries.

Brussels have been severely hit by the Covid pandemic with consultancy, horeca and commerce being the most affected sectors. More than one in four workers have been put on temporary unemployment since March 2020, while the city GDP is expected to shrink by 8% this year. Furthermore, the effect of the pandemic has also been felt unequally in Brussels, where infection rates have been two or three times higher in poorer, cramped neighborhoods than in richer, greener ones.

In contrast with the city of Milan that has articulated an organic city adaptation response, Brussels response to the Covid-19 has been relatively fragmented and characterized by a number of sectoral policies regulating different aspect of the urban life. These measures have been issued by the City Council between March and October 2020, targeting specific policy domains such as mobility, social welfare, land uses and public services. In particular, measures in the mobility domain have been the focus of the city administration. When confinement was imposed on 19 March, the immediate priority of Brussels authorities was indeed to encourage social distancing by giving more space to cyclists, pedestrians and shoppers. In this respect, the city started the construction of dedicated bike lanes in the capital – infrastructure that has been increasing in recent years but still lags behind cities in Flanders, the Netherlands, and Denmark and elsewhere. In particular, from May to November 2020 over 40 kilometers of new, dedicated cycle paths were developed. Even Rue de la Loi, one of Brussels' most congested streets that snakes past the Belgian parliament and the European Commission headquarters, got the bike lane treatment in May. Dedicated bike lanes and fewer cars on the road has led to an explosion in bike use – up 44% on the previous year in early September. Another important measure in the soft mobility domain concerns the extension of pedestrian areas in the historic city center. Since September 2020, the so-called "Pentagon" area has been divided into different residential areas where quality of life and safety are priorities and where the maximum speed of 20 km/h is maintained. In this way, the city created more space to respect the physical distance rules. The City of Brussels has decided to adjust this temporary measure in order to be better suited to residents and traders, but also commuters, visitors, customer. A participatory process has been also launched in September 2020 to review the impact of the adopted measure and to ensure that all city users are heard in this project.

The city has devoted increasing attention to the recovery of commercial, leisure and horeca activities and has developed in May 2020 a dedicated recovery plan. Beside financial aids and incentives, bars, restaurant and café have been allowed to expand their terraces onto sidewalks and even close roads in some areas.

Finally, the city has created a special structure, the Social Action Unit COVID (CSAC), to assist the inhabitants of Brussels who were materially, financially and psychologically affected by the Covid-19 crisis.

4. Discussion and conclusions

As Covid-19 spreads across the world, cities have become epicenters of the pandemic, amplifying the spread and transmission of infection, with their dense population and transport networks. At the same time, cities have become catalyst of sustainable recovery. Many examples of good practices taking place in cities across the word are captured by dedicated and constantly-updated reports of international organizations such as WHO (2020), UN (2020) and OECD (2020a) and UCCN (2020). This contribution provided a focus on Europe and examined policy response to the Covid-19 epidemic in three cities.

A cross-city analysis of measures implemented in the cities under investigation can be a useful exercise to derive a taxonomy of urban policy measures. This is reported below, together with some considerations on the effectiveness of such measures in providing answers to epidemic threats in urban areas while, at the same time, improving the sustainability and resilience of urban communities. Considering the social, the physical and the functional subsystems composing the city, measures could be addressed to:

PHYSICAL SUBSYSTEM

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

FUNCTIONAL SUBSYSTEM

- *Decentralization of public facilities*. Decentralization of public facilities is considered a fundamental property to contain the spread of the virus since it allows people to be able to get the goods and facilities they need within the minimum distance from their houses, thus limiting the interaction with the other sectors of the population (Pinheiro et al., 2020). Furthermore, the decentralization of healthcare services can reduce the response time, and saving operating costs (Pisani, 2020). A balanced juxtaposition of homes and services, is thus not only a well-known urban planning strategy to reduce long-distance trips and promote active transport, but represents also an emerging tool for containing epidemic spreading.
- *City time planning*. These measures might provide a valuable contribution in limiting social contacts and mass gatherings at facility sites as well as through the journey to reach such facilities. Furthermore, if coupled with opportune mobility and land use interventions these measure can also provide value in reducing traffic congestions during peak hours. However, the possibility to extend these measures in the long term might result problematic.
- *Improvement of IT infrastructures and digital services*. These measures can generate positive co-benefits: the digitalization of public services can indeed reduce the need to travel while at the same time contain physical contacts between public servants and city users. Furthermore, IT technologies can also provide a fast and concrete response to citizen's needs. Investments in this domain should be thus certainly encouraged.

SOCIAL SUBSYSTEM

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

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Image Sources

Image in paragraph 3.1 is from repubblica.it. Images in paragraph 3.2 and 3.3 are from wekepedia.org.

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TeMA Journal of
Land Use, Mobility and Environment

Call for Paper

TeMA vol. 14 (2021) The city challenges and external agents. Methods, Tools and Best Practices

Cities need to modify and/or adapt their urban form, the distribution and location of services and learn how to handle the increasing complexity to face the most pressing challenges of this century. On these topics and the ones born during the last year, the scientific community is working in order to minimise negative effects on the environment, social and economic issues and people's health.

For these reasons, the three issues of the 14th volume will collect articles concerning the six topics addressed in 2020 and also a seventh concerning the effects on the urban areas related to the spread Covid-19 pandemic.

In particular, TeMA Journal intends to propose articles that deal the effects of climate change, the ageing of the population, the reduction of energy consumption from fossil fuels, immigration flows from disadvantaged regions, innovation technology, the optimisation of land use and the impacts, in the short and long period, connected to the Covid-19 pandemic, with innovative methods, tools, techniques and practices.

For this reason, authors interested in submitting manuscripts addressing the issues may consider the following deadlines:

- First issue: 10th January 2021;
- Second issue: 10th April 2021;
- Third issue: 10th September 2021.

TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2020) 479-483
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: http://dx.doi.org/10.6092/1970-9870/7292
Received 3rd November 2020, Available online 31st December 2020

www.tema.unina.it

REVIEW NOTES – Economy, business and land use

Entrepreneurship in the city: sustainability and green entrepreneurs

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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 underlines the benefits that entrepreneurship exerts on the city, with a specific focus on sustainability and green entrepreneurs. These ones are individuals who start business ventures without just seeking their profit maximization as a unique goal, but rather contribute to the sustainable development of the communities in which they are embedded. However, in order for them to have positive and long-lasting impacts, they need to cooperate with networks that embed several stakeholders and mainly local governments.

Keywords
Green entrepreneurship; Sustainability; City

How to cite item in APA format
Franco, S. (2020). Entrepreneurship in the city: sustainability and green entrepreneurs. *Tema. Journal of Land Use, Mobility and Environment*, *13* (3), 479-483. http://dx.doi.org/10.6092/1970-9870/7292

1. Introduction

Cities are important nodes of social and economic life since most of the economic activities take place here and most of the worldwide population lives in urban centers (Bai et al., 2018). Due to the density of people and organizations, cities are also characterized by social and environmental risks that impose them to deal with problems related to climate change and socio-economic inequalities (Bai et al., 2018; Ramaswami et al. 2016). According to the United Nations, people living in slums rose to 28% in 2018 in urban areas, where up to 4,2 million people died in 2016, and where over 90% of Covid-19 cases were registered (UN, 2020). Environmental problems, in particular, are among the most relevant issues affecting cities as most of the energy consumptions occur in urban centers, accounting for the 70% of the global carbon emissions (Gargiulo & Russo, 2017) and affecting cities economies and competitiveness as well (Carpentieri, 2020; Carter et al., 2015). Public and governmental organizations are increasingly aware of such trends and are pushing urban centers towards the identification of the main socio-environmental concerns that affect them and the activities to implement in order to reduce their carbon footprint contributing to the mitigation of climate change. The most representative initiative demonstrating the commitment of global policies towards the issue of sustainable cities is probably the sustainable development goal number 11: "Making cities and human settlements inclusive, safe, resilient and sustainable". Recently, the Green New Deal signed by European Commission also put the environment at the center of the policy debate highlighting the important role that cities have in tackling climate change, whose effects are summarized by Zucaro and Morosini (2018) and are referred to the following factors: health, accessibility and supply, energy use, migration, economic and fiscal crises, social instability. Strategies to mitigate climate change are thus needed in order to have more livable and sustainable places. There are several possible ways through which urban areas can deal with the issue of mitigating their environmental impacts. Cities, indeed, may implement activities aimed for example at preserving soil and make a responsible land use (Carpentieri et al., 2019), may invest in infrastructures – namely systems that provide water, energy, food, shelter, transportations and communications - (Ramaswami et al., 2016), finance green infrastructures or nature-based solutions (Haase et al., 2017; Salata & Yiannakou, 2016). More in general, cities can face climate change by implementing sustainable activities in several ways involving several stakeholders (Jabareen, 2013). Among them, firms may play a relevant role in addressing environmental problems. This work aims at shedding light on the importance that green firms, and thus green entrepreneurs, are gaining in literature and in practice, unveiling their possible contribution to the sustainable transition of cities, whose political support is needed for a systemic and effective implementation of green initiatives that may overcome the idea of firm maximization and create positive externalities for the whole territory.

2. Green entrepreneurs and initiatives

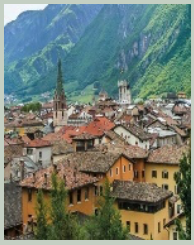
The issue of sustainable, or green, entrepreneurship has recently become widely discussed in literature (e.g., Brandt & Svendsen, 2016; Demirel et al., 2019; O'Neill & Gibbs, 2016). Individuals who combine an entrepreneurial action with socio-environmental awareness, thus not seeking exclusively profits maximization may be defined as sustainable, or green, entrepreneurs (Gibbs & O'Neill, 2014). While the popular image sees entrepreneurs as profit-maximization seeking actors, green entrepreneurs display different mindsets "evidenced through donations to environmental causes, employee-friendly working conditions, an interest in wider social and environmental issues beyond bottom-line profits, and a concern for the longer term implications of their business activities" (Gibbs & O'Neill, 2014, p. 1093). Green entrepreneurs are those who develop business initiatives based on sustainability and green values, and they have a central role in pursuing sustainable development through the spread of sustainable products and processes (Gasbarro et al., 2017; Parrish & Foxon, 2006). The central role that green entrepreneurship is gaining is demonstrated by the increasing attention dedicated to the topic by several differentiated fields of knowledge such as urban studies (Yu & Gibbs, 2020), management (Mrkajic et al., 2019), economy (Unay-Gailhard & Bojnec, 2019), innovation

(Cojoianu et al., 2020). The impact of green ventures is not just related to their private profits but is able to generate positive externalities as well, in particular when they create scalable business models that trigger the transformation of their supply chains (Silajdžić et al., 2015). If able to do so, green entrepreneurs have the potential to strongly contribute to the sustainability transition in cities. However, the extent of their contribution to such transition is also determined by the networks in which they are embedded, that are conditioned by spatial contexts and multiple relationships with local public and private actors (Yu & Gibbs, 2020). In other words, the role of governs is fundamental to sustain green enterprises, thanks to whom cities are more likely to achieve an effective and successful sustainable transition.

An extreme case of the extent to which green entrepreneurs may drive cities towards a sustainable transition is that of the town of Babcock Ranch, located in Florida in the United States, which is one of the first solar-powered town in the world. Currently under development, Babcock Ranch is a newborn city founded by a sustainable-oriented entrepreneur working in the field of real estate. The town is built upon the concept of the sustainable use of products and resources. It aims at hosting about 50 thousand inhabitants and 6 million squares of commercial space in the next years and is powered by a solar field composed of 650 thousand solar panels. All buildings are built following strict environmental and energy efficiency measures, and most of the urban space is covered by natural areas and sport infrastructures. The building sector, indeed, is among the most impacting ones about the relationship between green entrepreneurship and cities. With reference to Italy, many firms, supported by local governs, have developed in time green technologies aimed at implementing effective waste and energy management measures. In Italy, for example, the Kerakoll GreenLab is the prototype of a building thought as an ecosystem in balance with the surrounding environment and capable of self-producing energy, recovering rainwater to purify it and guaranteeing the highest levels of indoor air quality and well-being. Besides its technical characteristics, the building hosts one of the most advanced labs for the research about green materials for buildings. Green initiatives such as the one just described realize their potential at maximum when they meet favorable local policies and support. Oslo, for example, has been awarded with the European Green Capital of 2019 by European Commission, due to its strong impact towards the mitigation of climate change. Among the several initiatives involving sustainable mobility, green buildings and waste management, Oslo also established a network of businesses, citizens and NGOs called "Business for Climate Network" that group about 100 companies that design and implement strategies consistently with the sustainable goals of the city. Similarly, the city of Nijmegen, that won the prize in 2018, developed its sustainable strategy also trying to attract green investments coming from private businesses.

In line with the discussion provided in the previous number of this section, the following sub-sections underline some virtuous initiatives related to the Italian context. Indeed, one of the aims is to identify recent and relevant practical examples that show how Italian cities are facing the different challenges discussed.

Green entrepreneurship in Trento



Habitech is a technological district for the energy and the environment located in the area of Trento, in the north of Italy. Composed by 300 private green firms mainly operating in the building sector, it is supported by local authorities that are part of the consortium such as local governs of several towns in the area of Trento. The mission of Habitech is to drive the transition of energy and building supply chains towards sustainability. It promotes and manages complex innovation processes valuing the real estate assets of the surrounding area. Given its expertise along the whole supply chain, it operates through five different brands. In the last years its cooperation with local territories has even increased as it also participates in local green initiatives such as Car Sharing Trentino, going beyond the commitment into buildings and real estate green management, reinforcing the relationship with governmental actors.

Green entrepreneurship in Naples

Amicar Sharing is the first fully electric vehicle sharing service with zero emissions and integrates public and private transport in Naples. It is promoted by Gesco, the largest group of social enterprises in Campania region – to which Naples belongs -, actively committed to the defense of the environment and sustainable mobility and sees the collaboration with several business partners along the whole supply chain and the eShare platform developed by Be Smart. Amicar Sharing has an electric car park located in the main streets of Naples and in key points of the city. The service offers the possibility to move at low cost, to park for free in the affiliated car parks of the city of Naples, to move freely in the limited traffic areas and preferential lanes. Amicar Sharing contributes to the reduction of environmental and noise pollution, and to the reduction of costs for city mobility, with the aim of reducing urban traffic. Amicar Sharing is part of the activities of the Gesco group of "Mobility for all", together with the disabled transport service Amicar Care.

3. Discussion and conclusions

The aim of this work is to shed lights on late advancements in research about the topic of green entrepreneurship in the urban context, a topic of great relevance extensively discussed by both urban and economic studies. Green entrepreneurs are driven by motivations that overcome the mere profit-maximization, seeking for the creation of socio-environmental value (O'Neill & Gibbs, 2016). Through the overview of recent literature and of some practical cases, it is possible to understand the relevance of green entrepreneurs for the sustainable transitions of cities and territories. However, in order to make this aim effective and efficient, the support of local authorities is a fundamental requirement (Gasbarro et al., 2017; Yu & Gibbs, 2020). The cases presented in this work also underline the importance of the public-private relationship to practically implement green strategies in urban and regional contexts. Future studies may furtherly investigate the ways through which such interaction takes place, and under which conditions green entrepreneurs may deliver the highest possible value for their performance and for the local communities. The understanding of such mechanisms would be even more relevant nowadays, after that the pandemic of Covid-19 has imposed new paradigms for the sustainable development of cities (Capasso & Mazzeo, 2020).

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