TeMA

Journal of
Land Use, Mobility and Environment

The fragile/resilience city represents a topic that collects itself all the issues related to the urban risks and referred to the different impacts that an urban system has to face with. Studies useful to improve the urban conditions of resilience are particularly welcome. Main topics to consider could be issues of water, soil, energy, etc..

Tema is the Journal of Land use, Mobility and Environment and offers papers with a unified approach to planning and mobility. TeMA Journal has also received the Sparc Europe Seal of Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ).

THE RESILIENCE CITY / THE FRAGILE CITY. METHODS, TOOLS AND BEST PRACTICES.

Vol.11 n.3 Dicember 2018

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

TeMA

Journal of
Land Use, Mobility and Environment

THE RESILIENCE CITY/THE FRAGILE CITY. METHODS, TOOLS AND BEST PRACTICES

3 (2018)

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

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

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

Editorial correspondence
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"
Piazzale Tecchio, 80
80125 Naples
web: www.tema.unina.it
e-mail: redazione.tema@unina.it

TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.

The Italian *National Agency for the Evaluation of Universities and Research Institutes* (ANVUR) classified TeMA as scientific journal in the Area 08. TeMA has also received the *Sparc Europe Seal* for Open Access Journals released by *Scholarly Publishing and Academic Resources Coalition* (SPARC Europe) and the *Directory of Open Access Journals* (DOAJ). TeMA is published under a Creative Commons Attribution 3.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

TeMA Journal of Land Use, Mobility and Environment

CALL FOR PAPERS: TeMA VOL. 12 (2019)

The Times They Are a-Changin'

In these last ten years, TeMA Journal has published several international studies and researches supporting the scientific debate on the urban complexity and the future challenges of urban areas. Thus, the three issues of the 12th volume will think again the debate on the definition and implementation of methods, tools and best practices connected to the evolution of the main scientific topics examined in depth in previous TeMA Journal volumes.
In detail, the Journal welcomes papers on topics about the interdisciplinary interaction among Land Use, Mobility and Environment, and also urban studies from the domains of engineering, planning, modelling, behaviour, regional economics, geography, regional science, architecture and design, network science, complex systems, energy efficiency, urban accessibility, resilience and adaptation.
Publishing frequency is quadrimestral. For this reason, authors interested in submitting manuscripts addressing the aforementioned issues may consider the following deadlines:

- first issue: 10th January 2019;
- second issue: 10th April 2019;
- third issue: 10th September 2019.

CALL FOR PAPERS: GENERAL CALL

Papers in Transport, Land Use and Environment

The Journal welcomes papers on topics at the interdisciplinary intersection of transport and land use, including research from the domains of engineering, planning, modelling, behaviour, economics, geography, regional science, sociology, architecture and design, network science, and complex systems

Interreg MARITTIMO-IT FR-MARITIME GIREPAM

International Conference
on Innovation in Urban and Regional Planning

INPUT aCAdemy 2019

planning, nature and ecosystem services

24-26 June 2019
Cagliari (Italy)

University of Cagliari
Department of Civil and Environmental Engineering, and Architecture
DICAAR

Call for papers

DICAAR Società italiana degli urbanisti SIU urbIng ricerca scientifica La cooperazione al cuore del Mediterraneo

TeMA
Journal of
Land Use, Mobility and Environment

THE RESILIENCE CITY/THE FRAGILE CITY. METHODS, TOOLS AND BEST PRACTICES

3 (2018)

Contents

361 REVIEW PAGES

Gennaro Angiello, Gerardo Carpentieri, Rosa Morosini,
Maria Rosa Tremiterra, Andrea Tulisi

EDITORIAL PREFACE: TEMA JOURNAL OF LAND USE MOBILITY AND ENVIRONMENT 3 (2018)

THE RESILIENCE CITY/THE FRAGILE CITY. METHODS, TOOLS AND BEST PRACTICES

ROCCO PAPA
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples Federico II
e-mail: rpapa@unina.it

The 11th volume of TeMA Journal consecrates the three issues of 2018 to promotes the scientific debate on the fragile/resilience city that represents a topic collecting itself all the issues related to the urban risks and referred to the different impacts that an urban system has to face with. Studies useful to improve the urban conditions of resilience represent the aim of our editorial work of this year. The identification of 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 and territorial transformations.

The section "Focus" contains two articles. The first article, titled "Land Use Conflicts in the Energy Transition: Dutch Dilemmas" by Mark Koelman (Utrecht University, Nederland), Thomas Hartmann (University of Wageningen, Nederland and Universiteit Jan Evangelista Purkyně, Czech Republic) and Tejo Spit (Utrecht University, Nederland). The central question for this contribution is therefore: how can governments cope with the dilemmas underlying the land use conflicts of renewable energy development? By using Dutch examples, these dilemmas will be further examined. The Dutch energy transition is characterized by complex land use change because every inch of land already has a certain function assigned to it through land use plans. Finally, by exploring the underlying dilemmas of land use conflicts, the complexity of governing land use conflicts will be revealed, and a land use management approach will be discussed as promising.

The second article "A Methodology for Urban Sustainability Indicator Design" by Ricardo Alvira Baeza (Universidad de Murcia, Spain), explains a methodology for sustainability indicator design that allows understanding what these indicators should measure and how aiming to set a common framework that will enable to use by the scientific community.

The section "Land Use, Mobility and Environment" collects three articles. The first article, titled "Limit Condition for the Intermunicipal Emergency", by Luana Di Lodovico, Donato Di Ludovico (University of L'Aquila, Italy), deepens the issue of the Emergency Plan (EP). As the result of study about risk for each context, it allows to identify potential emergency scenarios. The paper illustrates model of analysis of Intermunicipal Emergency Plan (I-EP) through Limit Condition for the Intermunicipal Emergency (I-LCE), with the purpose of large-scale assessment and mitigation of the seismic risk. The proposed methodology is applied in the area of Sele, in the district of Salerno (Southern Italy), territory characterized by high levels of seismic and hydrogeological vulnerability.

The second article, titled "Cyclability in Lahore, Pakistan: Looking into Potential for Greener Urban Traveling", by S. Atif Bilal Aslam (University of Engineering and Technology Lahore, Pakistan), Houshmand E. Masoumi (Technische Universität Berlin, Germany), Muhammad Asim (University of Engineering and Technology Lahore, Pakistan), Izza Anwer Minhas (University of Engineering and Technology Lahore, Pakistan), presents the results of a survey about cyclability in Lahore, Pakistan, focusing on human perceptions rather than the built environment. The overall sample included a total of 379 respondents from three socio-economic classes: those from lower socio-economic backgrounds accessing traditional/older bazaars, respondents from the middle socio-economic class accessing uptown bazaars, and respondents of higher socio-economic status accessing pedestrian shopping malls.

The third article, titled "New water footprint indicators for urban water cycle", by Rossana Varriale (University of Naples Federico II, Italy), investigates the possibility of using the water footprint indicators in order to have common values on the uses of water in urban areas, where "value" means a measurement of water used and subtracted from the natural environment for anthropic uses. First of all, a general framework will be made of the studies that have dealt with "value" to water flows in the urban and non-urban context. In paragraphs 3 and 4, footprint indicators have been proposed to assess the variability of water consumption within urban territories. Then, the Blue Water Footprint and the Green Water Footprint were calculated only for the water flows consumed in the Italian cities, like drinking water and domestic water. In paragraph 5, it was argued on the links between UWF values and urban planning instruments and how the UWF indicators can address urban transformations towards sustainable approaches.

The section "Review Pages" defines the general framework of the issue's theme, with an updated focus on websites, publications, laws, urban practices and news and events on the subject of the Resilience City and the Fragile City. In particular, the Web section by Rosa Morosini describes three web resources of: (i) World Atlas Desertification; (ii) Soil Map and (iii) United Nation Environment Programme. The Books section by Gerardo Carpentieri briefly reviews three relevant books related to the Issues' theme: (i) Open Data Infrastructure for City Resilience. A Roadmap, Showcase and Guide; (ii) Transformation towards sustainable and resilient societies in Asia and the Pacific and (iii) Transport and Climate Change Global Status Report 2018. The Law section by Maria Rosa Tremiterra keeps readers up to understand in which way the European Union is addressing the integration between Climate Change Adaptation and Disaster Risk Reduction with a specific reference to the urban planning implications. The Urban Practices section by Gennaro Angiello presents two case studies for planning for resilience in in two South-American capitals, (i) the Quito (Ecuador) Resilient Strategy and (ii) the Santiago (Chile) Resilient Strategy. The News and Event section by Andrea Tulisi, select conferences deliberately deal with different issues not necessarily related to the theme of resilience, but which basically question on the future of cities.

TeMA
Journal of
Land Use, Mobility and Environment

TeMA 3 (2018) 273-284
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/5830

review paper received 4th September 2018, accepted 17th December 2018

www.tema.unina.it

How to cite item in APA format:
Koelman, M. Hartmann, T., & Spit, T. (2018). Land use conflicts in the energy transition: Dutch dilemmas. *Tema. Journal of Land Use, Mobility and Environment*, *11*(3), 273-284. doi:http://dx.doi.org/10.6092/1970-9870/5830

ABSTRACT

The transition from fossil to renewable energy requires changes in land use. The development of renewable energy sources introduces extra and sometimes new externalities, such as shadows, noise, and changes to the landscape. Several governments are experiencing difficulties when developing renewable energy sources, especially when existing land owners (and others) start anticipating externalities. Therefore, land use conflicts have become a major issue for governments in meeting renewable energy policy objectives. This paper explores how three dilemmas—tiers of government, mode of governance, and norm-setting—are approached by public authorities, using policy document reviews, interviews, literature research, and examples of the Dutch energy transition.

LAND USE CONFLICTS IN THE ENERGY TRANSITION: DUTCH DILEMMAS

Mark Koelman, Thomas Hartmann, Tejo Spit

[a] Utrecht University (NL)
e-mail: m.koelman@uu.nl; T.J.M.Spit@uu.nl
URL: https://www.uu.nl/

[b] University of Wageningen (NL),
Universiteit Jan Evangelista Purkyně (CZ)
e-mail: thomas.hartmann@wur.nl URL: https://www.wur.nl

KEYWORDS:
Energy Transition; Land Use Change; Externalities; The Netherlands

TeMA 有关土地使用、交通和环境的杂志

TeMA 3 (2018) 273-284
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/5830

review paper received 4th September 2018, accepted 17th December 2018

www.tema.unina.it

How to cite item in APA format:
Koelman, M. Hartmann, T., & Spit, T. (2018). Land use conflicts in the energy transition: Dutch dilemmas. *Tema. Journal of Land Use, Mobility and Environment*, *11*(3), 273-284. doi:http://dx.doi.org/10.6092/1970-9870/5830

能源转型的土地利用冲突 荷兰困境

Mark Koelman, Thomas Hartmann, Tejo Spit

[a] Utrecht University (NL)
e-mail: m.koelman@uu.nl; T.J.M.Spit@uu.nl
URL: https://www.uu.nl/

[b] University of Wageningen (NL),
Universiteit Jan Evangelista Purkyně (CZ)
e-mail: thomas.hartmann@wur.nl URL: https://www.wur.nl

摘要

从化石向可再生能源转型需要改变土地利用。可再生能源的发展带来了额外的、有时是新的外部因素，如阴影、噪音和地形变化。一些国家政府在开发可再生能源方面遇到困难，特别是当现有的土地拥有者(和其他人)开始预测外部因素时。因此，土地利用冲突已成为各国政府实现可再生能源政策目标的一个重大问题。本文通过政策文件审查、访谈、文献研究和荷兰能源转型的实例，探讨了政府当局如何处理三重困境-政府、治理模式和规范制定-的问题。

关键词：
能源转型；土地利用变化；外部因素；荷兰

1 INTRODUCTION

Energy transitions change how land is used. Renewable energy sources need land to be built on and sources such as wind turbines, solar plants, and biomass produce externalities (Wüstenhagen et al., 2007). These externalities include noise, shadows, air pollution, or changed landscapes. The development of renewable energy sources therefore interferes with existing land use and land use plans. This interference is increasing because renewable energy systems require more land to produce the same amount of energy as fossil fuels do (Boyle, 2004). For example, a traditional gas or coal plant can generate over 400 MW of electric energy a year while a single wind turbine can generate up to 7 MW of electric energy a year while using almost the same amount of land. Consequently, land use for energy transition increasingly interferes with current land use, resulting in land use conflicts.

Public authorities experience difficulties coping with land use conflicts because existing land use plans and land owners anticipate renewable energy source interference with their land use (Deppisch & Dittmer, 2015). There is a tendency to solve these land use conflicts on the local level, however most land use issues are complex and encompass a wide variety of stakeholders (Foley et al., 2005). This level of complexity makes it challenging for local governments to cope with land use conflicts and develop renewable energy sources within their municipality boarders. To cope with land use conflicts, local governments could consider changing their land use plans. This is traditionally the work of local authorities. But it is not clear if land use conflicts from energy transition are any different in comparison to traditional land use issues. We argue that land use conflicts from energy transition are more complex, due to three reasons: differentiation, fragmentation, and level of urgency.

- Differentiation of renewable energy sources encompasses a variety of sources such as wind turbines, solar panels, biomass, and so on. Within traditional planning, such differentiation plays a role in what functions can be planned near each other. Just like residential, industrial, and recreation areas, renewable energy sources also impact their surroundings. However, the technical issues (enough wind and sun in the area), safety issues (wind turbines cannot be placed near residential and infrastructural areas), and personal issues (people tend to dislike renewable energy sources nearby) increases the complexity of building renewable energy sources in comparison to more traditional land uses;
- Renewable energy sources are built as single objects, multiple objects, or in large numbers. This variety makes governmental instruments such as land use plans inefficient. The effect that renewable energy sources have on the surroundings depend on the number being built. Consequently, a single wind turbine or a large wind turbine park needs different planning instruments with different time spans. This fragmentation is a major issue for implementing instruments to change land use;
- Governments all over the world have agreed upon the urgency to become fossil free before 2050. The energy transition is therefore one of the most urgent global issues today. Traditional land use planning doesn't have such urgent planning issues with such a large impact on all kinds of land uses. Most land use issues, such as housing shortages, are local or at large regional.

Traditional land use planning deals with all three of the issues as described above. Land use planning is used to change the use of land. However, the scale and urgency of the energy transition is tremendous and therefore more complex in comparison to other land use issues. Another factor linked with differentiation, fragmentation, and urgency is the number of end users that play a role in the energy transition, most of whom are local actors. Renewable energy sources can be built by local, regional, and national governments, or by companies and citizens. Due to the link between different actors and their responsibilities, when building renewable energy sources, current energy policies and coherent traditional planning approaches aren't effective enough (Verbong & Loorbach, 2012). Whenever a citizen, farmer, company, or local government wants to build one or more renewable energy source(s), there are land use plans to be recognized, but also local and regional policies which require environmental and building permits. The current approach towards development of renewable energy sources limits the number being developed, nearby cities but also in rural areas (Papa et al., 2015; Wolsink, 2007). Therefore, the quest to find solutions for energy transition land use issues is rather interesting. Before the solution can be found, understanding the complexity and underlying difficulties is of high importance.

The complexity of mobilizing land use change is increased by three dilemmas: the tier of government, mode of governance, and norm-setting. These dilemmas exist out of choice issues such as a top-down or bottom-up approach, local (regional) or national decision-making, and short- or long-term solutions. All these options have advantages and disadvantages and are therefore defined as dilemmas. Consequently, it is important to not only govern land use conflicts through changes in land use but also by working through the underlying dilemmas. Change of land for energy transition (considering externalities, assigning land use, and acquiring land for renewable energy developments) are urgent but at the same time difficult to govern, which puts pressure on governmental renewable energy objectives. The central question for this contribution is therefore: how can governments cope with the dilemmas underlying the land use conflicts of renewable energy development? By using Dutch examples, these dilemmas will be further examined. The Dutch energy transition is characterized by complex land use change because every inch of land already has a certain function assigned to it through land use plans. Finally, by exploring the underlying dilemmas of land use conflicts, the complexity of governing land use conflicts will be revealed, and a land use management approach will be discussed as promising.

2 METHODOLOGICAL APPROACH: EXPLORATIVE RESEARCH OF DUTCH GOVERNMENTAL ENERGY POLICIES

The research methods used in this contribution are mainly explorative. As such, multiple case study analyses on energy policy implementation, semi-structured interviews with government officials, and private actors and literature research gather the information for these contributions. In this contribution, the governmental energy policies of different tiers in the Netherlands are a starting point. The Dutch cases are chosen because the Netherlands is a dense country, in the sense that every piece of land has one or even multiple uses attached to it. Due to the land use claims of renewable energy sources, the issues with building renewable energy sources are very clear within the Netherlands. The policy analysis, interviews and literature review are therefore exemplary for other (European) countries experiencing land use conflicts with energy transition.

The cases which are the subject of the governmental policy analysis vary from the national government project 'Wind op land' (3500 MW of wind energy scattered on land over 12 provinces) and municipal projects in regional areas of Noord-Holland and Groningen. The case study analysis allowed examination of the role of spatial planning in general energy policies as well as those specific to the energy transition. Both these research methods show indications of three dilemmas: the tier of government, mode of governance, and norm-setting. These dilemmas underpinned the existing difficulties described by government officials that they face when using land for renewable energy. Based on empirical findings we found that regional policy is both obstructing and supporting local developments in different ways, thus creating a dilemma of tiers of governments. We also came across the mode of governance dilemma where some tiers of governments applied a top-down steering policy while other tiers of government applied a more bottom-up approach, both showing successes and failures. The norm-setting dilemma was found in competing policies of tiers of government and further explored during interviews with government officials. This analysis is complemented by secondary data from other studies and an extensive literature review. Semi-structured interviews were selected as research methods because they are well suited for the exploration of the perceptions and opinions of government officials and private actors and at the same time allow further exploration of sensitive issues (Louise Barriball & While, 1994).

As can be concluded from chosen research methods and material, this study does not pretend to be all-encompassing. However, we think this study provides a new perspective on three dilemmas (tier of government, mode of governance, and norm-setting) and the underlying difficulties of implementing policies for renewable energy development.

3 DILEMMAS OF COPING WITH LAND USE CONFLICTS

Recent events have increased the discussion about the need for a different perspective on governing the energy transition (section 1). Governments all over the world are increasingly acknowledging that the transition to a renewable based, more bottom-up, and decentralized energy system, is a complex one, due to the impact of renewable energy developments on its surroundings (Breukers, 2010; Devine-Wright, 2014; Larsson, 2014). During our literature research, three dilemmas were found underlying land use conflicts rising from renewable energy development. In this section the underlying differences between tiers of government are explored by introducing three dilemmas: the tier of government, the mode of governance, and norm-setting.

3.1 FIRST DILEMMA: TIERS OF GOVERNMENT

To change renewable based energy systems, participation of different tiers of government is needed to "*redesign infrastructure, buildings and equipment*" (Bridge et al., 2013). The traditional way of governing the energy system is top down. National governments are active on the international level for formulating energy objectives and national policies but decide that lower tier governments are responsible for meeting national objectives. The dilemma here is the question of which tier of government should be responsible for renewable energy development? There are two issues that impact this dilemma.

First, more land is needed. Generating the same amount of energy that fossil energy generates with renewable energy sources requires much more land. As described in the introduction, the energy density of renewable sources is lower than fossil energy alternatives (Smil, 2010). Thus, land use conflicts arise from the multiple locations needed for energy generation. This generation takes place through wind turbines, solar parks, and other renewable energy sources. The land needed for such developments has other potential uses or already-existing uses that compete. Through land use plans, local tier governments can cope with competing uses. However, depending on the size of renewable energy projects, local tier governments don't have the means (financial or instrumental) or authority (plans exceeding municipal borders) to cope with the conflicts that arise. Second, with the new responsibility and difficulties faced, lower level governments are increasingly relying on developments led by private parties for meeting energy policy objectives (Upreti & van der Horst, 2004; Westerink et al., 2016). This has led to a certain attitude where local concerns and interests concerning renewables have been brushed aside by private parties (Breukers, 2010; Westerink et al., 2016). In turn, this attitude has increased local opposition towards renewable energy developments (Ellis, 2004; Gross, 2007; Wolsink, 2000). Therefore, local governments are struggling to make suitable land for renewable energy production available, whereas higher tiers of governments are holding tight onto existing approaches, such as coping with local opposition by using traditional instruments such as buying land voluntarily or compulsorily. By using these traditional (top-down) instruments for enabling renewable energy developments, lower governments must change existing land use plans, which can take up to six months or longer depending on the nature of the change (Rijkswaterstaat, 2018). These two examples show two major difficulties found in interactions between different levels of government. While on the one hand, local governments are given the responsibility to meet objectives for local issues, they are not given the right means or support to cope with such complex issues. The performance-based approaches of national government and the more condition-based approach of the regional tier compete both with each other and also with the local approach which addresses concerns of renewable energy developments. As such, the competing approaches between tiers of government results in delayed or cancelled projects.

3.2 SECOND DILEMMA: MODE OF GOVERNMENT

The top-down steering by tiers of governments on implementing energy policy is also present in the next dilemma, the sectoral approach towards the energy transition. The energy transition is still being approached as a top-down sectoral issue instead of as an integral (planning) issue (Verbong & Geels, 2007; Verbong & Loorbach, 2012). Governments and private parties work together in vertical (top-down and bottom-up) and horizontal ways (sharing responsibilities) modes of governance. The governmental policy approach defines the mode of governance in which the development of renewable energy sources take place. Driessen et al. (2012) wrote about how to cope with different modes of governance and discusses that the mode of governance "*refers to the means by which society determines and acts on goals related to the management of (…). It includes instruments, rules and processes that lead to decisions and implementation".* The mode of governance dilemma is found in the current sectoral approach and integral alternative approach of how governments and private parties cope with land use conflicts.

Major actors like utility companies, infrastructural companies, and regulators still have a large influence on the management of the current energy system. Therefore, economic, social, and energy issues are being addressed separately, which have a major impact on the effectiveness of executing energy policies. This approach has increased competition between different governmental departments (housing, retail, industry, leisure, etc.) in acquiring land for their own objectives. The current Dutch situation is in some cases closely related to the one Runhaar et al. (2009) studied. Runhaar et al. (2009) argue that the absence of environmental planning in urban and regional developments has led to missed opportunities to improve environmental quality, "*because the incorporation of environmental aspects often only occurred in a later stage of the planning process*".

The mode of governance dilemma which different tiers of government are facing is mainly created by the lack of a successful approach for coping with land use conflicts with renewable energy developments. Although new policies are still based on the already-existing centralized mode of governance and our society is still heavily relying on fossil fuels, a successful integral approach has yet to be found (Verbong & Loorbach, 2012). A new mode of governance is needed with a focus on 'how do we cope with land use conflicts surrounding renewable energy developments' and settle the differences between a sectoral and integral mode of governance. Such an integral alternative approach could help governments internalize externalities of renewable energy developments, but also other complex issues such as mitigation of climate change effects (Papa et al., 2014). This internalization of externalities gives governments the ability to use other instruments (economic and social focused) and means to cope with the impact of renewable energy developments. A possible issue with applying an integral approach is that it becomes increasingly complex. Creating a solution for a sectoral issue is already complex. Finding a solution which includes several other sectors only makes the issue more complex because of increasing and conflicting interests. This makes choosing the 'right' mode of governance a real dilemma.

3.3 THIRD DILEMMA: NORM - SETTING

The norm-setting dilemma is about weighing renewable development objectives against other urgent issues, such as local health department reforms, resettling of refugees, or protection of landscape. Another characteristic is that changing and developing land use or zoning plans are time consuming issues and smaller municipalities deal with a lack of means, without a clear path of how to address the challenges. Therefore, local governments aren't always capable of integrating renewable energy initiatives in their main land use management policies (Wegener, 2012). Because of the high costs and time needed for developing land use plans, lower governments are more interested in a facilitating role, which can be a risk because private parties are mainly focused on making profits. In certain situations, the change to a facilitating role has led to the interests of local citizens being left out in planning and decision making, igniting local opposition as result

(Breukers, 2010). Due to such land use conflicts, renewable alternatives (especially wind projects) have increasingly been confronted by negativity, which in turn, have led to delays and cancellation of projects (Krohn, & Damborg, 1999; Wolsink, 1996). To influence the role of governments and the market in the energy transition, persistence and continuity of energy policy is needed (Grubler, 2012). In Grubler's (2012) view, long term policies are consistent and therefore attracting investors and companies wanting to finance or develop renewable energy projects. Additionally, approaches to renewable energy development should be free from contradictions by aligning land use and energy policies to promote shared norms between all stakeholders.

Another issue of the norm-setting dilemma is the short time cycle for appointing government officials. The opportunity for officials to be re-elected is therefore an important factor in norm-setting on the local level. For example, Healy and Lenz (2014) argue that voters assign higher weight to the conditions of the election-year economy. Sitting officials can therefore be incentivized to *"...take action to inflate election-year growth even at the cost of larger long-term economic damage"* (Healy & Lenz, 2014). This implies that for government officials in short-term positions, meeting short-term objectives does have a more positive effect for re-election than working on long-term issues, such as local opposition towards renewable energy developments. So next to the urgency challenges, it is possible that the political agenda of government officials also influences the way norm-setting takes place between tiers of government.

4 LAND USE CONFLICTS IN THE NETHERLANDS

The Netherlands are known for its traditional windmills, which were built to use wind power for grinding grain to flour and manage drainage of the so called 'polders'. These windmills aren't used for this work anymore, but they are still a welcome sight in traditional Dutch landscapes. In contrast to these traditional windmills, modern wind turbines aren't seen as welcome sights, especially not near living areas. While in the 70s the Netherlands was one of the pioneers of building these wind turbines and making use of this sustainable energy source, in the 20th century this has completely changed. Dutch governments have experienced difficulties, resulting in a second to last place on generating renewable energy in Europe (Eurostat, 2016). This section will elaborate on why the Dutch government is having these problems by examining and discussing the three dilemmas. The Dutch government has agreed on the need for a transition from the current fossil-based energy system to a renewable based energy system. The challenges and associated coping strategies with making this energy transition happen in the Netherlands are documented in an agreement called the 'Energieakkoord'. This 'Energieakkoord' is an agreement between the Dutch government and forty organisations, including employers and employee organisations, nature and environmental organisations, civil organisations, and financial institutions. The main goal of this agreement is to strengthen the economic structure by making investments in our society with a focus on energy challenges of today and those of the future (S.E.R., 2013). This agreement should have ignited a new incentive for renewable energy projects to be developed. Despite the effort to successfully execute the agreement, in 2014, the Netherlands was still 8,5 percent removed from its national objective to reach 14 percent of renewable energy as part of all energy generated by 2020, which is less than the 16 percent objective (Eurostat, 2016).

<u>Tier of government dilemma</u>

In the Netherlands, all tiers of government can have a renewable energy policy, however regional policies overrule local, and national policies in turn overrule regional policies. Existing policies and laws can also overrule local policies and development plans. The tier of government dilemma becomes visible in the province of Friesland where so-called small wind turbines may only be replaced by wind turbines that are of the same height. Even though municipalities want to build new or replace old wind turbines, the coalition accord of the province of Friesland obstructs such developments due to protection of the landscape (Province of Friesland, 2015). In Groningen, a province next to Friesland, these smaller wind turbines are allowed and encouraged by the province and are a success with more than 50 being built in 2017 already. Different levels of government have their own energy objectives which compete with other policy objectives. Based on empirical findings from interviews with government officials, choices are made between meeting renewable energy objectives and other policy objectives. For example, the province of Friesland and Groningen both have the same dilemma with developing solar fields. Municipalities in both provinces want to develop such fields as far away from residential areas as possible while provincial policy terms state that, to protect cultural agricultural land, these solar fields need to be built near residential areas. This is also a norm-setting dilemma where choices must be made between different and often competing policy objectives.

The recent 2016 energy report (Ministry of Economic Affairs, 2016), states that a reversal in transport and generation of (fossil fueled) energy can only happen when new developments are integrated in and accepted by its surroundings (Ministry of Economic Affairs, 2016). However, in the Netherlands, the traditional top-down sectoral approach of the national energy policy doesn't seem to cope with land use conflicts of renewable energy developments, resulting in delayed and cancelled projects. The land needed for renewable energy sources isn't always available due to opposition towards these developments (Breukers, 2010) and existing land use plans (Ministry of Economic Affairs, 2016). Besides, as the Amsterdam harbour cases shows, even when there is land available and local support for development plans, higher level governments can still prevent development of renewable energy sources through extra-legal policies.

Mode of governance dilemma

The importance of an integral approach instead of a sectoral approach can be discussed through the ambitious, mainly private paid, project 'Wind op Land' as an example. This project intended to develop 3500 (MW) of wind energy scattered on land, is stalled because the impact on its surroundings weren't included in the cost-benefit analyses (CPB, 2016). The same happened with the IJsselmeer project which has been stalled because of the impact on surrounding land uses (Gemeente Súdwest-Fryslân, 2014). Due to local resistance, the government stopped the project for further research on this subject. For both these projects, problems of externalities and issuing land were enough to postpone the project after a sectoral approach during the first stages of development. The land needed to develop two to twenty-eight thousand wind turbines on land and sea, and more than one-hundred-thousand sun boilers and panels and other renewable energy sources is a lot more than the fossil-based energy system requires (PBL, 2013; Verbong & Loorbach, 2012). The energy transition can no longer be seen as a sectoral technical challenge.

As sustainable energy initiatives are left out of planning policies (section 3.2), their land claims are competing with already-existing interests (Runhaar et al., 2009). This top-down approach steering can be found in the Amsterdam harbour case where the regional government implements top-down policy to prevent local development. However, based on empirical findings of the interviews with government officials, smaller and local private parties are together developing more renewable energy plans and are accomplishing these plans without the major traditional private parties. As one government official said, "large private parties such as NUON, a large energy company in the Netherlands, do not have a large role in the development of wind turbines in our province". This suggests that new smaller parties also successfully invest in wind turbines.

Norm-setting dilemma and tier of government

Based on empirical findings from interviews with Dutch government officials and private actors, the norm-setting dilemma makes relations between different actors more complex, creating conflicts between governmental norms and ambitions. The subsidiarity principle within the Netherlands has left lower level governments responsible for policy that was traditionally a national government subject. Youth healthcare, the housing of refugees, and other policy subjects have increased the workload of municipalities. The responsibility for renewable energy developments is therefore seen as an issue for the long term and less politically important in comparison with other policy subjects. How does this norm-setting impact renewable energy sources developments? Norm-setting is the weighing of the spatial consequences of developing renewable energy sources against other functions and public interests like health, safety, defence, and water management. As such, difficulties of acquiring and assigning land suitable for renewable energy sources governments are visible in the Dutch energy transition.

This dilemma can be found in the development plans of the municipality of Amsterdam and private led initiatives and several municipalities in the province of Friesland. These initiatives gained high amounts of support in the region, however the provinces of Noord-Holland and Friesland have denied most of the building permits because of different objectives on preservation of landscapes (NOS, 2016). Both the Province of Friesland and Noord-Holland appointed certain areas for wind turbines to be build, to gain control over the sprawling, and at the same time protect certain historical landscape sights, which have social-cultural and economic worth (Wolsink, 2007). However, renewable energy development of nearby cities is needed to supply cities with enough energy (Barresi & Pultrone, 2013).

These examples of policy implementation and renewable energy development in the Netherlands raise questions about why land use conflicts aren't addressed well enough in (national) energy policy. In some cases lower governments do not have the means to effectively cope with these concerns. However, the examples also show that when lower governments do have the right means, higher governments can obstruct local development of renewable energy sources. The other two dilemmas, the sectoral mode of governance and norm-setting, are also found in the Dutch cases.

5 CONCLUSION

To overcome the dilemmas, a different approach is needed. In our analysis we found successes and failures of certain approaches and accompanying policies. In some cases, a certain policy approach can be useful to accomplish a project while in another case it will only obstruct the development of renewable energy sources. Existing literature about the spatial impact of the energy transition lacks the spatial perspective on how governments approach renewable energy developments. Increasing land use claims, created through development of renewable energy sources close to land users and owners, result increasingly in 'hard conflicts' between different land claims. Governments, such as the Netherlands, are failing to cope with these conflicts, putting pressure on meeting renewable energy objectives. The differentiation, fragmentation, and urgency addressed in the introduction shows that traditional land use planning cannot deal with all land use issues. This paper adds knowledge to the existing body of literature about land use conflicts, dilemmas of tier of government, mode of governance, and norm-setting, and identifies future research questions on these subjects.

Based on our empirical findings, we conclude that land use conflicts and the underlying dilemmas make development of renewable energy sources a complex issue. We have discussed the level of government, the mode of governance, and norm-setting. The way these dilemmas are intertwined with and mutually dependent on each other increases the complexity for governments to implement energy policy to meet renewable energy objectives. The interviews with government officials confirmed the existence of these dilemmas and that addressing only one of these will only partly solve the real problem. The dilemmas are substantiating why a gap between (inter)national decision-making and local implementation exists. Local governments aren't always capable of meeting (inter)national objectives and try to transfer their responsibility to the market. The issue is that the government is responsible for energy security and availability, while the market is more focused on the financial aspect of renewable energy developments. This mode of governance doesn't seem to be effective for coping with opposition and is also maintained because of the differences in norm-setting. The norm-setting dilemma asks for a long-term approach. Although governments are sensing the urgency to build renewable energy sources, the energy transition is a long-term challenge. Because of this long-term character, local governments tend to cope with more urgent issues and leave the implementation of renewable energy policy to the market.

Based on our analysis we conclude that differences exist in various tiers of government in the Netherlands and therefore a new way is needed to overcome land use conflicts. There are multiple problem owners that need different instruments to solve their problems. Who are these problem owners and what are their interests in the energy transition? Governments that apply one single instrument to change land use are likely to fail because of the number of actors and the limited ability to include the actors in the direct surroundings of owners that are affected by development plans. The local character of the energy transition asks for a more (but not exclusively) bottom-up integral decentralized approach to cope with or prevent hard conflicts created by new and existing land claims.

A solution to some of these issues can be found in land use management. The role of land use management in governing land use conflicts has been significant, even though it is less applied by solving local issues surrounding the development of renewable energy sources (Breukers, 2010; Verbong & Loorbach, 2012). An integral land use management approach is therefore relevant because of two important aspects. The first aspect is that thousands of wind turbines on land (and sea), solar panels, sun boilers, thermal systems, and so on, have to be built and need a certain amount of often privately-owned land to be developed. Secondly these developments have a major impact on their surroundings. This impact consists of noise, shade, sight-blocking, and so on and affect the lives of citizens and other stakeholders (rights) living nearby renewable energy developments. Both these aspects relate to how land is used. An integral approach concerns the internalization of externalities, and because land use conflicts are mainly about externalities created by certain land uses on other land uses, such an approach is assumed to be promising to introduce solutions for land use conflicts surrounding renewable energy developments. Now that we have added these insights to the existing body of literature, for future research we can ask: how can a land management approach include local interests, overcoming dilemmas, and successfully meet energy transition objectives?

REFERENCES

Barresi, A., & Pultrone, G. (2013). European strategies for smarter cities. *TeMA. Journal of Land Use, Mobility and Environment*, *6*(1), 61-72. doi:http://dx.doi.org/10.6092/1970-9870/1455

Boyle, G. (Ed.) (2004). *Renewable energy.* Oxford, UK: Oxford University Press. ISBN:9780199261789

Breukers, S. (2010). Local Social Acceptance Through Local Involvement: The Case of Wind-Power Implementation North Rhine–Westphalia. In P.A. Strachan, D. Toke and D. Lal (Eds.), *Wind Power and Power Politics. International Perspectives* (pp. 53-74). London, UK: Routledge.

Bridge, G., Bouzarovski, S., Bradshaw, M., & Eyre, N. (2013). Geographies of energy transition: Space, place and the low-carbon economy. *Energy Policy*, 53, 331-340. doi:https://doi.org/10.1016/j.enpol.2012.10.066

Netherlands Bureau for Economic Policy Analysis (CPB) (2016). *Uitstel project 'Wind op Land' beste optie* (In Dutch). Retrieved from https://www.cpb.nl/persbericht/3213544/uitstel-project-wind-op-land-beste-optie

Deppisch, S., & Dittmer, D. (2015). Urban Planning Dealing with Change and Infrastructure. *TeMA. Journal of Land Use, Mobility and Environment, 8*(2), 131-144. doi:http://dx.doi.org/10.6092/1970-9870/2982

Devine-Wright, P. (Ed.). (2014). *Renewable Energy and the Public: from NIMBY to Participation*. London, UK and Washington, USA: Earthscan.

Driessen, P. P., Dieperink, C., Laerhoven, F., Runhaar, H. A., & Vermeulen, W. J. (2012). Towards a conceptual framework for the study of shifts in modes of environmental governance–experiences from the Netherlands. *Environmental policy and governance*, *22*(3), 143-160. doi:https://doi.org/10.1002/eet.1580

Eurostat (2016). *Renewable energy in the EU Share of renewables in energy consumption in the EU rose further to 16% in 2014. Eurostat newsrelease*, 3(2016), 2.

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., ... & Helkowski, J. H. (2005). Global consequences of land use. *Science*, *309*(5734), 570-574. doi:https://doi.org/10.1126/science.1111772

Gemeente Súdwest-Fryslân (2014). *Uitstel keuze windmolens Ijsselmeer* (In Dutch). Retrieved from http://www.gemeentesudwestfryslan.nl/inwoners/nieuws-kernenbeleid_44405/item/uitstel-keuze-windmolens-ijsselmeer_55363.html

Grubler, A. (2012). Energy transitions research: Insights and cautionary tales. *Energy Policy*, *50*, 8-16. doi:https://doi.org/10.1016/j.enpol.2012.02.070

Healy, A., & Lenz, G. S. (2014). Substituting the End for the Whole: Why Voters Respond Primarily to the Election‐ Year Economy. *American Journal of Political Science*, *58*(1), 31-47. doi:https://doi.org/10.1111/ajps.12053

Krohn, S., & Damborg, S. (1999). On public attitudes towards wind power. *Renewable energy*, *16*(1-4), 954-960. doi:https://doi.org/10.1016/S0960-1481(98)00339-5

Larsson, S. (2014). *Law and Spatial Planning: Socio-Legal Perspectives on the Development of Wind Power and 3G Mobile Infrastructures in Sweden* (Doctora dissertation). Blekinge Institute of Technology, Karlskrona, Sweden.

Louise Barriball, K., & While, A. (1994). Collecting Data using a semi‐ structured interview: a discussion paper. *Journal of advanced nursing*, *19*(2), 328-335. doi:https://doi.org/10.1111/j.1365-2648.1994.tb01088.x

Ministry of Economic Affairs (2016). *Energierapport - transitie naar duurzaam* (Energy report – transition to sustainable (In Dutch). The Hague, The Netherlands.

Netherlands Environmental Assessment Agency (PBL) (2013). *Het Energieakkoord: wat gaat het betekenen? Inschatting van de gemaakte afspraken* (In Dutch). Retrieved from http://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2013-het-energieakkoord-wat-gaat-het-betekenen-1087_0.pdf

NOS (2016). *Amsterdam strijdt om extra windmolens* (In Dutch). Retrieved from http://nos.nl/nieuwsuur/artikel/2132567-amsterdam-strijdt-om-extra-windmolens.html

Papa, R., Gargiulo, C., & Zucaro, F. (2014). Climate Change and Energy Sustainability. Which Innovations in European Strategies and Plans. *TeMA. Journal of Land Use, Mobility and Environment, Special Issue INPUT 2014*. doi:http://dx.doi.org/10.6092/1970-9870/2554

Papa, R., Galderisi, A., Majello, V., Cristina, M., & Saretta, E. (2015). Smart and resilient cities. A systemic approach for developing cross-sectoral strategies in the face of climate change. *TeMA Journal of Land Use, Mobility and Environment*, *8*(1), 19-49. doi:http://dx.doi.org/10.6092/1970-9870/2883

Province of Friesland (2015). *Mei elkienen foar elkienen* (In Dutch dialect). Retrieved from https://www.fryslan.frl/document.php?m=16&fileid=958&f=6c517a3a37621ddae7297b98947b0b17&attachment=0

Runhaar, H. (2009). Putting SEA in context: A discourse perspective on how SEA contributes to decision-making. *Environmental Impact Assessment Review*, *29*(3), 200-209. doi:https://doi.org/10.1016/j.eiar.2008.09.003

Smil, V. (2010). *Energy transitions: history, requirements, prospects*. Santa Barbara, USA: ABC-CLIO.

The Social and Economic Council of the Netherlands (S.E.R.) (2013). *Energieakkoord voor duurzame groei* (In Dutch). Retrieved from http://www.energieakkoordser.nl/~/media/files/internet/publicaties/overige/2010_2019/2013/energieakkoordduurzame groei/energieakkoord-duurzame-groei.ashx

Upreti, B. R., & van der Horst, D. (2004). National renewable energy policy and local opposition in the UK: the failed development of a biomass electricity plant. *Biomass and bioenergy*, *26*(1), 61-69. doi:https://doi.org/10.1016/S0961-9534(03)00099-0

Verbong, G., & Geels, F. (2007). The ongoing energy transition: lessons from a sociotechnical, multi-level analysis of the Dutch electricity system (1960–2004). *Energy Policy*, 35(2), 1025–1037. doi:https://doi.org/10.1016/j.enpol.2006.02.010

Verbong, G., & Loorbach, D. (2012). *Governing the Energy Transition, Reality, Illusion or Necessity?* New York, USA: Routledge.

Wegener, M. (2012). Government or governance? The challenge of planning for sustainability in the Ruhr. In T. Hartmann and B. Needham (Eds.), *Planning by law and property rights reconsidered* (pp. 157–168). Farnham, UK: Ashgate.

Westerink, J., Kempenaar, A., van Lierop, M., Groot, S., van der Valk, A., & van den Brink, A. (2017). The participating government: Shifting boundaries in collaborative spatial planning of urban regions. *Environment and Planning C: Politics and Space*, *35*(1), 147-168. doi:https://doi.org/10.1177%2F0263774X16646770

Wolsink, M. (1996). Dutch wind power policy: stagnating implementation of renewables. *Energy policy*, *24*(12), 1079-1088. doi:https://doi.org/10.1016/S0301-4215(97)80002-5

Wolsink, M. (2000). Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support. *Renewable energy*, *21*(1), 49-64. doi:https://doi.org/10.1016/S0960-1481(99)00130-5

Wolsink, M. (2007). Planning of renewables schemes: Deliberative and fair decision-making on landscape issues instead of reproachful accusations of non-cooperation. *Energy policy*, 35(5), 2692-2704. doi:https://doi.org/10.1016/j.enpol.2006.12.002

Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy policy*, *35*(5), 2683-2691. doi:https://doi.org/10.1016/j.enpol.2006.12.001

AUTHOR'S PROFILE

Mark Koelman is a Master of Science at Department of Human Geography and Spatial Planning of Utrecht University.

Thomas Hartmann is Associate Professor at the Land Use Planning Group of Wageningen University & Research. Thomas Hartmann has a special expertise and research interest in (1) Planning theory, with a specialization in aspects of justice and ethics in the city; (2) Land policies and planning instruments; and (3) Land and water governance, with a focus on risk management of river floods. Thomas Hartmann is also the acting vice president of the international academic association on Planning, Law, and Property Rights.

Tejo Spit is a Full Professor in urban and regional planning at the Department of Human Geography and Planning (Utrecht University). He is also associated with the Land Use Planning Group at Wageningen University. His specialisms are: land policy, planning methodology, infrastructure planning and administrative aspects of spatial planning.

TeMA

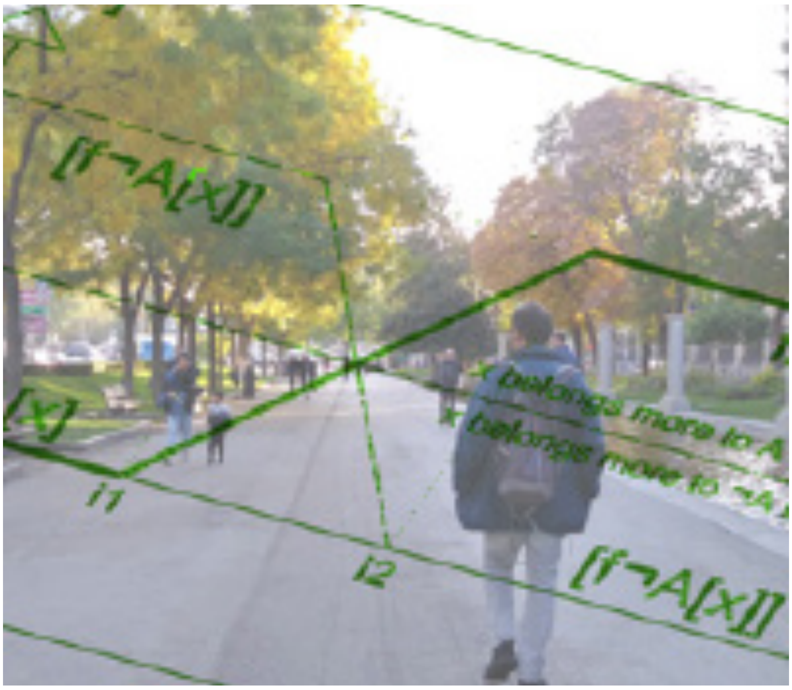
Journal of
Land Use, Mobility and Environment

TeMA 3 (2018) 285-303
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/5795

review paper received 4th June 2018, accepted 17th December 2018

www.tema.unina.it

How to cite item in APA format:
Alvira Baeza, R. (2018). A Methodology for Urban Sustainability Indicator Design. *Tema. Journal of Land Use, Mobility and Environment*, *11*(3), 285-303. doi:http://dx.doi.org/10.6092/1970-9870/5795



A METHODOLOGY FOR URBAN SUSTAINABILITY INDICATOR DESIGN

RICARDO ALVIRA BAEZA

Universidad de Murcia (Spain)
e-mail: ricardo.alvira@gmail.com
URL: https://www.um.es

ABSTRACT

In recent times we have witnessed proliferation of indicators and models for measuring sustainability. This reveals both the importance of the issue and the lack of common and shared scientific paradigm/ framework.
With the aim of advancing towards such common framework which enables quantitatively assessing the sustainability of our cities and societies, in this article it is explained a formal methodology for designing urban sustainability indicators based on Fuzzy Sets Theory. The interest of this methodology is threefold:

- Firstly, formal procedures enable testing, a most fundamental issue forgotten in many current proposals of sustainability indicators.
- Secondly, a formal procedure can become a common language allowing shared use of the indicators and facilitating their continuous improvement.
- And thirdly, fuzzy logic is widely used in computing and artificial intelligence, thus facilitating progressive automation of our sustainability monitoring models.

To help understand the procedure, the design of two indicators is reviewed, showing the applicability and easiness of the methodology.
Therefore, herein proposed methodology stands as an easy procedure, which generalization could allow us to increase the accuracy [testability] and shared used [efficiency] of our scientific research in sustainability as well as integrating it into artificial intelligence systems, increasing our capacity of successfully confronting current extremely high unsustainability of our society.

KEYWORDS:
Sustainability Measurement; Urban Sustainability; Indicator Design; Climate Change

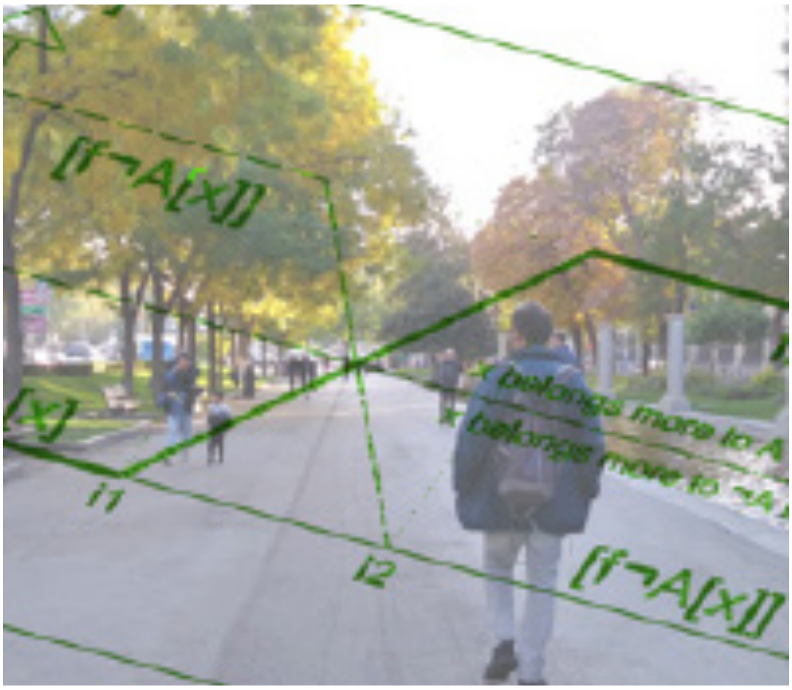
TeMA 有关土地使用、交通和环境的杂志

TeMA 3 (2018) 285-303
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/5795

review paper received 4th June 2018, accepted 17th December 2018

www.tema.unina.it

How to cite item in APA format:
Alvira Baeza, R. (2018). A Methodology for Urban Sustainability Indicator Design. *Tema. Journal of Land Use, Mobility and Environment*, *11*(3), 285-303. doi:http://dx.doi.org/10.6092/1970-9870/5795



城市可持续性指标设计方法论

RICARDO ALVIRA BAEZA

Universidad de Murcia (Spain)
e-mail: ricardo.alvira@gmail.com
URL: https://www.um.es

摘要

最近，我们目睹了衡量可持续性的指标和模式激增。这既表明了这一问题的重要性，也表明缺乏共同和共享的科学范式/框架。
为了实现城市和社会可持续性定量评估的共同框架，本文阐述了一种基于模糊集理论的城市可持续性指标设计的正规方法。该方法的优点有三方面：
- 第一，正规程序能够允许进行测试，这是目前许多可持续性指标提案中常容易忘记的一个最根本的问题。
- 第二，正规程序可以成为一种共同的语言，允许共享使用指标并促进其不断改进。
- 第三，模糊逻辑在计算领域和人工智能中得到了广泛的应用，从而促进了可持续发展监测模型的逐步自动化。

为了帮助明白该程序，对两个指标的设计进行了回顾，并说明了该方法的适用性和易用性。
因此，本文所提议的方法是一个简单的程序，其泛化性可以使我们提高可持续性科学研究的准确性[可测试性]和共享使用[效率]，并将其整合到人工智能系统中，从而提高我们成功应对当今社会极高不可持续性的能力。

关键词：
可持续性度量；城市可持续性；指标设计；气候变化

1 INTRODUCTION

Our current concern in relation to the increasing unsustainability of our society and development model, in conjunction with the increasing importance of cities to define such unsustainability, has taken to an everyday increasing number of different proposals for modeling and measuring urban sustainability. These proposals take the form of sustainability indexes or sustainability indicators dashboards, and their importance is that sustainability measurement stands as prerequisite for being able to increase it.

This constant increase of indicators and indexes for quantitatively assessing sustainability can be understood as something positive, as it increases the number of available tools for helping us moving towards sustainability. But it also conceals two negative issues:

- the lack of a common framework for sustainability measurement[1] leads to every new proposal defining its own framework, which often cannot be linked to most existing knowledge. This implies great effort and forgets two important issues: connection to previous proposals makes scientific research more efficient and usually enables its easier testing, the last being an often forgotten yet fundamental issue for science: an untested proposal is unscientific by definition;
- contradiction between statements made by different models generates lack of consensus greatly hindering making the required decisions for advancing towards sustainability. Most of these decisions are collective decisions; i.e., decisions that need to be made by consensus among many agents with different preferences/interests. Which model should we use then if different models suggest different courses of action that imply different utility for different agents?

Advancing towards shared/consensual knowledge in Sustainability currently stands as prerequisite for advancing towards Sustainability. With this goal, in this article a methodology for sustainability indicator design is explained that allows us to understand what these indicators should measure and how, aiming to set a common framework that enables their shared used by the scientific community.

To define this framework, a review of Sustainability conceptualization is undertaken from the two approaches to *logic* from Set or Class Theory[2]:

- Classic Set Theory or Boolean Logic (Boole, 1854; Hacking, 1995) allows us to conceptualize the class of sustainable Cities [S] as opposed or complement to that of Unsustainable Cities [¬S];
- Fuzzy Sets Theory or Fuzzy Logic (Zadeh, 1965) allows us to conceptualize the sustainability degree of a city as its Grade of membership to the set or class of sustainable cities [S].

The second approach is better fitted to our objectives; therefore, we build the methodology for designing the indicators on Fuzzy Logic/Fuzzy Sets Theory. For greater clarity, two urban indicators are reviewed using herein proposed methodology. Prior to the review, it is convenient to state two easy definitions of sustainable city built on two perspectives:

- from a probabilistic perspective, a sustainable city is that maximizing its probability of indefinitely enduring;
- from an optimality perspective, a sustainable city is that maximizing the degree to which it is in its optimal state[3].

Let us start by reviewing the conceptualization of sustainability according to Classical Sets Theory.

[1] Beware by common framework we do not refer to a unique context-independent model to be used anywhere around the world, but to the logical framework underlying the models. Different contexts may imply the relevant variables and indicators for sustainability (their sustainability thresholds) are different.

[2] There is a difference between a set and a class (i.e., a set is a class that belongs to another class) yet for the present work both terms are considered to be synonym and equivalent to class.

[3] Although this definition is somewhat redundant, it could be more briefly stated as "a city which is in its optimal state" (Alvira, 2017), it help us to easier understand herein explained approach.

2 CLASSIC SET THEORY OR BOOLEAN LOGIC: SUSTAINABILITY AND UNSUSTAINABILITY AS COMPLEMENTARY SETS[4]

Classic Set Theory *groups* objects into different classes by assigning each object to each set or class by a binary membership function. Given an object x and a set or class A, a value *zero* means that x does not belong to A (therefore, it belongs to ¬A), and a value *one* means that x belongs to A.

$$f_A[x] = \begin{matrix} 0 \; if \; x \notin a \\ 1 \; if \; x \in a \end{matrix}$$

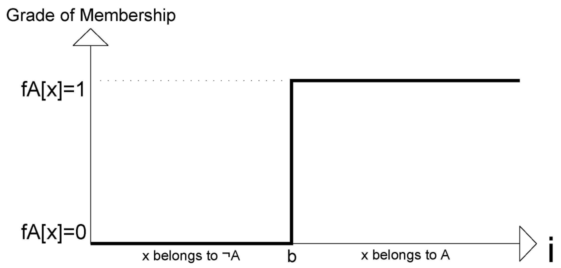


Fig.1 Binary Membership function, where b is the value of some variabl i describing x, which separates null from full membership of x to class A

Membership as conceptualized by Classic Set theory or Boolean logic implies therefore the idea of mutually exclusive classes or concepts that can be defined as those whose intersection is empty and their union provides the universe of discourse:

$$A \cup \neg A = \Omega \; [R] \tag{1}$$

$$A \cap \neg A = \emptyset \tag{2}$$

This last statement expresses the *Duality Law* (Boole, 1854) as a condition for the interpretability of logical functions, which is a formalization of *Aristotle's Non-contradiction Principle*. It is possible building a first conceptualization of Urban Sustainability on above statement. If we consider the set that includes all cities and we divide it into two subsets:

- we designate S or *Sustainability* the set composed by all sustainable cities;
- we designate ¬S or *Unsustainability* the set composed by all non-sustainable cities.

Following above criteria the union of S and ¬S (sustainable and non-sustainable cities) must contain all cities, while their intersection must be empty:

$$\begin{gathered} S \cup \neg S = 'Cities' = \Omega \; [R] \\ S \cap \neg S = \emptyset \end{gathered} \tag{3}$$

We can represent it as:

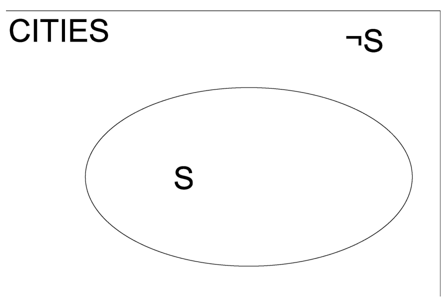


Fig.2 Sustainability [S] and Unsustainability [¬S] sets are complement in the universe Cities

[4] This chapter and the following are a reformulation and update of Alvira (2018 [2013])

The drawback of this approach from Boolean logic is that though being theoretically correct (in the long run a binary approach is the only possible; a city endures or not) it does not fit above proposed definitions:

- a city may have a *continuum* range of probabilities to indefinitely endure;
- a city may be *closer or further* from its optimal state.

Being able to characterize cities consistently with above two definitions requires confronting it from Fuzzy Sets Theory or Fuzzy Logic.

3 FUZZY SET THEORY AND LOGIC: SUSTAINABILITY DEGREE AS GRADE OF MEMBERSHIP

A Fuzzy set is a class characterized by a membership function $f_A[x]$ that associates to each element x of a universe X a number in the range [0,1]; i.e., a class with a continuum of grades of membership[5]:

$$a = \{[x, f_A[x]] | x \in X\}$$
$$f_A[x] \rightarrow [0,1] \tag{4}$$

Fuzzy Logic is a development of Boolean logic to confront intermediate situations that allow *grades of membership and exclusion*; widening the applicability of the Non-contradiction Principle.

While classical logic can only be used with mutually exclusive concepts (i.e., concepts that must be true or false applied to an object) *fuzzy logic can be also used with any concept or quality that can be partly true. Any object can be characterized by the degree it possess some quality and the non-quality*; i.e., by the degree it belongs – its grade of membership – to a class and to its opposite or complement.

A fuzzy membership function can take any value in the range [0-1], which allows us to measure urban sustainability and unsustainability in terms of *sustainability / unsustainability degree:*

- the *Sustainability Degree* of a city I at a moment T is its *grade of membership* to S and we designate it as $S_T[I]$

$$S_T[I] = f_s[I] \tag{5}$$

- the *Unsustainability Degree* of a city I at a moment T is its *grade of membership* to ¬S and we designate it as $\neg S_T[I]$

$$\neg S_T[I] = f_{\neg s}[I] \tag{6}$$

Therefore, the Sustainability Degree of a city I at any moment T has a value in the range 0 and 1, and we can assign different meaning to said value:

- $S_T[I] = 1$ the membership to *Sustainability* class is complete, and therefore the grade of membership to *Unsustainability* class is zero;
- $0 < S_T[I] < 1$ the city has a grade of membership to *Sustainability* class, complementary to its grade of membership to *Unsustainability* class;
- $S_T[I] = 0$ the grade of membership to *Sustainability* class is zero, and therefore the membership to *Unsustainability* class is complete.

We see Fuzzy Sets Theory allows us to characterize urban sustainability consistently with above definitions. Let us then review some properties of the fuzzy sets which are useful for understanding herein proposed methodology.

[5] This definition and the majority that follow are from Zadeh (1965).

3.1 PROPERTIES OF FUZZY SETS

Fuzzy sets have four properties interesting for our proposal:

- Complementary set or complement, the complement of a set A is denoted as ¬A and defined as:

$$f_A[x] = 1 - f_{\neg A}[x] \tag{7}$$

- Containment, if A is contained in B its membership function $f_A[x]$ is smaller than B $f_B[x]$ for any x:

$$\forall x \in X: A \subset B \rightarrow f_A[x] \leq f_B[x] \tag{8}$$

This property has great relevance for urban sustainability analysis because it imposes an important condition to the Sustainability Degree of a city; it is equal or lower than the Sustainability Degree of the environment that contains it.

- Union, the union of two fuzzy sets A and B with respective membership functions $f_A[x]$ y $f_B[x]$ is a fuzzy set C, which membership function is $f_C[x]$

$$C = A \cup B \rightarrow \forall x \in X: f_C[x] = max\left[f_A[x] \cap f_B[x]\right] \tag{9}$$

- Intersection, the intersection of two fuzzy sets A and B with respective membership functions $f_A[x]$ y $f_B[x]$ is a fuzzy set C which membership function is $f_C[x]$:

$$C = A \cap B \rightarrow \forall x \in X: f_c[x] = min\left[f_A[x] \cap f_B[x]\right] \tag{10}$$

To summarize, above formulas allow us to relate membership functions to Sustainability and Unsustainability classes as:

$$f_S[I] + f_{\neg S}[I] = 1 \tag{11}$$

Therefore, the *Sustainability Degree* and the *Unsustainability Degree* of a city are linked by the equation:

$$S_T[I] = 1 - \neg S_T[I] \tag{12}$$

Above equation means that any *lack of complete Sustainability necessarily implies some unsustainability degree*, and $S_T[I] = 0{,}5$ becomes a *limiting* value that separates the cities that are more *sustainable* than *unsustainable* ($S_T[I] > 0{,}5$) from the cities that are more *unsustainable* than *sustainable* ($S_T[I] < 0{,}5$).

$$S_T[I] > 0{,}5 \leftrightarrow S_T[I] > \neg S_T[I] \tag{13}$$

$$S_T[I] < 0{,}5 \leftrightarrow S_T[I] < \neg S_T[I] \tag{14}$$

After reviewing these basic properties of fuzzy sets, we review below a useful tool for working with fuzzy membership functions: their graphic representation.

3.2 GRAPHIC REPRESENTATION OF MEMBERSHIP FUNCTIONS

Graphic representation of membership functions is always advisable since it provides a lot of information that is not always easily noticeable in the mathematical formulations. Additionally, it allows us to understand some important issues: the first is that if we consider a membership function on a continuous variable i that defines the grade of membership of an element x to a class A, graphical representation allows us to see the existence of two especially relevant values or points:

- A value i_1 so that if $I \leq i_1$ then x membership to class A is zero (and therefore, its membership to class ¬A is complete)

$$\exists i_1: i \leq i_1 \leftrightarrow f_A[x] = 0 \wedge f_{\neg A}[x] = 1 \tag{15}$$

- A value i_2 so that if $I \geq i_2$ then x membership to class A is complete (and therefore, its membership to class ¬A is zero)

$$\exists i_2: i \geq i_2 \leftrightarrow f_A[x] = 1 \wedge f_{\neg A}[x] = 0 \tag{16}$$

Both values are fundamental for the design of an urban sustainability indicator in relation to some variable information i of a city I. *We designate $\boldsymbol{i_1}$ as its unsustainability limit or threshold, and i_2 as its sustainability limit or goal.*

$$\boldsymbol{f_A[x] = max\left[min\left[\frac{i - i_1}{i_2 - i_1}, 1\right], 0\right]}$$

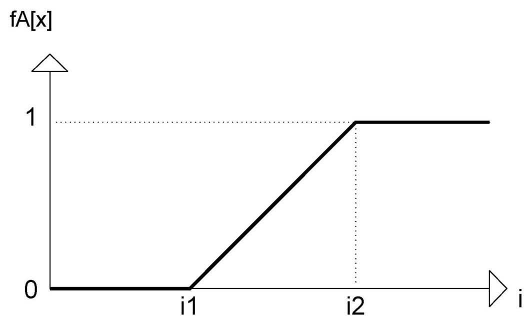


Fig.3 Linear fuzzy membership function, i_1 is the value of i for which x membership to A becomes 0 and i_2 is the value of i for which x membership to A becomes complete

The necessary existence of these limits allows us to define a *relevant variable for urban sustainability* as a variable for which at least one unsustainability limit and one sustainability limit exist [they may be or may not be known]. As consequence, the sustainability limits of a variable are the delimiting values for the range of the variable i that produces fuzzy membership of I to S; i.e., the extreme values of the range which imply either complete membership of the city to S or to ¬S classes.

The second interesting issue of graphical representation is that it allows synthesizing the membership to a set and to its complement in one graphic:

$$\boldsymbol{f_A[x] = max\left[min\left[\frac{i - i_1}{i_2 - i_1}, 1\right], 0\right]}$$

$$\boldsymbol{f_{\neg A}[x] = 1 - f_A[x]}$$

$$\boldsymbol{f_{\neg A}[x] = max\left[min\left[1 - \frac{i - i_1}{i_2 - i_1}, 1\right], 0\right]}$$

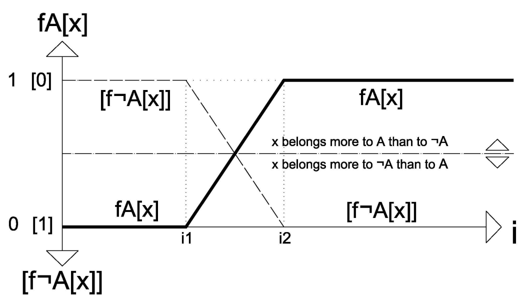


Fig.4 Membership function of an element x to A and ¬*A* sets. There is a horizontal symmetry at f_A[x]= 0.5, which separates the values of i for which x belongs more to A of the values of i for which x belongs more to ¬*A*

And this property implies that membership to S and ¬S can be represented in the same graphic, but even if we represent only one of them (it is usually more interesting representing membership to S) then membership to the complement (i.e., membership to ¬S) is easily obtained.

4 DESIGNING SUSTAINABILITY INDICATORS: SUSTAINABILITY DEGREE OF A CITY IN RELATION TO THE VARIABLES THAT DESCRIBE IT

We have conceptualized the sustainability degree of a city I as its grade of membership to class S, but it is necessary to state that it depends on many different variables and relationships between variables and usually we are not able to calculate it with only one formulation. Thus, we approach the modelization progressively. We analyze the concept *Sustainable* to detect the concepts or qualities S_i that we expect in a sustainable city (i.e., that we expect to be *true* when referred to a *sustainable city)* and we review the information that defines the truth value[6] of these concepts or *propositions* when referred to the city.

For instance; we usually state that a sustainable city must have *high employment levels*; *accessible public transport service*; *adequate provision of green areas*, etc... And indicators measure the degree of truth of those propositions referred to the city (i.e., the degree of truth of the statements 'city I has *high* employment levels'; 'city I has accessible transport',...); which can be modeled as *membership functions* to those different classes implied by said propositions (to the class of the cities with high employment levels, to the class of the cities with accessible public transport service…).

Urban sustainability indicators are equivalent to membership functions of the city to the different classes S_i *contained* in class S for each possible range of different relevant variables i, and its maximum and minimum values have the following meanings:

- $S[I_i] = 0$ means *null membership* to S_i (and complete membership to $\neg S_i$); the city does not have at all a quality expected in a *Sustainable City*;
- $S[I_i] = 1$ means *complete membership* to S_i (and null membership to $\neg S_i$); the quality expected in a *Sustainable City* is completely present in the city.

Therefore, the unsustainability/sustainability *limits* of the relevant variables for each class S_i are the values i_1 and i_2 at which null or complete membership to classes S_i and $\neg S_i$ are reached. Both values are especially relevant for indicators formulation, which we review below.

4.1 SUSTAINABILITY AND UNSUSTAINABILITY LIMITS

A variable i is relevant for the sustainability of a system I if and only if different values of the variable can imply a variation on both city sustainability and unsustainability, being the sustainability and unsustainability limits, those values of the variable for which the city reaches its maximum possible membership to classes S and $\neg S$[7].

These limits may or may not be known, but in general, the formalization of indicators can only be done if we are able to establish (even if approximately) their value.

In their more *simple* form, the limits are two parameters that divide in three different zones the impact on the *Grade of membership* of a city I to any class S_i implied in S, for the range of possible values of i:

- the first is value of i for which I reaches null membership to S_i which we designate as *Unsustainability limit or threshold;*
- the second is value of i for which I reaches complete membership to S_i which we have designated as *Sustainability limit or goal*.

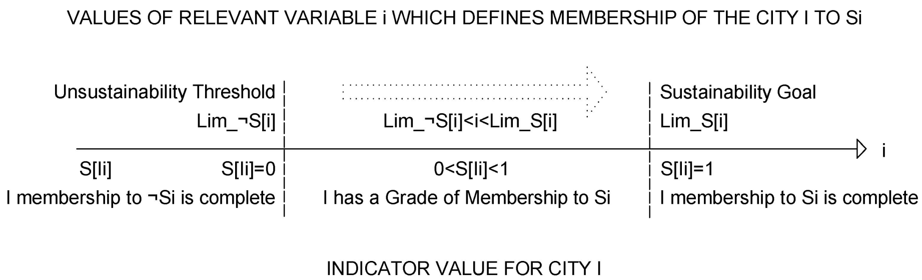


Fig.5 Relation between i values, thresholds and sustainability degree

---

6 The concept of Truth Value (Fuzzy Logic) is equivalent to the concept of Grade of Membership (Fuzzy Sets Theory).

7 The majority of relevant variables do not imply complete membership of the city to classes S and $\neg S$, but their complete membership to classes Si and $\neg$Si. Therefore the worst value of the variable does not indicate complete membership to $\neg S$, but the maximum membership to $\neg S$ such variable can imply. Also, the optimal value of the variable does not imply complete membership to S but the maximum membership to S said variable can imply.

Additionally, there are some important issues that need to be highlighted regarding the limits:

- they can be *exact* values but also *ranges of values* or even *dynamic values*[8]: the *state* of the system may modify the value of the limits and any *change* in the system–environment (including evolutionary processes) may change the limits;
- containment property implies that sustainability degree of any city is always equal or lower than that of its environment; which may impose *additional limits;*
- for some variables urban sustainability may imply *more than two limits;*
- *different contexts* may imply *different limits.*

4.2 FORMULATION OF SUSTAINABILITY INDICATORS FOR DIFFERENT TYPES OF VARIABLES

We have thus arrived to a conceptualization of a sustainability indicator as a membership function of a city I to a subclass S_i (partly) contained in class S regarding the possible values of some relevant variable information 'i'. And 'i' sustainability/unsustainability limits are fundamental for indicator formulation. Though there are many different possible formulations (linear, quadratic, logarithmic ...), in most cases, a linear function can sufficiently accurately model membership[9]. These linear functions can be formalized building on a four limits (two sustainability and two unsustainability limits) formulation:

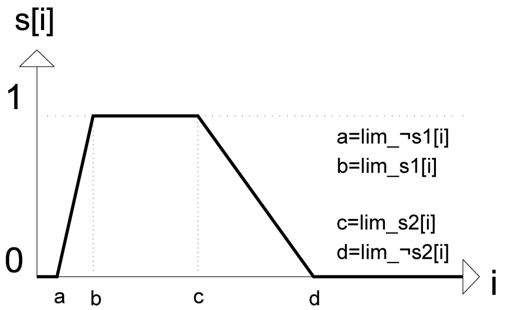
Indicator Formalization

$$\boldsymbol{s[i] = max\left[min\left[\frac{i-a}{b-a}; 1; \frac{d-i}{d-c}\right], 0\right]}$$

Thus:

$$\boldsymbol{S[I_i] = max\left[min\left[\frac{i - \underset{\neg s1}{lim}[I_i]}{\underset{s1}{lim}[I_i] - \underset{\neg s1}{lim}[I_i]}; 1; \frac{\underset{\neg s2}{lim}[I_i] - i}{\underset{\neg s2}{lim}[I_i] - \underset{s2}{lim}[I_i]}\right]; 0\right]}$$

Graphic Representation



Source: own elaboration using the following codes:

1) $S[I_i]$ _ Value of the sustainability indicator I_i for a system I
2) i_ value of the relevant variable (it can be an aggregation of variables)
3) $Lim_{\neg s1}[Ii]$_unsustainability threshold 1 for the system I related to variable i.
4) $Lim_{\neg s2}[Ii]$_ unsustainability threshold 2 for the system I related to variable i.
5) $Lim_{s1}[Ii]$_ sustainability limit or goal 1 for the system I related to variable i.
6) $Lim_{s2}[Ii]$_ sustainability limit or goal 2 for the system I related to variable i.

Tab.1 Membership Function and Graphic Representation of a four limits variable i

Starting from above function, many different types of indicators can be built; using two or three limits; substituting some or all linear functions by non- linear functions (Alvira, 2017a, 2017b, 2018). Since our aim in this article is to explain how this approach can be used to easily design sustainability indicators, instead of an extensive review of possible functions, we focus in reviewing formulation of two indicators using herein explained methodology.

4.3 EXAMPLES OF INDICATORS DESIGNED USING THE PROPOSED APPROACH

To better understand the proposed methodology, below two indicators are explained whose formulation implies different level of difficulty:

[8] For an explanation related to the limits of global ecosystem 'Earth' refer to Steffen et al. (2015) who suggest that if certain variables of a system get close to their unsustainability thresholds, the sustainable range of values for other relevant variables changes.

[9] In my opinion, unless an appreciable accuracy increase is achieved, it is not convenient to use more complicated functions, since it may hinder the comprehension of indicators and as consequence their shared use.

- firstly, we review the formalization of an indicator to assess the *optimality of the Green Areas Provision of a city*. It is an easy formulation to assess an issue about which there is little controversy at present;
- Secondly, we review the formalization of an indicator to assess the degree to which *Population Density* places an urban area between its optimal and worst possible states. It is necessary to use a somewhat more complex formulation (it requires four limits), and it is also necessary to estimate two unsustainability thresholds since we find scarce or no proposals.

Let us review these indicators[10].

Indicator to assess the sustainability of green areas provision [GA]

Sources and related indicators:

- Hernández Aja et al., 1997;
- AEUB, 2010. Indicator 25. Green Areas Provision per inhabitant;
- JSBC, 2011. Indicator 2.1.2. Adequate provision of parks and open spaces;
- MFOM, 2012. Indicators EVB.05.23 & EVB.05.26. Green Areas provision (New Developments & Existing Urban Areas);
- Alvira, 2017a. Indicator Q3.1. Green Areas Provision and Functionality.

Indicator description, sustainability limits and calculation.

It is a relatively easy to formulate indicator, for an issue on which there is enough agreement among experts: *what is the per capita surface of green areas that approaches a city to its optimal state.* There is wide agreement on the importance of urban green areas to define the quality of life of the population and urban sustainability[11], which is sustained on several perspectives:

- their use as a leisure, walking and sports space (AEUB, 2010; MFOM, 2012);
- their nature of 'social relation' space accessible to the entire population, which makes them spaces that promote social cohesion (Hernandez Aja et al., 1997; Higueras, 2009);
- they can be designed as 'green infrastructure', providing increased climate change adaptation (Beauchamp & Adamowski, 2013; Salata & Yiannakou, 2016; TCPA/The Wildlife Trusts, 2012; Zucaro & Morosini, 2018);
- they have psychological benefits by enabling people's contact with nature (Prescott-Allen, 2001).

There is also high agreement that the optimal provision of green areas is between 10 and 15 sq.m per resident/inhabitant, finding more or less compatible proposals from different authors:

- Hernández Aja et al. (1997) proposes different provision ratios for different types of urban fabric and green areas. At the overall city level the author proposes: proximity Parks [several types and surfaces] = 8 sq.m/inhabitant; city Scale Parks [Urban Parks]: 5 sq.m/inhabitant; city total provision: 13 sq.m/inhabitant.
- JSBC (2011) proposes an *acceptable* value of Green Areas provision of 7 sq.m/inhabitant and an optimal value of 13 sq.m/inhabitant;
- WHO (quoted by several authors) suggests between 10 y 15 sq.m/inhabitant;
- AEUB (2010) proposes a 10 sq.m/inhabitant minimum and a desirable goal of 15 sq.m/inhabitant;
- MFOM (2012) proposes between 10 and 12 sq.m/inhabitant of Green Areas for both new urban developments and as overall city wide provision. However, for urban areas within existing cities the authors suggest a 15 sq.m/inhabitant optimum provision.

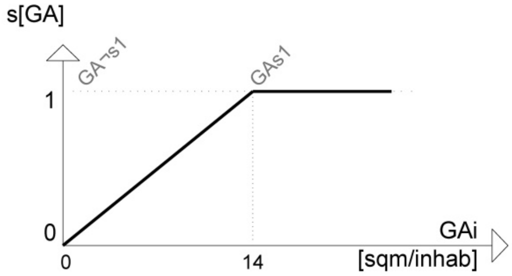
[10] Noteworthy, the indicators we review below are proposed for neighborhood type areas in developed countries cities. Other contexts could require different designs.

[11] "Green spaces are considered by the World Health Organization [WHO] 'essential' spaces for the benefits they bring in the physical and emotional well-being of people and for helping to mitigate the urban deterioration of the city, making it more livable and healthy' (AEUB, 2010)

We observe high similarity in the proposals, with a 13-15 sq.m/inhabitant range as optimum value (slightly lower values are only proposed in central areas of the city where clogging prevents reaching higher values), being possible to adopt for the indicator the middle value of said range: 14 sq.m/inhabitant.
Therefore, the two sustainability/unsustainability limits for the indicator are:

- sustainability goal GA_{s1}: 14 sq.m/inhabitant;
- unsustainability threshold GA_{is1}: 0 sq.m/inhabitant.

The graph and formula of the sustainability function are:

Graphic Representation	Indicator Formalization
	$s[GA] = \max\left[\min\left[\frac{GA_i - GA_{\neg s1}}{GA_{s1} - GA_{\neg s1}}; 1\right]; 0\right]$ Being: GA_ Green Areas provision Indicator; GA_i_ Green Areas provision in the assessed Area GA_{s1}_ Sustainability goal in Green Areas $GA_{\neg s1}$_Unsustainability threshold in Green Areas provision.

Tab. 2 Indicator for measuring the sustainability of Green Areas Provision

Since the unsustainability limit $GA_{\neg s1}$ is 0 sq.m/inhabitant; the sustainability limit GA_{s1} is 14 sq.m/inhabitant, and the relevant variable GA_i (Green Area sq.m per inhabitant) cannot have a lower value than 0, it is possible to simplify above function as:

$$s[GA] = \min\left[\frac{GA_i}{14}; 1\right] \quad (1)$$

This function is similar to many of the usual indicator formulations, which allows us to understand why it is sometimes possible to *intuitively* confront indicators design achieving coherent results[12].

<u>Further comments</u>

It is worth highlighting that as important as assessing the per capita surface of Green Areas are some issues which have not been included in the indicator to avoid complicating the explanation:
The first issue is *Green Areas quality/functionality* (WHO, 2016) which covers aspects such as: the percentage of landscaped area and type of landscaping, equipment, lighting, perceived and real safety, acceptable noise levels (especially in small surface GA). Some proposals to model it are:

- AEUB (2010), which proposes criteria differentiating two scales: neighborhood spaces: it suffices that 50% of the surface is permeable; urban parks: it is necessary to assess their Functionality, which is linked to a series of aspects that require individual modeling, and subsequent joint assessment[13];
- WHO (2016) suggests using the *Normalised Difference Vegetation Index* [NDVI], which it describes as 'an indicator of the degree to which an area is *green*'.

The second issue is *Green Areas accessibility*. In order to assess it several authors have proposed greater distances are acceptable the lower the expected frequency of use, setting thus different optimal distances according to green areas dimension/nature. For example, MFOM (2012) proposes the following maximum

[12] However, later we review another more difficult indicator which cannot be *intuitively* designed, supporting the interest of herein proposed methodology.

[13] AEUB (2010), Indicator 28. Index of functionality of Urban Parks [Surface > 1Ha]. Although the goal of the indicator is assessing biodiversity, evaluated aspects are closely related to the design quality of the green areas. Positive aspects in the valuation of the parks are: Tree coverage in percentage; Shrub Coverage in percentage; Lawn coverage in percentage; Water coverage in percentage; Number of large trees; Number of trees of average size; Number of trees of small size; Diversity of tree and shrub species. Negative aspects in the valuation of the parks are: Artificial Surface in percentage and Distance to natural habitats.

distances from green areas to expected users: green areas up to 500 sq.m maximum distance 200 m; green areas up to 5,000 sq.m maximum distance 750 m; green areas up to 1 Ha maximum distance 2 km; green areas up to 10 Ha maximum distance 4 km. And the third issue is that the overall layout of green areas throughout the city should use their high capability for *climate change adaptation*. Green areas distribution should not only take into account human accessibility and biodiversity connection, but also maximizing heat island mitigation, flooding prevention and optimizing water management (Galderisi, 2014; Zucaro & Morosini, 2018)[14].

Indicator to assess the sustainability of population density

Source and related indicators:

- Jacobs, 1961;
- AEUB, 2010. Indicador 01. Population Density;
- MFOM, 2012. Existing fabrics. Indicator 01. Population Density;
- Alvira, 2017a. Indicador Q1.1. Population Density;
- USGBC, 2018. Compact Development.

Indicator description, sustainability limits and calculation

It is a somewhat more complicated indicator to formulate. Experts agree cities are unsustainable when their population density is very low, but also that they are unsustainable when their population density is very high. Thus, there is an intermediate range of density values which are the optimal/most sustainable states of urban areas (Fariña Tojo & Naredo, 2010; Güneralp et al., 2017; MFOM, 2012; Jacobs, 1961).

The characterization of such states requires using a formulation that incorporates four sustainability limits (two sustainability and two unsustainability limits). However, we find few proposals regarding which population density values most approach cities to their worst possible states, so deeper review is necessary in order to establish these values. For clarity, we first review which limits have been proposed as optimal population density situations. Most consistent proposals have been made by two authors: Jacobs (1961) reviewed the density parameters of several *high vitality and diversity neighborhoods* in US cities, finding they located in an average range of 90 and 185 housing/ha[15], usually considered as *high values*. If we assume an average occupation of 2.5 persons/housing, we obtain an optimum density range between 225 and 463 inhab / Ha[16]. From her study, Jacobs suggested that excessively low or high densities are negative for cities and their inhabitants, i.e., that *there is an optimum range of densities to achieve attractive environments, with vitality and diversity. Agencia de Ecología Urbana de Barcelona* (AEUB, 2010), broadened the previous approach, by relating the range of optimal densities to complementary issues:

- *very low densities* imply a dispersed city model that requires consuming a lot of resources[17] and makes contact and shared use of the city difficult (public facilities, public transport,...);

[14] While the resilience/sustainability of the city could be further increased by incorporating urban orchards into Green Areas (Bianconi et al., 2018), this should be assessed using other indicators which assess membership to other classes such as biocapacity use or social relation spaces provision.

[15] Average values of the lower and upper limits for New York, Boston, Philadelphia and San Francisco neighborhoods that Jacobs (1961) considers as having *high vitality and diversity*. Building on her review, Jacobs stated that the prevailing paradigm in the USA that linked high urban quality to urban sprawl was wrong.

[16] Jacobs (1961) suggested a minimum value of 100 housing/acre (approx. 250 housing/Ha) of net density, but she indicated that a density value may had different meanings in different environments. Thus, she suggested that the central areas of the cities that have been conformed over time, have greater age of buildings and a greater variety of typologies and uses, admit higher densities than residential areas built in reduced time intervals, which present great homogeneity. In this last case, high density may imply conflicts and uprooting.

[17] Moore (2011) finds direct relationship between density and urban metabolism; an increase in density of 40 people/sq.km implies a reduction of approximately 0.06 hag in the per capita ecological footprint of the urban area.

- *very high densities* imply excessive congestion, and can lead to indirect consumption increase[18] in the form of greater demand for travel or second residence (MMA, 2007).

AEUB (2010) suggested an optimal density range of 220-350 inhab/Ha. Subsequently, the authors somewhat extended the optimum density range to 200-400 inhab/Ha (MFOM, 2012)[19].

There is some similarity among the three ranges of values, the range 220-350 inhab/Ha (AEUB, 2010) standing as acceptable *sustainability limits* for a varied range of urban environments.

On the contrary, we have not found proposals to establish *unsustainability thresholds*, so a review from several approaches is undertaken below: the first approach is based on the comparison of the two optimal ranges proposed by AEUB (AEUB, 2010; MFOM, 2012). Assuming the range 220-350 inhab/Ha (AEUB, 2010) as *optimal range*, and values 200 and 400 inhab/Ha (MFOM, 2012) as *excellent values*, the later values should imply equal variation in the indicator value. Assuming then the minimum possible value (i.e, zero) as unsustainability threshold $DP_{\neg s1}$, then $DP_{\neg s2}$ can be calculated by means of proportionality rules:

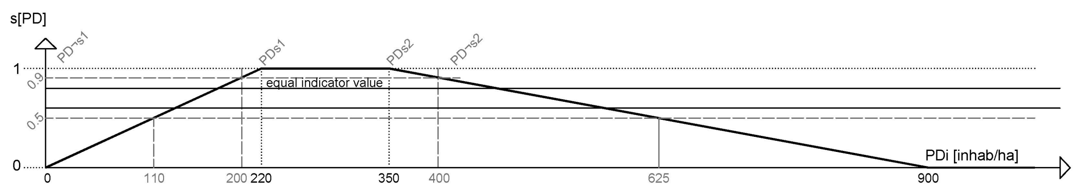


Fig.6 Unsustainability thresholds estimated by proportionality rules

Assuming 0 inhab/Ha as unsustainability threshold $DP_{\neg s1}$ and a linear function then 200 inhab/Ha provide value 0.9 for the indicator. Assigning the same indicator value to 400 inhab/Ha, 900 inhab/Ha value is obtained as unsustainability threshold $DP_{\neg s2}$.

The second approach is building on the concept of *ecological carrying capacity*. A reduced population density implies greater soil consumption to sustain the same population, reducing the area of bio-productive territory available to sustain said population. In Alvira (2017a) the available territory for urbanization in Spain is measured according to Ecological Footprint criteria, obtaining a maximum of 0.0715 hag-eq (447 sq.m) per capita assuming the current population is equally distributed and the available territory is used at 100% for residential use. This figure implies 22.4 inhab/Ha density. Applying maximum unsustainability criteria stated in said text, complete unsustainability is achieved if each inhabitant uses 1.7 times the maximum globally per capita available surface, i.e., when a person needs 0.128 hag-eq (800 sq.m) of urban territory equivalent to 12.5 inhab/Ha density. Since not all urban territory is residential, the previous figure is rounded up to $DP_{\neg s1}$=15 inhab/Ha. From said value $DP_{\neg s2}$ can be calculated by proportionality obtaining $DP_{\neg s2}$ = 862.5 inhab/Ha.

The third is reviewing the values proposed in different regulations:

- the maximum value of population density that we have found in Spanish legislation is in Canary Islands (CAC, 2017) where a maximum of 400 inhab/Ha gross density in residential areas is accepted, reaching a maximum of 500 inhab/Ha in urban centers rehabilitation;

[18] The graph that relates energy consumption to housing density is U-shaped. Consumption in environments with low housing density is very high (caused mainly by transportation and single-family housing), and decreases as density increases, then it stabilizes, yet from certain higher density values it increases again as people tend to make more trips for leisure and further away. This has been called 'substitution hypothesis'; when urban areas become excessively dense, their inhabitants experience a 'lack of space' that they seek to replace by undertaking more trips away from 'congestion' or having second homes in the countryside (SEI/TUB, 2010).

[19] In Spain, most dense cities are Barcelona and Bilbao (198 and 196 inhab/Ha) (OSE, 2008). In Madrid most dense neighborhoods have net population and houses densities around 700 inhab/Ha and 350 housing/ha [420 inhab/Ha and 220 housing/Ha gross density]. Therefore, the densities range proposed by AEUB stands as *reasonable*.

— in international legislation, we have found the maximum value of population density in the City of Buenos Aires, with a maximum limit of 1,000 inhab/Ha[20]

The fourth approach is based on compliance with free space standards. Hernández Aja et al. (1997) proposes 10 sq.m road + 10 sq.m green area per inhabitant for central areas. If we establish a minimum road and green zone per inhabitant area of 5 sq.m/inhab as a high dense situation, we achieve 1,000 inhab/Ha as unsustainability threshold. The fifth is from the *streets section*.

If the maximum ratio building/street section is 3:1 [H:W], then for a 100 x 100 m grid with 20m wide streets we obtain 6,400 sq.m plots [80 x 80 m]. Assuming 60 m height buildings [20 floors] and 18 m built depth, we obtain 25,560 sq.m built per plot. Considering 100 sq.m/housing would result 255 houses * 2.5 hab/viv implying 639 inhab/Ha.

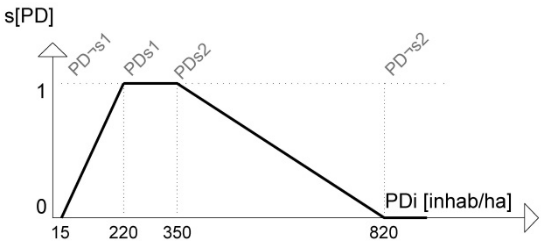
We see different criteria lead us to quite different figures of upper density limit, and the absence of a criterion that makes an assessment/perspective more important than the others makes us propose an *unsustainability threshold of 820 inhab/ha, approximately the average of the values obtained through the different approaches.*

Therefore, we establish the following sustainability / unsustainability limits for the Population Density indicator, PD:

— unsustainability limits. We adopt values proposed by AEUB (2010): PD_{s1} = 220 inhab/Ha and PD_{s2} = 350 inhab/Ha;

— unsustainability thresholds. We use above explained values: $PD_{\neg s1}$ = 15 inhab/Ha and $PD_{\neg s2}$ = 820 inhab/Ha.

The graph and formula of the sustainability function are:

Graphic Representation	Indicator Formalization
	$s[PD] = \max\left[\min\left[\frac{\mathrm{PD_i} - PD_{\neg s1}}{\mathrm{PD_{s1}} - DP_{\neg s1}}; 1; 1 - \frac{PD_i - PD_{s2}}{PD_{\neg s2} - DP_{s2}}\right]; 0\right]$ Alternatively: $s[PD] = max\left[min\left[\frac{PD_i - 15}{220 - 15}; 1; 1 - \frac{PD_i - 350}{820 - 350}\right]; 0\right]$

Tab.3 Indicator for measuring the sustainability of Population Density

Therefore, to calculate the indicator, we first calculate the Population Density of the area using the formula:

$$PD_i = \frac{\mathrm{N}}{\mathrm{S}} \tag{2}$$

Being: PD_i Population Density [in persons/ha]; N_ Number of inhabitants and S_ Total gross surface of the urban area [Ha]

From above Population Density value PD_i we calculate the indicator as:

$$s[PD] = max\left[min\left[\frac{PD_i - 15}{205}; 1; 1 - \frac{PD_i - 350}{470}\right]; 0\right] \tag{3}$$

Futher comments.

The proposed indicator seeks to assess the sustainability of urban population density in neighborhood type areas (i.e., from 16-25 to 50 Ha surface) in a developed-country city model, with a 20m or more street width network. Noteworthy, there are issues that may require reducing above suggested limits in some cases:

[20] Código de Ordenamiento del territorio del Partido de General Pueyrredón, Buenos Aires. Art. 4.1.4.a. Maximum Net Population Density admissible values.

- the relation between maximum population and available residential area, which leads us to place the optimum population density in 2-3 hab/100 built sqm ratios, with a maximum threshold in a density somewhat lower than 4 inhab/100 built sq.m[21];
- the relation between optimal population density and streets width, which means that admissible/optimal densities are lower in urban networks with narrow streets[22];
- the existing relation between residential density and spatial segregation by income (Alvira, 2017a; Leal et al., 2012). Optimal densities explained above usually imply high spatial integration of different income residents, provided other related issues are adequate (green zones provision; street network functionality; urban scenery; housing area ratio per capita ...);
- the relation between optimal density values and the dimension of reviewed area means that suggested values should be lowered when assessing whole cities, neighborhoods of small towns or villages[23].

In addition, optimal population density values should be compatible with the morphological differentiation of cities areas, which requires admitting a sufficiently wide optimal density range excluding unsustainable morphologies.

Thus, herein proposed indicator assigns an acceptable sustainability value to a variety of urban morphologies, but urban morphologies implying lower than 110 inhab/Ha[24] or higher than 625 inhab/Ha population densities achieve lower than 0.5 indicator values. These densities stand as the thresholds from which population density starts to be more unsustainable than sustainable. Also, the increasing need for adaptation to climate change suggests herein proposed unsustainability thresholds could have to further approach the sustainable range (i.e., increasing $PD_{\neg s1}$ and decreasing $PD_{\neg s2}$).

The high energy and land consumption (increase in CO_2 emissions and reduction of agricultural land and biodiversity] coupled to low density values[25] as well as the overcrowding and high energy consumption (heat island effect, congestion, increase in air conditioning use…) coupled to excessively dense urban areas, may be increasingly unsustainable as the clime effectively changes, reducing thus the sustainability range.

Lastly, it is most likely that in many developed countries a large part of their territory whose urbanization is sustainable has already been urbanized[26], so territory for urban use stands as an increasingly scarce resource worldwide. This highlights the need to complete *population density* assessment with measures preventing urban land underutilization; more specifically, regulations that limit the construction of second residences and vacation homes. Besides, urban developments or cities densification should be planned and designed to

[21] Madrid City central area shows negative correlation [-0.57] between housing density and housing built area per capita (own calculation based on Madrid City Council and Cadaster data), which means an increase in the population density usually implies a reduction in per capita housing surface. Thus, when high densities are detected, it is necessary to monitor the per capita housing area. Nevertheless, it is worth highlighting overcrowding in cities is not as much linked to high population density as to homes overcrowding. To detect it Jacobs (1961) proposed assessing the number of people per room. JSBC (2011) assesses the ratio of housing area per inhabitant, suggesting a lousy situation if less than 28 sq.m/inhab and optimal if equal or greater than 40.5 sq.m/inhab [cities] or 47 sq.m/inhab (villages). It is interesting that Gómez-Piovano and Mesa (2017) find that the average per capita housing area in Mendoza Metropolitan Area is approx. 50 sqm/inhab but in lower income areas it reduces to 10 sq.m/inhab.

[22] Gómez-Piovano and Mesa (2017) calculate different recommended maximum densities to achieve good sunlight of the city in the Metropolitan Area of Mendoza (Argentina), which they relate to streets width. The authors suggest a range from 80 inhab/Ha for 10m wide streets to 395 inhab/Ha for streets wider than 19 m.

[23] Higueras (2009) suggests 100 housing/Ha as maximum admissible value to prevent congestion (between 250 and 300 inhab/Ha). OMAU (2012) suggests a minimum/desirable level of 120 inhab/Ha for a group of Mediterranean cities, stating that the optimum density value depends on the context.

[24] An area of semi-detached housing with 45 housing/ha, provides a population density of 112 inhab/ha for an average occupation of 2.5 persons/viv. Calthorpe Associates (2011) calculate water and energy consumption according to type of housing (detached houses big size; detached houses small size; townhouses and collective dwelling), obtaining that the consumption of an isolated detached house is between two and three times higher than that of a collective dwelling. According to own calculations (Alvira, 2017a) only row houses/townhouses and collective dwellings are below current thresholds for sustainable energy and water consumption.

[25] Güneralp et al. (2017), find urban density has similar (sometimes higher) impact for reducing energy consumption in cities than buildings energy efficiency. Energy savings are both linked to lower consumption in collective than isolate housing and to smaller housing surface, requiring lower energy for heating or cooling.

[26] This hypothesis has been tested in Spain, where at least 80% of sustainable urban territory according to Ecological Foot standards is already built up (Alvira, 2017a).

maximize resilience and adaptation to climate change (e.g., densification of current urban areas near the sea and close to sea level should be avoided) (Dodman, 2009).

5 CONCLUSIONS

The present article explains an easy methodology for formulating sustainability indicators within the framework of fuzzy logic/fuzzy sets theory. Building on this framework provides us several advantages compared to the usual *intuitive design* of indicators; both in the indicators formulation / design phase as well as in their subsequent testing[27]. Specifically, herein proposed methodology:

- it allows conceptualizing urban *sustainability assessment indexes* as functions that define the grade of membership of each city or urban area to Sustainability class [S] linking it to its non-membership to Unsustainability class [¬S];
- it allows conceptualizing *urban sustainability indicators* as functions that define the grade of membership of each urban area to each of the S_i subclasses implicit in class S; i.e., subclasses to which the city must have some membership to be able to have some membership to S[28];
- it provides a criterion to select which are the *relevant variables* that should be assessed in each indicator, those that can modify the membership of the city to subclass S_i, which is measured the indicator;
- it provides a criterion to define the *sustainability and unsustainability limits* for the relevant variables, as well as for the mathematical modeling of each indicator.

It is important to insist that the above four issues are criteria for both indicators formulation as well as for their testing and possible refutation or confirmation:

- *sustainability assessment indexes* should meet above condition; if a model does not properly -and simultaneously- characterize membership of the city to S and ¬S classes, then it is not a sustainability index (though it may be assessing another quality or urban phenomenon);
- *sustainability indicators* should satisfy above definition: if an indicator is not an adequate membership function to some class S_i necessary for sustainability, then it is not a sustainability indicator;
- the *relevant variables for each indicator* should satisfy above definition; if the relevant variables (it might be an aggregated variable) do not adequately characterize the city membership to class S_i assessed by the indicator, then they are not the relevant variables (or there are other relevant variables that also need to be valued);
- the *sustainability limits for the relevant variables* must delimit the range of values beyond which variations of the value of the variable do not modify the sustainability of the system and the membership function must adequately model the transition between said values.

Therefore, herein proposed methodology allows us to simplify and clarify -but also to systematize- the design of urban sustainability indicators. It facilitates communication to the rest of the scientific community of the premises on which each indicator is built. And it allows empirical test (both by the person who formulates the proposal and by other scientists).

These are three fundamental issues to optimize research in Sustainability and a requisite to effectively confront the urgent need to reduce the extremely high unsustainability of our cities and societies. Additionally, it is necessary to emphasize that urban sustainability should be assessed in an integrated manner so it can be

[27] For example of indicators testing, see Alvira (2017a & b).

[28] Conceptualizing Sustainability and Unsustainability as complementary classes S and ¬S also makes it easier to detect which are the qualities (subclasses S_i) that maximize the membership of a city to class S (both in terms of the city's probability of enduring and the degree to which its state is optimal) in terms of opposites. If it is possible to determine the qualities that make a city unsustainable (i.e., which imply its membership to ¬S), then it is possible to determine the issues that make it sustainable, which are the opposite. This facilitates detecting some relevant issues for sustainability which are difficult to detect as membership to class S, yet easy to detect in terms of membership to class ¬S. For details of the procedure to design a complete assessment model as well as criteria to check the completeness of the models, refer to Alvira (2014).

used as objective criteria for decision making regarding possible urban transformations. Furthermore, the urgency of reducing our cities unsustainability requires incorporating sustainability as the key decision making criterion when designing their transformations, which constitute their long term evolution. A rational society should be deemed as that which seeks to maximize its sustainability in all its decision making processes[29].

This implies that besides designing sustainability indicators, it is necessary to define their organization in models that should incorporate different levels linked to indicators structure of aggregation, and to define procedures so they can be used in most important decision making processes in our cities, which not only involve new urban projects, but also the modification of current legislation[30].

REFERENCES

Agencia Ecología Urbana Barcelona (AEUB) (2010). *Sistema de indicadores y condicionantes para ciudades grandes y medianas.* Ministerio de Medio Ambiente y Medio Rural y Marino, Gobierno de España.

Alvira, R. (2014). *A Mathematical Theory of Sustainability and Sustainable Development.* Scotts Valley, USA: CreateSpace Independent Publishing Platform.

Alvira, R. (2016). Proyecto Haz[Otea]. *Cuadernos de Investigación Urbanística*, 107, 1-84. Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=5919988

Alvira, R. (2017a). *Un modelo y una metodología para la transformación de ciudades hacia la sostenibilidad* (Doctoral dissertation). Universidad Politécnica de Cartagena, Cartagena, Spain.

Alvira, R. (2017b). Segregación Espacial por Renta. Concept, measurement and evaluation of 11 Spanish cities. *Cuadernos de Investigación Urbanística*, *114*. doi:https://dx.doi.org/10.20868/ciur.2017.114.3563

Alvira, R. (2018). Una Aproximación al Diseño de Indicadores de Sostenibilidad desde la Lógica de Clases. In Instituto Tecnológico de Galicia, BREEAM ES and Universidade da Coruña (Eds.), *Breeam Urbanismo: Reflexión, Análisis y Casos de Estudio*.

Aristotle (350 B.C.E) *Metaphysics*. *Books I to VI* (Translated by W. D. Ross). Retrieved from http://classics.mit.edu/Aristotle/metaphysics.html

Beauchamp, P., & Adamowski, J. (2013). An integrated framework for the development of green infrastructure: A literature review. *European Journal of Sustainable Development*, *2*(3), 1-24. doi:http://dx.doi.org/10.14207/ejsd.2013.v2n3p1

Bianconi, F., Clemente, M., Filippucci, M., & Salvati, L. (2018). Re-sewing the urban periphery. A green strategy for fontivegge district in Perugia. *TeMA Journal of Land Use, Mobility and Environment*, *11*(2018), 107-118. doi:http://dx.doi.org/10.6092/1970-9870/5216

Boole, G. (1854). *An Investigation of The Laws of Thought, on which are founded the Mathematical Theories of Logic and Probabilities*. New York, USA: Dover Publications

Calthorpe Associates (2011). *Rapid Fire Model. Technical Summary. Model Version 2.0*.

Comunidad Autónoma de Canarias (CAC) (2017). *Ley 4/2017, de 13 de julio, del Suelo y de los Espacios Naturales Protegidos de Canarias*.

Dodman, D. (2009). Urban density and climate change. *Analytical review of the interaction between urban growth trends and environmental changes*, (1). Retrieved from https://www.uncclearn.org/sites/default/files/inventory/unfpa14.pdf

Tojo, F.J., & Naredo, J.M. (2010). *Libro blanco de la sostenibilidad en el planeamiento urbanístico español*. Ministerio de Vivienda, Gobierno de España. Retrieved from http://habitat.aq.upm.es/lbl/a-lbl.es.pdf

[29] Needless to say, in an interconnected world, sustainability of different cities and societies is interconnected. Maximizing one's sustainability often requires maximizing the sustainability of other cities/societies. In order to achieve it global agreements are required, an issue which largely exceeds the present proposal. For an approach on how a global agreement could be designed see Alvira (2017a).

[30] In order to do so, the author proposed in 2014 a general axiomatic framework that provides a guideline for the design of models to quantitatively assess sustainability. In terms of operational models (i.e., models which can be used for decision making), the author has proposed a complete model which enables using sustainability maximization as a decision criterion in most urban transformations (Alvira, 2017a). For an application of this model to draft a Rooftop Code for a neighborhood of Madrid city (Alvira, 2016).

Galderisi, A. (2014). Climate Change Adaptation. Challenges and Opportunities for a Smart Growth. *TeMA. Journal of Land Use, Mobility and Environment*, *7*(1), 43-67. doi:http://dx.doi.org/10.6092/1970-9870/2265

Gómez-Piovano, J., & Mesa, A. (2017). Determinación de densidades urbanas sostenibles en base a metodología relativa al acceso solar: caso área metropolitana de Mendoza, Argentina. *Revista de Urbanismo*, 36, 131-145.

Güneralp, B., Zhou, Y., Ürge-Vorsatz, D., Gupta, M., Yu, S., Patel, P. L., ... & Seto, K. C. (2017). Global scenarios of urban density and its impacts on building energy use through 2050. *Proceedings of the National Academy of Sciences*, *114*(34), 8945-8950. doi:https://doi.org/10.1073/pnas.1606035114

Hacking, I. (1995). *El surgimiento de la probabilidad: un estudio filosófico de las ideas tempranas acerca de la probabilidad, la inducción y la inferencia*. Barcelona, ES: Editorial Gedisa.

Hernández Aja, A., Alguacil, J., Medina, M., & Moreno, C. (1997). La ciudad de los ciudadanos. Madrid, ES: Ministerio de Obras Publicas, Transporte y Medio Ambiente. Retrieved from http://habitat.aq.upm.es/aciudad/aciudad.pdf

Higueras, E. (2009). *El reto de la ciudad habitable y sostenible*. Pamplona, ES: Editorial DAPP Publ. Juridicas S.L.

Jacobs, J. (1961). *The Death and Life of great American cities*. New York, USA: Random House.

Japan Sustainable Building Consortium (JSBC) (2011). *CASBEE for Cities. Technical Manual 2011. The Committee for the Development of an Environmental Performance Assessment Tool for Cities. Japan Sustainable Building Consortium*.

Leal, J., Martínez, M., Echaves, A., & García, E. (2012). Densidades urbanas y sociales en dos barrios centrales de Madrid: virtudes, excesos y desigualdades de fondo/Social and urban densities in the central historical district of Madrid: virtues, excesses and inequalities. *Urban*, 4, 61-79. Retrieved from http://polired.upm.es/index.php/urban/article/view/1867

Ministerio de Fomento (MFOM) (2012). *Guía Metodológica para los Sistemas de Auditoria, Certificación o Acreditación de la Calidad y Sostenibilidad en el medio urbano*. Ministerio de Fomento, Gobierno de España.

Ministerio de Medio Ambiente (MMA) (2007). *Libro Verde de Medio Ambiente Urbano. Tomo I.* Agencia de Ecología Urbana de Barcelona y Ministerio de Medio Ambiente, Gobierno de España.

Moore, D. (2011). *Ecological Footprint Analysis San Francisco-Oakland-Fremont, CA*. Oakland, USA: Global Footprint Network.

Observatorio de la Sostenibilidad De España (OSE) (2008). *Sostenibilidad Local. Una aproximación Urbana y Rural*. Madrid, ES: Ediciones Mundi-Prensa.

Observatorio de Medio Ambiente Urbano (OMAU) (2012). *CAT-MED, Modelos urbanos sostenibles. Metodología de trabajo y resultados*. Retrieved from http://www.catmed.eu/archivos/desc7_CatMed%20Esp-Eng.pdf

Prescott-Allen, R. (2001). *The Wellbeing of Nations A Country-by-Country Index of Quality of Life and the Environment*. Washington, USA: Island Press. Retrieved from https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/19881/IDL-19881.pdf?sequence=1

Salata, K. D., & Yiannakou, A. (2016). Green Infrastructure and climate change adaptation. *TeMA. Journal of Land Use, Mobility and Environment*, *9*(1), 7-24. doi:http://dx.doi.org/10.6092/1970-9870/3723

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Folke, C. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*(6223), 1259855. doi: https://doi.org/10.1126/science.1259855

Stockholm Environmental Institute and Technische Universität Berlin (SEI/TUB) (2010). *Developing a pragmatic approach to assess urban metabolism in Europe. A Report to the European Environment Agency*.

Town & Country Planning Association and The Wildlife Trusts (TCPA/The Wildlife Trusts) (2012). *Planning for a healthy environment – Good practice guidance for green infrastructure and biodiversity*. Retrieved from https://www.tcpa.org.uk/Handlers/Download.ashx?IDMF=34c44ebf-e1be-4147-be7d-89aaf174c3ea

United States Green Building Council (USGBC) (2018). *LEED v4 for Neighborhood Development. Rating System. Updated July 2, 2018*.

World Health Organization (WHO) (2016). *Urban green spaces and health*. Copenhagen, DK: WHO Regional Office for Europe.

Zadeh, L. A. (1965). Fuzzy Sets. *Information and Command*, *8*(3), 338-353. doi:https://doi.org/10.1016/S0019-9958(65)90241-X

Zucaro, F., & Morosini, R. (2018). Sustainable land use and climate adaptation: a review of European local plans. *Tema. Journal of Land Use, Mobility and Environment*, *11*(1), 7-26. doi:http://dx.doi.org/10.6092/1970-9870/5343

IMAGE SOURCES

Fig. Cover: Monica Vilhelm & Ricardo Alvira.

Rest of figures and tables by the author.

AUTHOR'S PROFILE

Ricardo Alvira Baeza is an architect and Urban Designer. From 2000 to 2010 he has worked in several major architectural firms, focusing on medium-large projects including: design and construction of a residential neighborhood; skyscrapers and retail centers; a university campus [this last project was designed seeking compliance with BREEAM and LEED ND sustainability criteria]. After 2010, he has focused on research, achieving a DEA in Urban Design and Planning [Polytechnic University of Madrid], with a study comparing the two major sustainability certification systems at the moment: LEED ND and BREEAM for Communities. His PhD Thesis in Architecture and Urban Planning [Polytechnic University of Cartagena], is a complete mathematical model for measuring cities sustainability [Meta_S] including a procedure so it can be used in most urban transformations [both urban projects and legislation drafting, …].

TeMA

Journal of
Land Use, Mobility and Environment

CALL FOR PAPERS: TeMA VOL. 12 (2019)

The Times They Are a-Changin'

In these last ten years, TeMA Journal has published several international studies and researches supporting the scientific debate on the urban complexity and the future challenges of urban areas. Thus, the three issues of the 12th volume will think again the debate on the definition and implementation of methods, tools and best practices connected to the evolution of the main scientific topics examined in depth in previous TeMA Journal volumes.

In detail, the Journal welcomes papers on topics about the interdisciplinary interaction among Land Use, Mobility and Environment, and also urban studies from the domains of engineering, planning, modelling, behaviour, regional economics, geography, regional science, architecture and design, network science, complex systems, energy efficiency, urban accessibility, resilience and adaptation.

Publishing frequency is quadrimestral. For this reason, authors interested in submitting manuscripts addressing the aforementioned issues may consider the following deadlines:

- first issue: 10th January 2019;
- second issue: 10th April 2019;
- third issue: 10th September 2019.

CALL FOR PAPERS: GENERAL CALL

Papers in Transport, Land Use and Environment

The Journal welcomes papers on topics at the interdisciplinary intersection of transport and land use, including research from the domains of engineering, planning, modelling, behaviour, economics, geography, regional science, sociology, architecture and design, network science, and complex systems

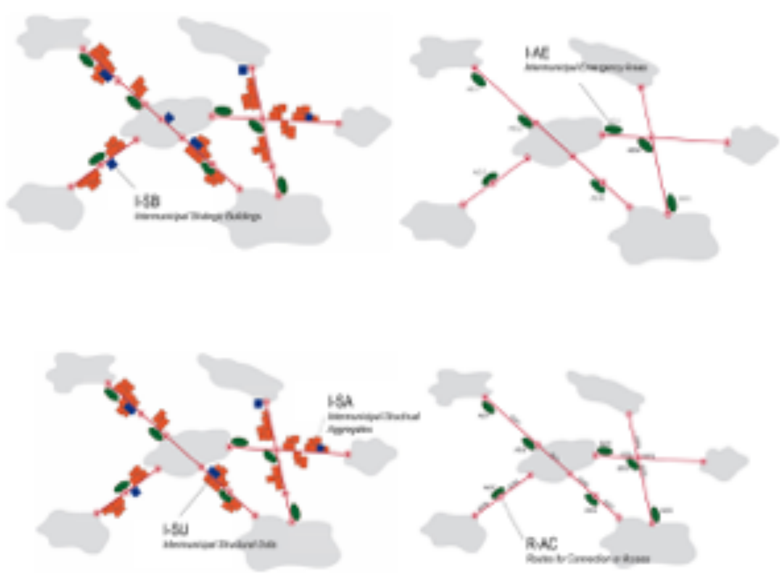
TeMA Journal of Land Use, Mobility and Environment

TeMA 3 (2018) 305-322
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/5845

review paper received 4th June 2018, accepted 17th December 2018

www.tema.unina.it

How to cite item in APA format:
Di Lodovico, L., & Di Ludovico, D. (2018). Limit Condition for the Intermunicipal Emergency. *Tema. Journal of Land Use, Mobility and Environment*, *11*(3), 305-322. doi:http://dx.doi.org/10.6092/1970-9870/5845



LIMIT CONDITION FOR THE INTERMUNICIPAL EMERGENCY

LUANA DI LODOVICO, DONATO DI LUDOVICO

Department of Civil, Construction-Architectural and Environmental Engineering
University of L'Aquila (Italy)
e-mail: luanadilodovico@hotmail.it; donato.diludovico@univaq.it
URL: http://diceaa.univaq.it

ABSTRACT

The traditional urban planning issues, related to the design and city shape, today are faced with those derived from safety and risk. The Emergency Plan (EP) is the result of study about risk for each context, and it allows to identify potential emergency scenarios. The paper illustrates model of analysis of Intermunicipal Emergency Plan (I-EP) through Limit Condition for the Intermunicipal Emergency I-LCE), with the purpose of large-scale assessment and mitigation of the seismic risk. This is an approach that extends the methodological principles of Limit Condition for the Emergency (LCE) to the territory, we consider that the EP, in the same way as urban planning, is not a planning activity that can be concentrated only on urban area but must work on the "territory system", especially for the effect control of natural phenomena such as seismic risk. This not only threatens a significant innovation for the LCE but also for its relationship whit the urban planning its design strategies aimed at reducing territorial fragilities. The proposed methodology is applied in the area of Sele, in the district of Salerno (Southern Italy), territory characterized by high levels of seismic and hydrogeological vulnerability. Through this case study we had the opportunity to discuss the potential of I-LCE and its additional recommended updates to increase its effectiveness and efficiency, in addition the necessary innovations of urban and territorial planning systems.

KEYWORDS:
Safety; Resilience; Urban Planning; Territorial Planning; Management Risk Plan; Prevention and Territorial Recovery Projects

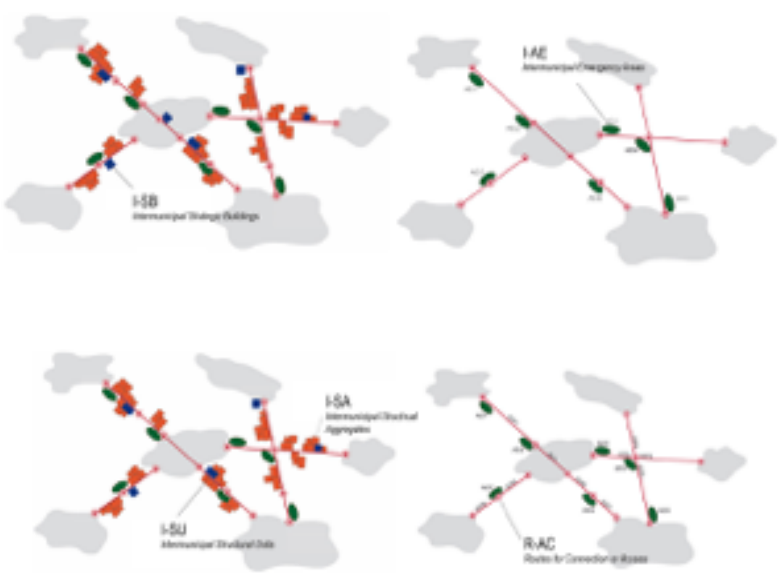
TeMA 有关土地使用、交通和环境的杂志

TeMA 3 (2018) 305-322
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/5845

review paper received 4th June 2018, accepted 17th December 2018

www.tema.unina.it

How to cite item in APA format:
Di Lodovico, L., & Di Ludovico, D. (2018). Limit Condition for the Intermunicipal Emergency. *Tema. Journal of Land Use, Mobility and Environment*, *11*(3), 305-322. doi:http://dx.doi.org/10.6092/1970-9870/5845



城际突发事件的极限条件

LUANA DI LODOVICO, DONATO DI LUDOVICO

Department of Civil, Construction-Architectural and Environmental Engineering
University of L'Aquila (Italy)
e-mail: luanadilodovico@hotmail.it; donato.diludovico@univaq.it
URL: http://diceaa.univaq.it

摘要

涉及到城市的设计和形态的传统城市规划问题，今天面临着由安全和风险衍生出来的问题。应急方案(EP)是对每一种情况下的风险进行研究的结果，能够确定潜在性的突发事件。本文通过城际应急方案(I-LCE)的极限条件，阐明了城际应急方案(I-EP)的分析模型，旨在大规模的评估与降低地震危险。这是将“突然情况的极限条件”(LCE)的方法原则扩展至地域/区域的一种方法。我们认为，EP与城市规划一样，并不只是一项集中于城市地区的规划活动，而是必须作用于“地域/区域系统”上的规划活动，特别是针对地震风险等自然现象方面的效果控制。这不仅威胁到LCE的重大创新，而且还威胁到它与城市规划、旨在减少领土脆弱性的设计战略之间的关系。所提议的方法适用于地震频发和水文地质脆弱的Salerno省(意大利南部)的Sele区域。通过该案例的研究，我们有机会就I-LCE的潜在性及其附加的建议更新及探讨城市和地区规划系统的必要创新进行探讨，以提高其有效性和效率。

关键词:
安全、适应力、城市规划、地域规划、风险管理规划、预防与地域复原项目

1 INTRODUCTION

The main theme of the research is the reduction of seismic risk for resilience territories. These risks include not only natural disasters but also all the likely crises in the city (Molavi, 2018). The International Strategy for Disaster Reduction of the United Nations defines resilience as the capacity of a system, community or society potentially exposed to hazards to adapt to a new scenario by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure (UNISDR, 2015). Resilience is determined by a social system capable of organizing itself to increase its capacity of learning from past disasters for its future protection, as well as to improve risk reduction measures (Cara et al., 2018). Every city can express a certain level of resilience, and the identification of its most influent elements is strategic in order to detect intervention criteria aimed to its improvement (Burton et al., 2016). More recent studies focused on the possibility to carry out seismic vulnerability assessments quickly and with limited costs, in order to extend the application to entire urban systems (Formisano et al., 2011). In this last context the Limit Condition for the Emergency (LCE) is placed. The research presented stems from an agreement of the ICEAA Department of the University of L'Aquila with the Department of Public Works, Government of the Territory and Environmental Policies of the Abruzzo Region. In particular, the agreement concerns studies on LCE and I-LCE, on Seismic Microzonation (MZS), Levels 1 and 3 and on the reduction of seismic vulnerability of strategic buildings. In particular, for the analysis relating to LCE, the research has proposed an innovation considering it necessary to experiment, at a territorial level, a new methodology for the reduction of the seismic risk components and implementation of the effectiveness and efficiency of Intermunicipal Emergency Plan (I-EP). The result of this research, which is described in this article, have then become guidelines of the Abruzzo Region: "Condizione Limite per l'Emergenza, Linee di indirizzo regionale di analisi ed elaborazione della condizione limite per l'emergenza intercomunale" (Regione Abruzzo, 2017). In these guidelines the definition of I-LCE: «Instruments designed to:

- to integrate the project interventions on the territory for the seismic risk mitigation;
- to verify the emergency management systems of the I-EP (buildings, roads, emergency areas, etc.);
- to evaluate and verify strategic choices of EP of the individual municipalities».

It should be pointed out that the analysis of I-LCE does not replace the I-EP, but aims at its own updating, or of its elaboration, with the objective to guarantee the operation of the urban and extra-urban system in the event of emergency. The purpose of the research is to extend the concept of CLE, moving from the local level to the territorial level, to analyze performance levels of territorial system, to understand the potential levels of resilience whereas the response to natural disasters must be provided by a complex system of territories and not isolated urban areas. The research proposes an I-LCE can be considered, as well as an assessment tool, a tool to support the redesign of the spatial form and then of those fragmented structures of settlements typical of the modern era/period, especially from the post-industrial era.

Using I-LCE as a project tool means to identify new rules for the spatial organization /reorganization of the territory fabric and, in case of catastrophic events, to be able to ensure the safe exodus to emergency areas and stacking, to ensure access to first aid equipment and facilities (hospitals, first aid, gathering areas, etc.) and to the strategic buildings included in the EP but also spatial planning tools. The primary objective of the EP is explicitly stated to be the reduction of the expected human losses, rather than economic losses, so that the action is especially addressed to high hazard and high-risk areas (Dolce, 2012). Instead the I-LCE can be considered as a design tool, and as such can intervene on prevention by acquiring the characteristics of a pre-disaster planning that interacts with the traditional urban planning.

The research considers two levels of analysis: local and territorial. At local level, LCE can analyze: geological and morphological analysis of sites; relationships between handworks and urban systems (hierarchical level and percentage covered by the standard); amount of users and their daily or periodic movements; vulnerability (physical) component manufactured about classification and identification of building aggregates; amount of negative interactions between elements (building aggregates) and urban morphology; interactions of the various components and systems with basic and local hazard, hydrogeological and hydraulic hazard, status of underground storage; land use decisions on local strategic location of buildings. At Territorial level, I - LCE can analyze: distribution of the various functions in the municipality systems (performance Level); hierarchy of functional systems (networks and buildings); resource flows (people and goods); vulnerability assessment and explanation of the built system with respect to natural hazards (floods, earthquakes, etc.), land use decisions on location of territorial strategic buildings (D'Ascanio et al., 2016). Through the experimentation with the case study (area of Alto and Medio Sele) the limits of the model and the points to be perfected have been tested. Also the integration of all studies and analyzes related to the seismic risk mitigation (MZS, LCE, I-LCE, I.OPà.CLE) will be able to define a working model in such a way that the retrofit of the territories can be performed based on vulnerability, local risk and Emergency planning needs (Dolce, 2012).

2 LIMIT CONDITION FOR THE EMERGENCY (LCE) AND THE METHOD I.OPÀ.CLE

The analysis of the Limit Condition for the Emergency (LCE) of urban settlement, defined in detail by the law article 18 of the OCDC 171/2014 as «[...] that condition of urban settlement to which, following the occurrence of the seismic event, overcoming, in spite of the occurrence of physical and functional damage such as to lead to the interruption of almost all the existing urban functions, including residency, the urban settlement still retains, as a whole, the operation of most of the strategic functions for emergencies, their accessibility and connection with the territorial context». They are many legislative directives that have introduced LCE, among which we remember:

- the Legislative Decree of 28 April 2009, No. 39 (so called "Abruzzo Decree" - urgent interventions on behalf of the populations affected by earthquakes in the Abruzzo Region and further urgent interventions of Civil Protection), converted, with amendments, by the Law of 24.06.2009, No. 77;
- Ordinance President of the Council of Ministers (OPCM) No. 3907/2010 which, according to the art. 11 of the D.lgs. 39/2009 launched a multi-year seismic risk program for the period 2010-2016;
- OPCM No. 4007/2012 which introduced the analysis of Limit Condition for the Emergency (LCE) for the year 2011 in order to improve the management of emergency activities;
- order of the Head of the Civil Protection Department (OCDPC) No. 52/2013 that defines the financing modalities for the realization and/or completion of the studies of Seismic Microzonation (MZS) and of the Analysis of the Limit Condition for the Emergency (LCE) in municipalities that are part of a union and associations of municipalities, for the year 2012;
- OPDPC No. 171/2014 defines the financing modalities for the realization and/or completion of the studies of MZS and the analysis of LCE in municipalities that are part of a union and/or associations of municipalities, for the year 2013 (art. 21). Moreover, it introduces the faculty to the Regions and Autonomous Provinces to identify one or more union of municipalities on which to start a program aimed at guaranteeing the minimum conditions for management of the emergency system to obtain homogeneous results in MZS studies and analysis of LCE according to specific procedures and financing (art. 22);
- OCDPC No. 293/2015 defines the financing modalities for the realization and/or completion of the studies of MZS and the analysis of LCE in municipalities that are part of a union and/or associations of municipalities, for the year 2014 (art. 21), and reiterates the provisions of art. 22 of the OPDPC 171/2014;
- OCDPC No. 344/2016 defines the financing modalities for the realization and/or completion of studies on MZS and the analysis of LCE in municipalities that are part of a union and/or associations of municipalities, for the year 2015 (art. 21).

The operating methodology has been defined within the regional seismic risk mitigation program (Legislative Decree 28 April 2009, No. 38, Article 11). It is important to underline the importance of supporting LCE analysis to studies on MZS to integrate all those actions aimed at the mitigation of seismic risk, to improve management of emergency activities in the phase that follows immediately the earthquake (Di Lodovico & Di Ludovico, 2015). The graph shown in Fig. 1 describes what happens in an urban settlement following a seismic event before reaching the LCE (shown in the graph with the green point), or up to suffer physical and functional damages such as to cause:

- interruption of the residential function;
- interruption of most ordinary and strategic urban functions.

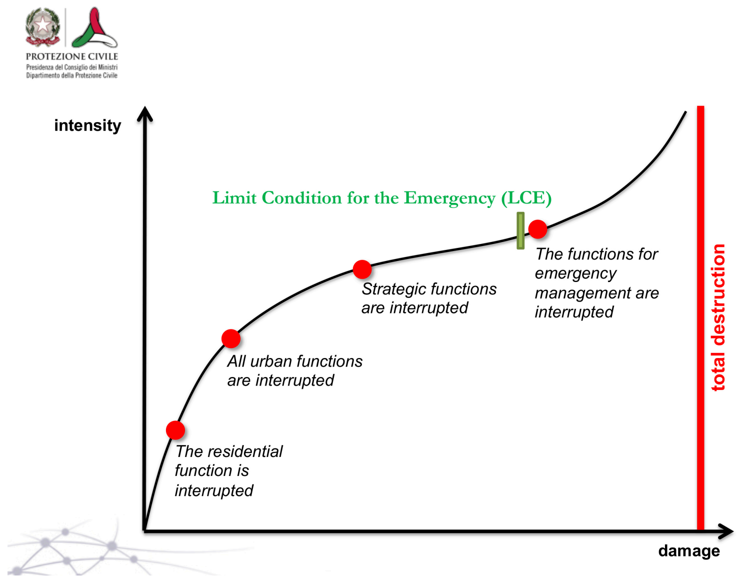


Fig. 1 What happens in an urban settlement following a seismic event before reaching the LCE

The LCE analysis involves:

- the identification of buildings and areas that guarantee strategic functions for emergencies;
- the identification of accessibility and connection infrastructures with territorial context, buildings and areas referred to in a. point and any critical elements;
- the identification of structural aggregates and single structural units that can interfere with the accessibility and connection infrastructures with territorial context (Castenetto, 2013).

The LCE analysis is performed using the forms prepared by the Technical Commission referred to in Article 5 paragraphs 7 and 8 of the OPCM 3907/2010 and issued with a special decree by the Head of the Civil Protection Department (CTMS, 2014a, 2014b). The analysis allows to identify on a basic cartography, all the minimum information necessary to evaluate the urban response to an earthquake. To this end, data archiving standards have been set up, collected in a specific form (5 types of cards) and represented on digital cartography (in shapefile format). The five relevant cards concern: Strategic Buildings, Emergency Areas, accessibility/connection infrastructures, Structural Aggregates, and Structural Units. Once computerized through the SoftCLE (a software drawn up by Civil Protection Department), the cards catalog allows to realize a first level of knowledge (level 1) on urban system quality. The next step is the analysis through GIS tools on the functionality / operation of the Municipal and / or intercommunal EP with respect to the services required to urban system during the emergency phase (CTMS, 2014a, 2017b). In fact, through the LCE analysis we can integrate interventions on territory for seismic risk mitigation. The aims of this analysis are to verify emergency management systems, conceived as a set of physical elements (strategic buildings, emergency areas, structural aggregates and structural units interfering with the connection and accessibility infrastructures), already identified in the EP, and to verify the strategic choices of the EP. It should be noted that analysis of LCE does not replace EP, especially in the identification of sites and strategic management structures of emergencies. It rather aims at its updating / adaptation. Starting from the ELC definition, in the literature, we find other more general analysis approaches based on performance for the probabilistic assessment of damage, seismic evaluation and resilience of urban systems with reference to different levels of performance (Burton et al., 2016; Lagomarsino & Cattari, 2015). There are two models studied and compared to enrich the I-LCE model: I.OPà.CLE (Operational efficiency indices for Emergency Limit Condition – LCE) and the simplified LCE model proposed by the study group of Cara et al. (the Antiga Esquerra de l'Eixample neighborhood of Barcelona), both models for the assessment and mitigation of the seismic risk (Cara et al., 2018).

Since 2013 the Italian Civil Protection Department has developed and further upgraded the method I.OPà.CLE for the assessment of operational efficiency of an EP described through LCE tools (Dolce et al., 2017a, 2017b). This is a method proposal that has remained only in the field of study, and is interesting because it deals, in a complex manner, with the topic of the evaluation of the EP. The method is based on the formulation of synthetic probabilistic indexes that measure the operational capacity in the aftermath of the seismic event, for each physical component, and its sub-elements of the emergency system. The indices are formulated for two seismic events with different return periods (T = 98 years and T = 475 years) as well as in absence of any earthquake occurrence (conventionally associated to return period T = 0). Coherently with LCE analysis, the method is specifically conceived for assessments at municipal scales. Limitedly to the level of accuracy of input data provided by LCE analysis, the final purposes of I.OPà.CLE are to outline the potential criticalities which might inhibit the management of a real seismic emergency, so as to enable the decision maker to undertake specific measures for fixing critical elements and hence upgrading the plan (Dolce et al., 2017a, 2017b). In addition to the operational indices, the method makes it possible to calculate the probability of maintaining the functioning of the physical emergency system described through the analysis of LCE. Flexibility of analysis and modularity of results (Global Indexes - Subsystem - Element) allows information to be provided in more detail, so as to be able to easily identify specific critical issues that require priority actions, thus supporting the decision-making process (Dolce et al., 2017a, 2017b). As with the I.OPà.CLE model, a system is being structured in the research, with probabilistic indices, which allows to evaluate the performances of the I-EP functionally to safeguard life.

The case study of Antiga Esquerra de l'Eixample neighborhood of Barcelona is a simplified model to investigate the influence of the collapse of interfering buildings on the operability of strategic urban roadways, as well as the possible actions that may lead to improve their functionality after the occurrence of an earthquake. The first stage of the proposed methodology consists in the identification of interfering buildings whose damage or collapse, may affect the functionality of vital connections during the post-seism emergency (Cara et al., 2018). The damage grade of the chosen buildings is evaluated after having determined the vulnerability indexes by using the GDNT method, distinguishing masonry buildings and reinforced concrete buildings. This model mainly studies the operativity of the interfering buildings of the LCE an appropriate mechanical model whose definition allows the assessment of the reliability of the urban system crossed by the strategic road. However, it is a model that mainly analyzes the vulnerability of individual buildings without taking into account the needs and hazard present in the area examined. The same research team provides for the improvement of the survey strategies on the existing building heritage and extending it to urban infrastructures, water supply systems, pipelines, communication networks, etc. Ultimately, the improved GIS database created for Antiga Esquerra de l'Eixample can be a starting point for optimized risk mitigation measures and civil protection planning. However, it is a model whose results are extremely important for public safety or civil protection agencies to assess the impact of possible intervention strategies, as well as to optimize the management of seismic emergencies (Cara et al., 2018).

3 FROM LCE TO I-LCE: A NECESSARY CHANGE FOR A RESILIENT TERRITORY

Following an earthquake of a given intensity, urban vulnerability depends both on how individual building components are damaged, and on functional performance that these buildings provide (commercial, services, production, energy, mobility, etc.). Vulnerability of an urban system thus measures the non-linear correlation between intensity of seismic event and extent of damage to the urban system itself, caused by exposure characteristics of its individual elements (Fabietti, 2013). The LCE allows the rapid assessment of urban vulnerability of specific strategic buildings, connecting areas and infrastructures and interfering buildings in urban area. However, analysis is a complex process because it involves different contexts from a spatial, geological-technical and functional point of view. It is therefore a multidisciplinary study that involves different technical and administrative, each with specific roles and competences, in order to optimize the activity and improve final quality of proposals for improvement / integration of EP (Fig. 2).

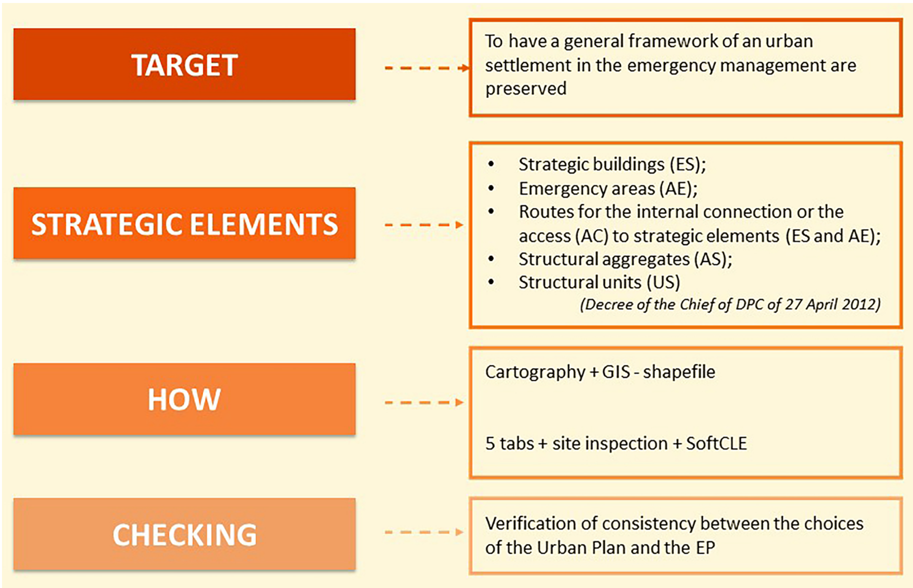


Fig. 2 The Limit Condition for the Emergency

The EP is the operational tool for the management of emergencies and for the mitigation of territorial risks. The main objective of the EP is to define the organizational model of emergency procedures, monitoring activities, risk prevention actions and assistance to the population.

The Plan is structured in three parts:

- collection of all information related to the knowledge of the territory with the identification of risks;
- planning of operations to be carried out during the pre-emergency, emergency and post-emergency phases;
- definition of the intervention model, with identification of responsibilities for the management of emergencies at the various levels.

The EP should be a dynamic and constantly updated document that should be updated and disseminated among the citizens, especially with simulations that allow you to test the contents of the plan, verify the organizational and management capacity envisaged. Because of this static and for other factors the EP and the LCE have limits:

- EP, in Italy, is static plan, sometimes not known by mayors, technicians and citizens; some Regions, such as Abruzzo, have promulgated guidelines for updating the common plans with the aim of making them become dynamic instruments;
- LCE provides analysis model that analyzes only the effects of a seismic event on the city (while the EP takes more risks into account);
- LCE does not provide for a systematic and dynamic knowledge of urban phenomena and structure;
- does not exist a platform that allows the comparison of urban planning processes, geographical information, territorial risks information and the structure of the EP;

- there is no urban analysis of the overall response to a disastrous event of a territory, which cannot be ascertained by the sole verification of the EP through the LCE.

The research also poses that of reading again and integrating experiences of pre-disaster planning (UNISDR, 2012) and mitigation planning (FEMA, 2013) to overcome these critical issues and to propose a new model of I-EP fully integrated with ordinary urban and territorial planning, connection that is possible through the construction of a digital platform for the construction and management of knowledge. The purpose is to obtain a territorial organization of the emergency able to safeguard and secure the building, infrastructural and natural heritage, which provides for the training of citizens to obtain resilient communities and territories.

Based on these concepts, and on the national laws, the I-EP has been prepared and integrated, and it has been elaborated the I-LCE. The I-EP is the reference operational support for the management of emergency situations and for the mitigation of the risk in the territory (National Law No. 100 of 12 July 2012). The I-EP is drawn up by an association of municipalities belonging to the same territorial area. It is the unitary tool of coordinated response of the local civil protection system to any type of crisis or emergency situation, making use of the knowledge and resources available on the territory. They must take into account and integrate the EP, all emergency operational plans of bodies, technical structures, public service operators and be completed with detailed technical procedures necessary for activation. It becomes a tool for the management of broad area issues, those topics, such as emergency management, risk prevention and mitigation, which need both an overview, which goes beyond or are only known the administrative boundaries of the single municipality, both of a certain autonomy, a sort of third party, with respect to local pressures and interests.

The I- LCE was conceived as a bivalent tool that allows both to assess the territorial seismic vulnerability, and to be a support element for the design / update of the I-EP. The I-LCE allows, in fact, to identify the critical issues of the plan and to reorganize the same at a spatial level in order to ensure both the safe exodus to emergency areas, and access to first aid equipment (hospitals, ready assistance, collection areas, etc.) and strategic buildings (Fig. 3). Particularly the synthesis of the information deduced by the I-LCE can be used:

to evaluate the conditions of danger and seismic vulnerability of an intermunicipal territory;

- to evaluate the effectiveness of I-EP;
- to plan further investigations and analyzes for strategic buildings and aggregates and/or structural units interfering with accessibility infrastructures;
- to establish possible methods of intervention in urban areas to guarantee accessibility to strategic buildings and / or accumulation areas and guarantee territorial accessibility;
- to ensure a coherent and comprehensive general emergency system between the municipalities of the Intercommunal Operation Center (IOC) of reference;
- to address spatial planning and land use towards safety-related modes.

A system conceived as such can to supported by a dynamic and continuous knowledge of urban contexts and of the phenomena that generate risks, assessed through a few effective indicators of functionality and operation, managed through a digital platform. This platform must be connected to mobile networks designed to maintain service even after disasters. In Abruzzo, through the extension of this research, we are proceeding to the creation of a regional knowledge platform that will be used for the preparation of the Regional Plan of Civil Protection (Article 11, Law No. 77/2009). Spatial planning is a fundamental tool: only by thinking about the evolution of an area as a whole, without fragmentation, one can well govern its development and its security.

3.1 METHODOLOGY

The methodology behind I-LCE derives from the forms prepared by the Technical Commission (Article 5, paragraphs 7 and 8, O.P.C.M. 3907/2010) for the analysis of LCE (CTMS, 2014a), revised and expanded to be able to identify strengths and weaknesses of the EP. The whole model is described in the regional Guidelines for the analysis and processing of I-LCE drew up by the DICEAA in collaboration with the Abruzzo Region (Regione Abbruzzo, 2017). The I-LCE facilitates integration between the Local EP and I-EP in a logic of multi-scalar risk, is also related to the co-planning that requires an integration of risk planning and disasters with other levels of risk. In general, the I-LCE model provides:

- analysis buildings and areas aimed at strategic management of emergency for a union of municipalities (strategic buildings and emergency areas);
- analysis infrastructures between the municipalities and the territorial context, buildings and areas referred to in point a) and any critical elements;
- analysis structural aggregates and individual structural units located in extra-urban areas that can interfere with infrastructures of territorial connection and emergency areas (art.18, O.P.C.M. 4007/2012);
- analysis strategic choices of I-PE;
- setting up of territorial knowledge frameworks to identify the elements of fragility through a shared platform;
- analysis of the vulnerability of natural, territorial and urban systems through synthetic indicators of performance.

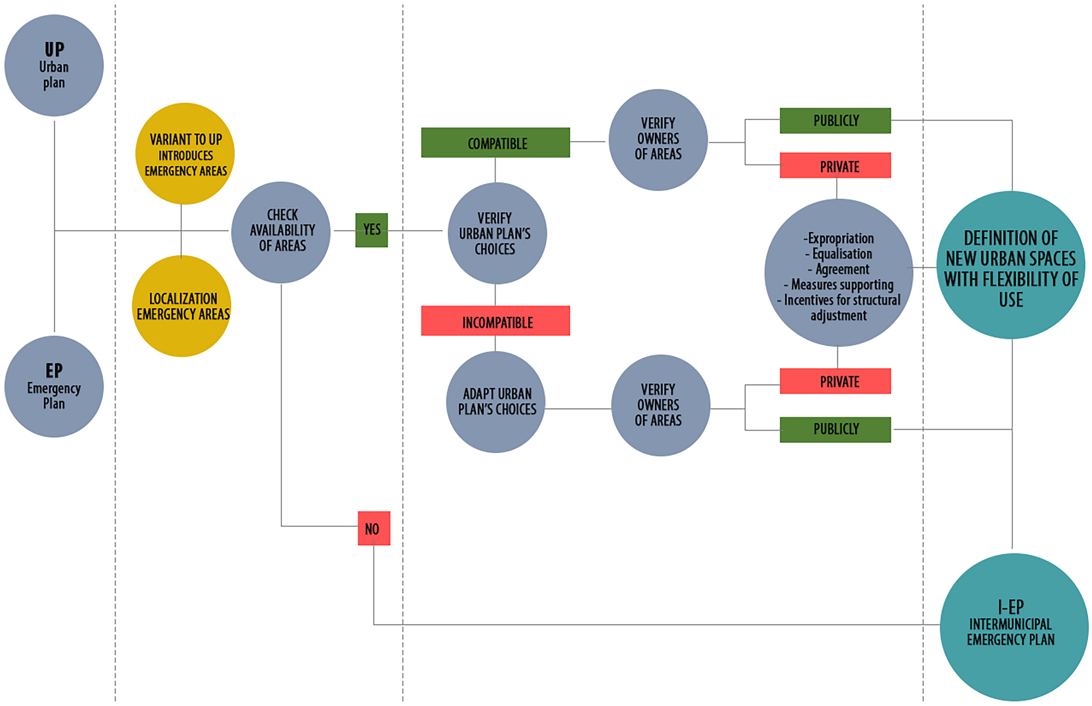


Fig. 3 Relationship between I-LCE, I-EP and urban plan

The final result of analysis makes it possible:

- to express a judgment on the functionality/operation of the I-EP respect to performances required to extra-urban system during the emergency phase, through performance evaluations of the individual elements;
- verify that the choices of the I-EP are compatible with spatial planning and urban planning;
- to identify an accurate image of the territorial risks and therefore of the critical areas through the know of a database to be put into a system with a regional / state platform, such as "Carta dei Luoghi e dei Paessaggi - CLeP" of the Abruzzo Region (Di Lodovico & Di Ludovico, 2014);
- to direct and to improve the strategic choices of the EP and the I-EP deriving from the latter.

- but, in innovative terms compared to the LCE, establish planning guidelines for the modification of spatial planning and land use. In this sense, the research intends the I-LCE also as a design tool and not just an evaluation tool.

To build a decidedly adequate digital platform when it comes to dynamic phenomena, such as risks, which change over time even abruptly, we need to consider many endogenous and exogenous factors. This platform can be addressed to the co-planning, to the verification of the knowledge system, to the dissemination and education of citizens on the Regional Management Risk Plan and the Local Mitigation Planning and finally to the governance of civil protection operations and to the verification of the risk management capacity. An example of a platform, which is being implemented in another line of research, is Hub Risk Data of the Abruzzo Region, elaborated starting from the geographical knowledge bases of the regional Geoportal. By a system whit EP/I-EP, LCE/I-LCE and a Platform of knowledge (of hazards, vulnerabilities and exposures, but even environmental and landscape components) we can:

- build multiple risk scenarios (multi-risk concept), to be used as a basis for territorial prevention and recovery projects in more fragile areas;
- addressing the strategic choices of emergency and ordinary planning;
- evaluate the performance and criticality of the local and regional emergency systems (which must relate to each other);
- work through a co-planning system;
- mitigate and prevent the effects of territorial risks;
- guarantee access to information for all.

These are issues that are only partly dealt with by the emergency planning and the LCE, and which are absolutely necessary to make the critical issues emerging from these instruments effective. Our proposal tries to follow this path towards integration (Di Lodovico & Di Ludovico, 2014).

4 CASE STUDY: THE AREA OF ALTO AND MEDIO SELE

The study area taken into consideration is that of Alto and Medio Sele, in the district of Salerno (Campania, Italy), and we considered in particular the municipalities of Buccino, San Gregorio Magno, Palomonte, Ricigliano and Romagnano al Monte (Fig. 4).

It is a homogeneous territorial area from the geomorphological, cultural and socio-economic point of view, essential prerequisite for implementing integrated planning. The study area is bounded to the north by the Monti Eremita-Marzano, Nature Reserve, and to the south by the mountain range of the Alburni Mountains, washed south by the river Platano – Bianco, tributaries of the river Tanagro, the main left tributary of the river Sele.

Over the centuries, the study area has faced multiple emergency situations:

- it was the epicentre of the earthquake that struck Irpinia in 1980 which caused extensive damage to people and property;
- it was affected by periodic phenomena of hydrogeological instability, including the most recent one dating back to 2011, when the territory to the north was invaded by muddy debris flows, damaging building and agricultural heritage.

Although the municipalities have provided emergency plans, the latter are already inadequate for initial analysis and identified resources. Five cognitive frameworks have been developed for the area: environmental, infrastructural, urban plans, risks.

That allows to identify the intrinsic and extrinsic characteristics of the territory, to analyze its vulnerabilities and exposure as well as to verify the system of management of emergencies in force in the individual municipalities. From this first phase of analysis it has emerged that on the territory of the study area there are many risk factors (through exposure, vulnerability and hazard analysis), a lack of functionality of the current emergency management system.

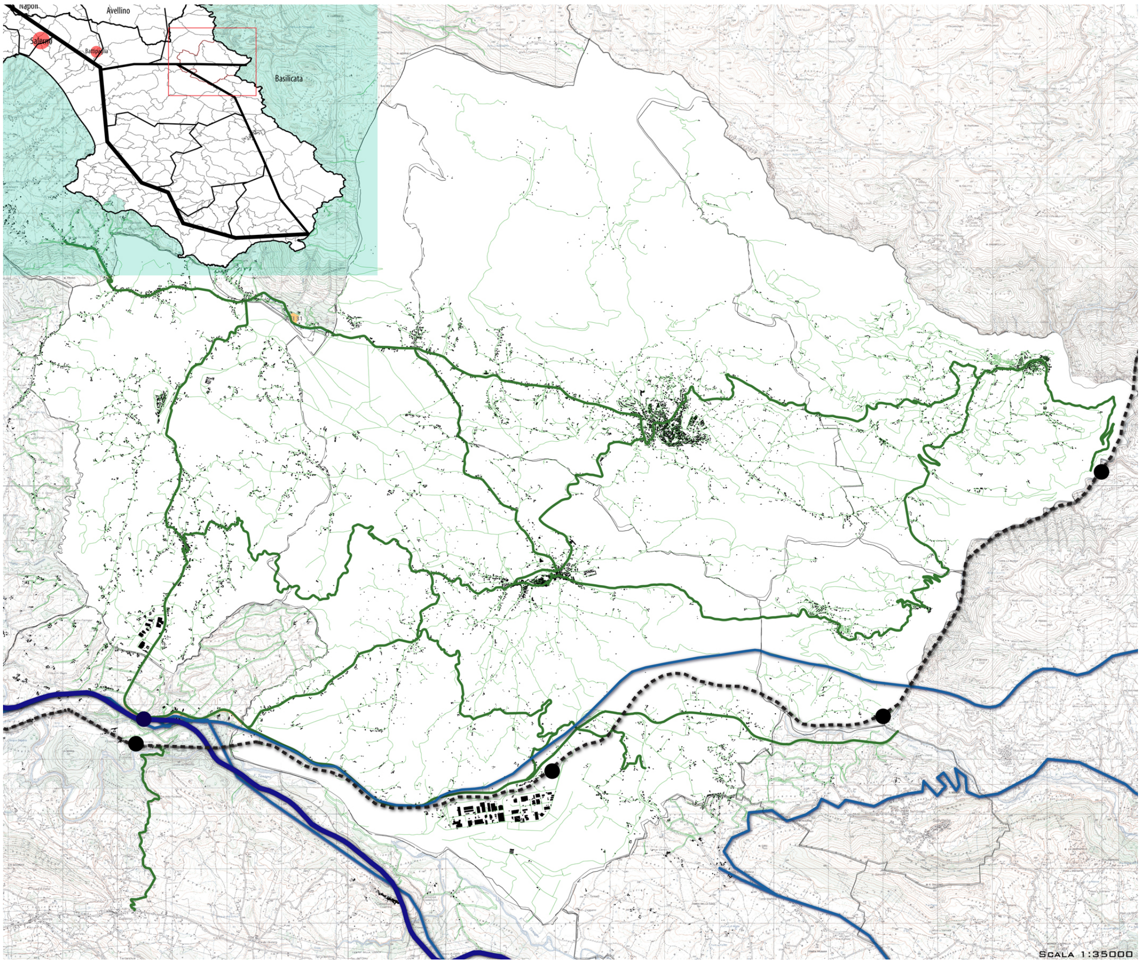


Fig. 4 Case study: the area of Alto and Medio Sele

The construction of the hazard map was very useful, the identification of all areas with different levels of hazard determined by natural and environmental factors. Particularly it was found that in the study area there are a total of 19,184 people, of which 3% are under 5 years of age and 11% are over 75 years old, about 2,795 residents move daily outside the municipalities for work and study. The inflows of people entering are 1,333 units. The territory is characterized by a medium-high seismic risk.

In addition, about 80% fall into areas at risk of landslides, while the hydraulic risk affects only the part south bounded by river effluents. The emergency management system limited to the municipal area (EP analysis) is undersized: all five municipalities have insufficient space and resources.

In particular, all the Emergency Areas identified by the Civil Protection Plans of the individual municipalities, in addition to not covering the needs required for the number of resident populations, fall into areas subject to danger, for which no mitigation action is planned (Tab. 1). It is evident that in the selection of emergency areas the criteria outlined by the Civil Protection guidelines have not been respected (Tab. 2).

Municipality	Max Users [US1]	Min Users [US2]	EP Waiting Areas [sqm]	Max Area [Standard, 2.5 sqm/US1]	Min area [Standard, 2,5 sqm/US2]	Max Deficit [sqm]	Min Deficit [sqm]
Buccino	7,224	5,474	8,691.39	18,060.00	13,685.00	-9,368.61	-4,993.61
San Gregorio Magno	5,892	4,939	10,001.00	14,730.00	12,347.50	-4,729.00	-2,346.50
Palomonte	5,450	4,339	4,273.00	13,625.00	10,847.50	-9,352.00	-6,574.50

Ricigliano	1,479	1,260	2,430.00	3,697.50	3,150.00	-1,267.50	-720.00
Romagnano al Monte	472	377	1,769.00	1,180.00	942.50	589.00	826.50
TOTAL	20,517	16,389	27,164.39	51,292.50	40,972.50	-24,128.11	-13,808.11

Tab. 1 Analysis table of the critical issues of Waiting Areas of Emergency Plan

Municipality	Max Users [US1]	Min Users [US2]	EP Meeting and Shelter Areas [sq.m]	Max Area [Standard, 17.50 sq.m/US1]	Min Area [Standard, 17.50 sq.m/US2]	Max Deficit [sq.m]	Min Deficit [sq.m]
Buccino	7,224	5,474	7,665.00	126,420.00	95,795.00	-118,755.00	-88,130.00
San Gregorio Magno	5,892	4,939	30,791.25	103,110.00	86,432.50	-72,318.75	-55,641.25
Palomonte	5,450	4,339	6,546.00	95,375.00	75,932.50	-88,829.00	-69,386.50
Ricigliano	1,479	1,260	6,135.00	25,882.00	22,050.00	-19,747.50	-15,915.00
Romagnano al Monte	472	377	1,686.00	8,260.00	6,597.50	-6,574.00	-4,911.50
TOTAL	20,517	16,389	52,823.25	359,047.00	286,807.50	-306,224.25	233,984.25

Tab. 2 Analysis table of the critical issues of Meeting and Shelter areas of Emergency Plan

Furthermore, in some urban areas, no emergency areas have been identified at all. There are many factors of exposure, vulnerability and risk and poor functionality of the current emergency management system, the results of the analysis suggest the need, for the municipalities under study, to have an I-EP based on the coordination of actions and procedures, on the sharing of spaces and resources.

Municipality	Max Users [US1]	Min Users [US2]	EP - Waiting Areas [sqm]
Buccino	7,224	5,474	101,366.00
San Gregorio Magno	5,892	4,939	120,020.00
Palomonte	5,450	4,339	83,468.00
Ricigliano	1,479	1,260	32,186.00
Romagnano al Monte	472	377	22,295.00
TOTAL	20,517	16,389	359,335.00

Tab.3 Project recovery areas for I-EP of Intermunicipal Emergency Plan

The aim of the project will be to define a new planning, territorial and emergency methodology that integrates safety with the theme of urban development (Tab. 3). These results were used to prepare I-EP of the area: a plan that allows coordination of actions and procedures to be implemented in an emergency phase that also includes sharing of spaces and resources. First of all, accessibility of the area was studied, identifying the main infrastructures for accessibility to the territory, determining in the GIS environment the travel time from the railway stations and the toll booths.

It is more than two hundred I-LCE tabs to were compiled to analyze:

- I - SB: Inter-municipal Strategic Buildings, essential for the emergency management (such IOC, hospitals, operational centers, etc) on a territorial scale, one of these buildings may become the headquarters of the DICOMAC[1];
- I- AE: Intercommunal Emergency Areas, such a meeting and shelter areas, as well as deposit areas where national Civil Protection can settle (National Mobile Column of Civil Protection);

[1] DICOMAC is a National Coordination Center of Civil Protection Operational Components and Structures activated in the territory affected by the event, if deemed necessary, by the Department of Civil Protection in case of national emergency.

- RAC: Routes for Access or Connection to strategic elements (I-ES, local Strategic buildings, Intercommunal and local Emergency Areas), analyzing primarily the functionality of the route, potential instability, structural aggregates potentially interfering with the route in case of structural collapse.
- I-AS: Intermunicipal structural aggregates, along paths whose collapse can interrupt their functionality or interfere with Emergency Areas (including SE);
- I-SU: Intermunicipal Structural Units.

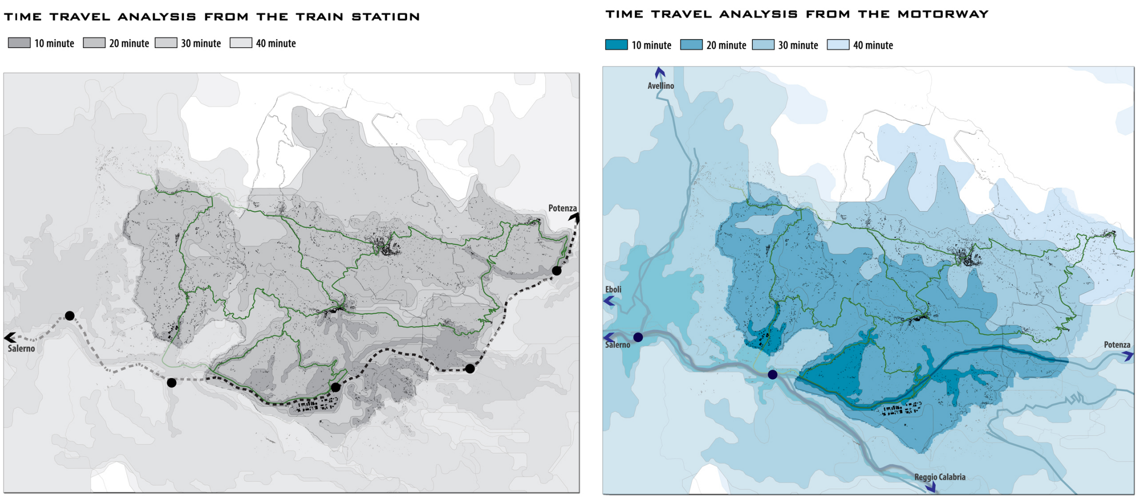


Fig. 5 Analysis of territorial accessibility from strategic transport elements

Information about these elements has been collected in a database and represented on digital cartography (in shapefile format) to understand the critical issues of the emergency system. Moreover, a verification was made about accessibility considering that in 40 minutes it is possible to reach all the areas of interest of the territory, starting from the main accessibility points (Fig. 5). The I-EP proposed for the union of municipalities consists of:

- a collection area for rescuers and inter-municipal resources located near the motorway exit in the territory of Buccino, with a size of 18,160 square meters;
- a storage area for rescuers and resources for each municipality;
- 51 areas of total population hospitalization distributed over the territory and sized according to the number of inhabitants and maximum users present in the area, considering the standard of dimensioning 17.5 sq.m/user.

The buildings that are part of the emergency management system have also been identified, in accordance with the DGR 438/2005 of the Abruzzo Region. Buildings are divided into:

- strategic, whose functionality during an event assumes fundamental importance for the purposes of civil protection;
- relevant, buildings that can become relevant in relation to the consequences of a possible collapse.

Among the strategic buildings, were located: in the municipality of Buccino, IOC, quickly reachable from the motorway exit; in each municipality a MOC (Mixed Operational Center) and a MOC (Municipal Operational Center).

Then it was possible to identify the strategic infrastructures, divided into:

- accessibility infrastructures which interconnect the emergency management system with the external territory sized in such a way as to allow rescue vehicles use;
- connection infrastructures connect strategic buildings and emergency areas.

Once the emergency management system has been defined, the same has been verified in terms of functionality and compliance of the areas and buildings with the criteria defined by the Civil Protection guidelines. For this purpose, the Inter-communal Emergency Plan was superimposed with maps of hazard and municipal urban plans, structuring a verification abacus. For each area and each strategic project building of interest, the location, characteristics, dimensions and level of dangerousness were indicated, and the travel times from each area and strategic building were calculated in the GIS environment. The emergency management system, emergency areas, strategic buildings, strategic infrastructures, were verified through field inspections that allowed the compilation of related experimental analysis forms defined in the I-LCE field. The sheets, duly completed, were computerized, so as to outline a first qualitative level of knowledge of the emergency management system. That permits to evaluate the functionality and operation of the plan regarding services required in the emergency phase, to define characteristics of individual areas, relationships between them and with the territory.

ELEMENTS OF I-EP / STRATEGIC INTERVENTIONS														
LANDSLIDES RISK MITIGATION														
EXAMINATION			DETAILED GEOLOGICAL SURVEY	DETAILED GEOLOGICAL SURVEY	DETAILED GEOLOGICAL SURVEY	DETAILED GEOLOGICAL SURVEY	DETAILED GEOLOGICAL SURVEY	DETAILED GEOLOGICAL SURVEY	DETAILED GEOLOGICAL SURVEY		DETAILED GEOLOGICAL SURVEY			
INTERVENTIONS			- Surfaces water canalization - Drainage	- Surfaces water canalization - Drainage - Suppotr structure and rainforcement stream	- Surfaces water canalization - Drainage	- Surfaces water canalization - Drainage	- Surfaces water canalization - Drainage	- Surfaces water canalization - Drainage - Suppotr structure and rainforcement stream	- Surfaces water canalization - Drainage - Suppotr structure and rainforcement stream		- Surfaces water canalization - Drainage			
HYDRAULICS RISK MITIGATION														
EXAMINATION														
INTERVENTIONS														
FIRES RISK MITIGATION														
EXAMINATION			DETAILED STUDY OF VEGETATION	DETAILED STUDY OF VEGETATION	DETAILED STUDY OF VEGETATION									
INTERVENTIONS			- Green fire boulevard - Prescribed fire - Appropriate forestry	- Green fire boulevard - Appropriate forestry	- Green fire boulevard - Appropriate forestry									
ACCESSIBILITY OF EMERGENCY AREAS														
SPACE	- Updating of the lighting - Maintenance of the area	- Upgrading of area - Creation of new spaces of community	- Recovery of existing building - Upgrading of area - Creation of new spaces of community	- Recovery of existing building - Upgrading of area - Creation of new spaces of community	- Recovery of existing building - Upgrading of area - Creation of new spaces of community - Updating of the lighting	- Updating of the lighting - Maintenance of the area	- Recovery of existing building - Upgrading of area - Creation of new spaces of community - Updating of the lighting	- Recovery of existing building - Upgrading of area - Creation of new spaces of community	- Recovery of existing building - Upgrading of area - Creation of new spaces of community - Updating of the lighting	- Updating of the lighting - Maintenance of the area	- Recovery of existing building - Upgrading of area - Creation of new spaces of community - Updating of the lighting	- Recovery of existing building - Upgrading of area - Creation of new spaces of community - Updating of the lighting	- Recovery of existing building - Upgrading of area - Creation of new spaces of community - Updating of the lighting	- Updating of the lighting - Maintenance of the area
NEW URBAN SPACES		Trade point	Camping area	Multifuntional urban space							Multifuntional urban space	Neighborhood macket	Urban vegetable garden	

Fig. 6 Matrix of interventions for the elements of the I-EP

The building stock was then analyzed, determining any interference with the strategic areas and infrastructures. For each interfering structural aggregate, the degree of vulnerability was defined considering the year of construction, the main structural typology, the maximum number of floors and the state of conservation. To create a system for the design actions on emergency spaces, strategic buildings and connecting elements, it was drawn up a matrix of interventions for the elements of the I-EP (Fig. 6).

The matrix establishes interventions for each emergency area, strategic building and strategic infrastructure to be implemented to make the I-EP operational and functional, to respond to the territorial development objective, to generate processes of re-functionalization that will allow revitalization and recovery of the territory. In fact, "families of interventions" have been identified for: risk mitigation, hydraulics, landslides and fires, expansion and territorial development, through the definition of new urban spaces with flexibility of use that respond to the need to make up for the shortage of territorial services and the lack of areas necessary for the management of emergency phases. For each element of the I-EP in the matrix, interventions aimed at guaranteeing accessibility and making available the necessary spaces have been indicated, including: updating of the lighting, recovery of existing buildings, maintenance and upgrading of the area, creation of new spaces of community.

To ensure coordination between urban planning and EP were identified a multifunctional areas destined in ordinary time to community spaces, and in emergency phase to a I-AE. In the case study, the new multifunctional areas are of the "F" type of the Urban Plan (Fig. 7). In these areas the use in ordinary time must be such as not to reduce or compromise characteristics of the area: they must be designed as territorial equipment, territorial centralities with a socio-economic and cultural value. For these reasons, they represent the places of resilience and experimentation to regenerate and reconvert with new functions and activities. At micro level, open spaces, if properly upgraded or in a suitable state of conservation, provide a range of benefits (Esopi, 2018).

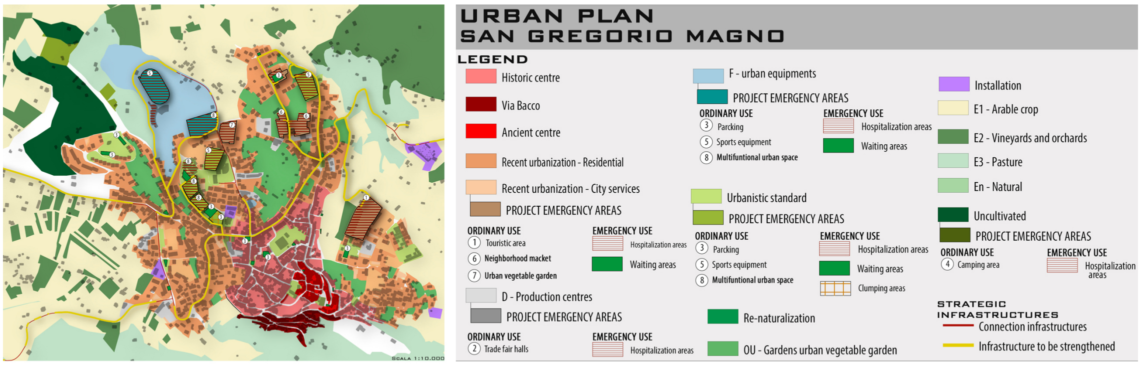


Fig. 7 Example coordination between urban planning and emergency planning

5 CONCLUSION

In the aftermath of a severe earthquake, one early priority in civil protection terms, is to guarantee the management of the emergency phase, which might be seriously inhibited when physical components of the contingency plan (critical buildings, emergency areas and lifelines) are either damaged or unusable (Dolce et al., 2017a, 2017b). The aim of the study is to define a new planning, territorial and emergency methodology, which integrates safety with the theme of urban development. The Plan will re-define or define a model of evolution and development, which is going to shift vulnerability and fragility of these territories to resilience (Rizzi et al., 2017). From this first experimentation we can point out that the analysis model of I-LCE thus identified allowed us:

- to have an overall picture of the emergency management system functioning when it results from urban settlements of associated municipalities and synergies between the choices and resources of individual municipalities;
- to integrate interventions on the territory for the mitigation of seismic risk;
- to verify the emergency management system, together with strategic buildings, emergency areas, connection and accessibility infrastructures identified by the I-EP;
- to verify choices for I-PE and EP of the individual municipalities;
- to verify the consistency between the choices of the I-EP and the real needs to respond to the emergency phase;
- to verify the consistency and compatibility between the choices of the I-EP and the strategic ones of the urban and spatial planning;
- to identify the most fragile areas on which to intervene;
- to use the "intervention matrix" prepared in the study for the I-EP elements to mitigate local and territorial risks and support changes in planning, retrofit and improvement of urban planning and spatial planning;
- to guarantee access to data for citizens, technicians and institutions through a shared database platform.

The next step concerns implementation and setting up of the system digital network platform, starting from the regional database, introduced previous paragraphs. This regional platform, it is currently under construction: only the cognitive part has been completed which will shortly be made accessible to everyone on the opengeodata (Regione Abruzzo, 2018). The data contained in the platform will be accessible for administrations, institutions and professionals and it will have a double goal: to create a dynamic knowledge of the territory and help and support decision makers in generate efficient policies and plans which support a sustainable development and increase resilience of the territories (Di Ludovico et al., 2017). A project of a digital platform will be developed (Damalas et al., 2018), addressed to the governance of civil protection operations and to the evaluation of the risk management capacity (EC, 2013), to the sharing of information (the cognitive framework), the Prevention Projects or the modalities of emergency intervention, and the communication and participation of citizens (Crawford et al., 2018; OECD, 2003; Poljanšek et al., 2017).
The I-LCE wants to be an integral part of this platform at the base of a planning model that is able to put into a system the urban planning issues, from the big scale to the local one, and the risk mitigation themes. It is a model that allows to define intervention strategies that, through the use of the most modern techniques and technologies, permit to identify and plan territorial interventions (regeneration, safety, etc.) according to shared priorities, certain times and costs (Di Lodovico & Di Ludovico, 2017). Therefore, a planning model based on the principles of caution, responsibility and prevention, in which the strategies for mitigating risks from earthquakes and floods must be understood as the responsibility of everyone. However, an effort to push forward decision making and to enhance cooperation with different members of community is necessary to restore affected territory and recreate the opportunity for future evolution of built-up area and evacuation sites (Mashiko et al., 2017). The encouraging results obtained from the first applications of I-LCE suggest continuing the experimentation on further settlements with different characteristics (size, complexity, problems), in order to test the sensitivity of the evaluation model on which we are still working, and which must be still perfected through the introduction of synthetic indexes. In addition to testing the model, we want to define more precise intervention matrices, with many types of risk mitigation measures. Furthermore, the use of platform allows us to create, what David Weinberger calls "The Smart Room": a system of knowledge that relates to the Internet of things, with an increasingly connected world. It is necessary to create a shared knowledge room that is filtered on several levels to improve decision-making, to allow the dissemination of knowledge to citizens and above all to be used to cooperate and share information and projects on several levels and to several stakeholders. This system wants to integrate models of territorial prevention with models of development of spatial and land-use plans to create a network of resilient territories.

REFERENCES

Burton, H. V., Deierlein, G., Lallemant, D. & Lin, T. (2016). Framework for Incorporating Probabilistic Building Performance in the Assessment of Community Seismic Resilience. *Journal of Structural Engineering*, *142*(8). doi:https://doi.org/10.1061/(ASCE)ST.1943-541X.0001321

Cara, S., Aprile, A., Pelà, L. & Roca, P. (2018). Seismic risk assessment and mitigation at Emergency Limit Condition of historical buildings along strategic urban roadways. Application to the "Antiga Esquerra de l'Eixample" neighbourhood of Barcelona. *International Journal of Architectural Heritage, 12*(7-8), 1055-1075. doi:https://doi.org/10.1080/15583058.2018.1503376

Castenetto, S. (2013). Gli indirizzi e criteri per la microzonazione sismica: un riferimento per la caratterizzazione sismica del territorio*. Urbanistica Dossier, 130*, 12-21.

Commissione Tecnica per la Microzonazione Sismica (CTMS) (2014a). *Manuale per l'analisi della Condizione Limite per l'Emergenza (CLE) dell'insediamento urbano. Draft 1.0.* Rome, IT: Betmultimedia. Retrieved from http://www.protezionecivile.gov.it/ resources/cms/documents/CLE2.pdf

Commissione tecnica per la Microzonazione sismica (CTMS) (2014b). *Standard di rappresentazione e archiviazione informatica. Analisi della Condizione Limite per l'Emergenza*. Rome, IT: Betmultimedia. Retrieved from http://www.protezionecivile.gov.it/resources/ cms/documents/StandardCLE_3.0.1.pdf

Crawford, M. H., Crowley, K., Potter, S. H., Saunders, W. S. A., & Johnston, D. M. (2018). Risk modelling as a tool to support natural hazard risk management in New Zealand local government. *International Journal of Disaster Risk Reduction, 28*, 610-619. doi:https://doi.org/10.1016/j.ijdrr.2018.01.011

Damalas, A., Mettas, C., Evagorou, E., Giannecchini, S., Iasio, C., … & Hadjimitsis, D. (2018). Development and Implementation of a DECATASTROPHIZE platform and tool for the management of disasters or multiple hazards. *International Journal of Disaster Risk Reduction, 31*, 589-601. doi:https://doi.org/10.1016/ j.ijdrr.2018.05.011

D'Ascanio, F., Di Lodovico, L., & Di Ludovico D. (2016). Design and urban shape for a resilient city. *Procedia - Social and Behavioral Sciences, 223*, 764-769. doi:https://doi.org/10.1016/j.sbspro.2016.05.265

Di Lodovico, L., & Di Ludovico, D. (2014). La "seconda stagione" Carta dei Luoghi e dei Paesaggi: Quadro Conoscitivo e Starting Point per la costruzione di Set di Indicatori di Criticità. *Planum Publisher, 30*, 956-961.

Di Lodovico, L., & Di Ludovico, D. (2015). La Vulnerabilità del Territorio. Dalla Condizione Limite per l'Emergenza Locale a quella territoriale. *Planum Publisher, 3*, 709-712.

Di Lodovico, L., & Di Ludovico, D. (2017). Territori fragili. Integrare le Conoscenze per una reale mitigazione dei Rischi. *Planum Publisher, 1*, 161-167.

Di Ludovico, D., Di Lodovico, L. & Basi, M. (2017). Rischi e funzionalità urbana per la pianificazione dell'emergenza. Il caso studio di Sulmona (AQ). *Planum Publisher, 1*, 1-7.

Dolce, M. (2012). *The Italian National Seismic Prevention Program*. Paper presented at the 15th World Conference on Earthquake Engineering. Retrieved from http://www.civil.ist.utl.pt/~mlopes/conteudos/SISMOS/DOLCE.pdf

Dolce, M., Speranza, E., Bocchi, F. & Conte, C. (2017a). *The method I.OPà.CLE for the formulation and calculation of structural operational efficiency indices for the assessment of emergency limit conditions*. Paper presented at the 17th Congress L'ingegneria Sismica in Italia, ANIDIS.

Dolce, M., Speranza, E., Bocchi, F. & Conte, C. (2017b). *Structural operational efficiency indices for the assessment of Emergency Limit Condition (I.OPà.CLE): experimental results*. Paper presented at the 17th Congress L'ingegneria Sismica in Italia, ANIDIS.

European Commission (EC) (2013). *Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism*. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013D1313

Esopi, G. (2018). Urban commons: social resilence experiences to increase the quality of urban system. *TeMA. Journal of Land Use, Mobility and Environment*, *11*(2), 173-194. doi:http://dx.doi.org/10.6092/1970-9870/5532

Fabietti, V. (2013). Dalla CLE alla SUM: i contenuti urbanistici della protezione dai rischi. *Urbanistica Dossier*, *130*, 38-39.

Federal Emergency Management Agency (FEMA) (2013). *Local Mitigation Planning Handbook*. Retrieved from https://www.fema.gov/media-library-data/20130726-1910-25045-9160/fema_local_mitigation_handbook.pdf

Formisano, A., Florio, G., Landolfo, R., & Mazzolani, F. M. (2011). *Numerical calibration of a simplified procedure for the seismic behaviour assessment of masonry building aggregates*. Paper presented at the 13th International Conference on Civil, Structural and Environmental Engineering Computing.

Lagomarsino, S., & Cattari, S. (2015). Perpetuate guidelines for seismic performance-based assessment of cultural heritage masonry structures. *Bulletin of Earthquake Engineering, 13*(1), 13-47. doi:https://doi.org/10.1007/s10518-014-9674-1

Mashiko, T., Satoh, S., Di Ludovico, D., & Di Lodovico, L. (2017). Post-earthquake Reconstruction and Urban Resilience: Japan and Italy Compared. *Urbanistica Informazioni*, *272*, 181-186.

Molavi, M. (2018). Meauring Urban Resilience to Natural Hazards. *TeMA. Journal of Land Use, Mobility and Environment, 11*(2), 195-212. doi:http://dx.doi.org/10.6092/1970-9870/5485

OECD (2003). *Emerging Systemic Risks in the 21st Century: An Agenda for Action*. Paris, F: OECD Publications Service. Retrieved from https://www.oecd.org/futures/globalprospects/37944611.pdf

Poljanšek, K., Marin Ferrer, M., De Groeve, T. & Clark, I. (2017). *Science for disaster risk management 2017: knowing better and losing less*. Publication Office of the European union, Luxembourg. doi:https://doi.org/10.2788/842809

Regione Abruzzo (2017). *Condizione Limite per l'Emergenza, Linee di indirizzo regionale di analisi ed elaborazione della condizione limite per l'emergenza intercomunale, draft 1.0*. Retrieved from https://protezionecivile.regione.abruzzo.it/index.php/condizione-limite-per-l-emergenza-cle

Regione Abruzzo (2018). *Opengeodata Regione Abruzzo*. Retrieved from http://opendata.regione.abruzzo.it/metadata_simple_search/ category/108

Rizzi, P., D'Ascanio, F. & Di Lodovico, L. (2017). *From fragile to resilient territories: the reconstruction after earthquakes in Central Italy*. Paper presented at the 53th ISOCARP-OAPA Conference 2017. Retrieved from https://isocarp.org/app/uploads/2017/12/Proceedings_V14_2017_12_21.pdf

United Nations Office for Disaster Risk Reduction (UNISDR) (2012). *Guidance note on Recovery: Pre-Disaster Recovery Planning*. Retrieved from http://www.unisdr.org/files/31963_predisa-sterrecoveryweb.pdf

United Nations Office for Disaster Risk Reduction (UNISDR) (2015). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. UN World Conference on Disaster Risk Reduction. Extract from the final report of the World Conference on Disaster Reduction (A/CONF.206/6)*. Retrieved from https://www.unisdr.org/2005/wcdr/intergover/official-doc/L-docs/Hyogo-framework-for-action-english.pdf

IMAGE SOURCES

Fig. 1: Civil Protection Department; Fig. 2: Author; Fig. 3: Roberto Fiaschi, Marco Natali, Francesca Tommasoni, Francesco Alberti, Figg. 4, 5, 6, 7: Nadia Robertazzi

AUTHOR'S PROFILE

Luana Di Lodovico, Ph.D., collaborates in the scientific research of the DICEAA-University of L'Aquila on the topics of Urban planning and design security oriented, risk mitigating, emergency-planning, preparedness and response, civil protection and rehabilitation measures and reduction of the vulnerability about urban system. She is currently member of INU (National Institute of Urban Planning); responsible of INU's community "Policies and interventions for the conservation of soils and urban vulnerability"; collaborates with the Urban Laboratory for the Reconstruction of L'Aquila (LAURAq-INU/ANCSA); collaborates with the AnTeA Laboratory (Territorial and Environmental Analysis) at the University of Aquila.

Donato Di Ludovico, Ph.D., researcher of Urban and territorial planning and design, Urban design professor at the University of L'Aquila (Engineering). He carries out scientific research activities within the new forms of Spatial and Strategic planning, Urban planning and design security oriented, knowledge and assessment systems (SEA). With regard to the Spatial planning, his research is focused on new models and new policies. He is currently secretary of INU Abruzzo-Molise section (National Institute of Urban Planning); director of Urban Laboratory for the Reconstruction of L'Aquila (LAURAq-INU/ANCSA); scientific responsible of AnTeA Laboratory (Territorial and Environmental Analysis) at the University of Aquila.

TeMA

Journal of
Land Use, Mobility and Environment

TeMA 3 (2018) 323-343
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/5806

review paper received 23th August 2018, accepted 10th December 2018

www.tema.unina.it

How to cite item in APA format:
Aslam, S. A. B., Masoumi, H. E., Asim, M., & Anwer, I. (2018). Cyclability in Lahore, Pakistan. Looking into Potential for Greener Urban Traveling. *Tema. Journal of Land Use, Mobility and Environment*, *11*(3), 323-343. doi:http://dx.doi.org/10.6092/1970-9870/5806

CYCLABILITY IN LAHORE, PAKISTAN

LOOKING INTO POTENTIAL FOR GREENER URBAN TRAVELING VALUE

S. ATIF BILAL ASLAM[a], HOUSHMAND E. MASOUMI[c]
MUHAMMAD ASIM[a], IZZA ANWER[b]

[a] Department of City and Regional Planning,
[b] Department of Transportation Engineering and Management,
University of Engineering and Technology Lahore (Pakistan)
e-mail: atif.aslam@uet.edu.pk; asim_planner@yahoo.com;
engr_izza@hotmail.com URL: http://www.uet.edu.pk/

[c] Center for Technology and Society (ZTG), Technische Universität Berlin
e-mail: masoumi@ztg.tu-berlin.de URL: https://www.tu-berlin.de

ABSTRACT

Measuring perceived or objective cyclability or bikeability has drawn less attention compared to walkability, particularly in developing countries like those in South Asia and the Middle East. This paper presents the results of a survey about cyclability in Lahore, Pakistan, focusing on human perceptions rather than the built environment. The overall sample included a total of 379 respondents from three socio-economic classes: those from lower socio-economic backgrounds accessing traditional/older bazaars, respondents from the middle socio-economic class accessing uptown bazaars, and respondents of higher socio-economic status accessing pedestrian shopping malls. The exploratory data collection was conducted in spring 2018 in Lahore by means of a short standard questionnaire with 19 questions, resulting in 17 categorical/dummy variables, two open-ended variables, and two continuous variables targeting socio-economics, bike trip characteristics, biking barriers, and preferred travel specifications. The results showed that the middle socio-economic group was more inclined, flexible, and willing to bike compared to the lower and higher socio-economic-groups. The lower socio-economic group used the bicycle more frequently than the middle socio-economic group. Around half of the middle socio-economic group commutes via bike compared to the lower socio-economic group. There was little to no representation of 55-64 and 65+ age groups in the data. The descriptive findings of this survey indicate some preliminary signs of differences of decisions and perceptions about biking compared to high-income and European countries. These differences need to be tested in future statistical analyses.

KEYWORDS:
Urban Transportation Planning; Sustainable Mobility; Active Transport; Cyclability; Pakistan

TeMA 有关土地使用、交通和环境的杂志

TeMA 3 (2018) 323-343
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/5806

review paper received 23th August 2018, accepted 10th December 2018

www.tema.unina.it

How to cite item in APA format:
Aslam, S. A. B., Masoumi, H. E., Asim, M., & Anwer, I. (2018). Cyclability in Lahore, Pakistan. Looking into Potential for Greener Urban Traveling. *Tema. Journal of Land Use, Mobility and Environment*, *11*(3), 323-343. doi:http://dx.doi.org/10.6092/1970-9870/5806

巴基斯坦拉合尔的循环稳定性
探索绿色城市旅游的潜力

S. ATIF BILAL ASLAM[a], HOUSHMAND E. MASOUMI[c]
MUHAMMAD ASIM[a], IZZA ANWER[b]

[a] Department of City and Regional Planning,
[b] Department of Transportation Engineering and Management,
University of Engineering and Technology Lahore (Pakistan)
e-mail: atif.aslam@uet.edu.pk; asim_planner@yahoo.com;
engr_izza@hotmail.com URL: http://www.uet.edu.pk

[c] Center for Technology and Society (ZTG), Technische Universität Berlin
e-mail: masoumi@ztg.tu-berlin.de URL: https://www.tu-berlin.de

摘要

与步行条件相比，衡量可感知的或客观的可循环性或自行车可骑性引起的关注较少，特别是在南亚和中东等发展中国家。本文介绍了在巴基斯坦拉合尔进行的一项关于可循环性的调查结果，强调的是人类感知，而不是建筑环境。普查包括来自三个社会经济阶层的379名受访者：来自社会经济背景底层的传统/较老的集市、来自社会经济中级阶层的受访者住宅区市场，以及社会经济地位上流的步行购物中心。2018年春季，在拉合尔通过一份包含19个问题的简短标准问卷进行探索性数据采集，得出17个分类/虚拟变量、两个开放变量和两个针对社会经济、骑车旅游、自行车障碍和首选旅行规范的连续变量。结果表明，与低、高社会经济群体相比，中层社会经济群体更倾向、更灵活、更愿意骑车。底层社会经济群体比中层社会经济群体更频繁地使用自行车。与底层社会经济群体相比，大约一半的中层社会经济群体骑自行车上下班。在数据中，55-64岁和65岁以上年龄组几乎没有骑车习惯。这项调查的描述性调查结果表明，与高收入国家和欧洲国家相比，关于骑自行车的决定和感知有一些初步的差异。这些差异需要在未来的统计分析中加以检验。

关键词:
城市交通规划，可持续流动，活跃交通方式，循环性，巴基斯坦

1 INTRODUCTION

This paper provides primary data derived from a mobility survey conducted in Lahore, Pakistan in 2018 and discusses the potentials and barriers of policy-making to promote biking in the Pakistani context. The findings might also be applicable for similar neighboring geographical and cultural contexts like the Indian subcontinent and the Middle East and North Africa (MENA) region. The necessity of conducing such cycling surveys is driven by the lack of reliable disaggregate data in Pakistan and its neighboring regions.

Urban cycling can curb the ill effects of motorized transport in urban areas with respect to congestion, parking spaces, amenity, air pollution and fatal accidents (Hickman & Banister, 2014). Therefore, there is a need to increase via urban planning the number of urban bicycle-users commuting short distances. Choice of transport mode has direct relation with household income as the literature findings suggest that high income group is more flexible in choosing the transport mode for commuting while the low income group has limited options (Replogle, 1992). Previous research has shown that the bicycle, along with cars and public transport modes, plays a significant role in mobility and livelihood for people especially the poor (Anand et al., 2006; Pinto & Sufineyestani, 2018). Pakistani cities are growing at a rapid pace. Lahore itself, the second biggest city in Pakistan, already has a population of 11.13 million (Government of Pakistan, 2017). While the population of Pakistan is 207.8 million with growth rate of 2.4% (Government of Pakistan, 2017), the share of population living in urban settings has increased from 32.5% to 36.4%. This growth puts pressure on infrastructure services, especially roads. Thus, it is important to conduct research on options that can reduce congestion on roads i.e. making Lahore (now considered a megacity) more cyclable to alleviate issues of pollution, congestion, parking, and high travel costs. There is no compiled data available in Pakistan on cycling trips, income level, age, and other factors that hinder bicycling as a mode of transport. Japan International Cooperation Agency (2011) stated that the bicycle, rickshaw, and horse carriage could play an important role in making urban transport a more convenient and affordable option in Pakistan. However, facilities and infrastructure for cyclists (being a sustainable and more affordable travel mode) are either nonexistent or inadequate. As a result, those who choose to use the bicycle regardless of this dearth of infrastructure end up being the victims of 50% of all road accidents (ibid). While the proportion of non-motorized daily trips including bicycles had remained relatively high in the past, it is now declining at a significant rate. In Lahore, this decreasing trend of bicycle trips can be attributed to the shift toward motorized vehicles and increased public transport usage in the absence of adequate cycling infrastructure. JICA study in 2011 stated that the estimated proportion of a person's daily trips using motorcycle/ bicycle was 18.8%, which suggests even a lower proportion of the trips being made explicitly by bicycles (Tab. 1).

Mode		Trips (,000)	Proportion	Proportion Excluding Walk
Public Transport		3,409	19.3%	35.4%
Private Vehicle	Cars	2,894	16.4%	30.1%
	Motorcycle/ Bicycles	3,314	18.8%	34.5%
Mechanized Total (Excluding Walk)		9,617	54.5%	100.0%
Walk		8,050	45.5%	-
Total		17,667	100.0%	

Tab. 1 Proportion of daily person's Trips in Lahore (JICA, 2011)

The 2011 JICA survey showed a significant decrease in use of bicycle. The major reason behind the decreasing trend of bicycling in Lahore is because of poor physical road infrastructure. The last few decades have also seen the development of several new housing communities that did not incorporate bicycles paths into their design. This mode is completely ignored in traffic junction design, forcing cyclists to dangerously mix in with motorized traffic and leading to low bicycle-usage. Thus, this research was conducted to collect primary data for the further analysis of the potential and constraints of cycling and to promote the integration of safe non-motorized transport modes into Pakistani urban planning.

This research is designed to address gaps in knowledge about the potential of cycling in Pakistani cities. The survey designed to answer the research gaps by investigating the effects of income, education, gender, travel distance, and bicycle ownership on cycling as a mode of transport. The survey results provide an overview of the potential of cycling in urban Pakistan. The questions sought to identify constraints like extreme weather, culture, gender, infrastructure for cycling, and dependence on family members for transport. Lastly, the survey also revealed users' mode choice depending on decisive factors like time, distance, and nature of trip. This contribution is limited to the descriptive statistics found during the data collection. In order to have enough space and capacity to present the details of the findings, this paper does not include any statistical hypothesis or modeling. The future works will use refer to this manuscript for the purpose of presenting modeling results. The survey and its findings provide numeric data for subsequent co-relational studies using dependent, independent, and extraneous variables. Statistical techniques like correlation and regression can be applied to this dataset. This study will also act as a reference unit for other urban areas in Pakistan with similar characteristics. The methodology and questions were designed to parallel the designs used in existing literature and to collect data in un-biased manner that represented all income groups.

2 CYCLABILITY

Cyclability usually refers to the ability to use the bicycle as a transport mode using spatial structures and streets, e.g. cyclability of a street (e.g. Guthrie et al., 2001) or a city (Muñoz et al., 2016). This study discusses urban cyclability but examines people's other travel choices and their individual and household conditions in addition to physical/spatial characteristics. The main reason is to improve the limited understanding of planners and decision-makers in Pakistan or similar contexts about people's perceptions of biking as a transport mode. Before it is possible to improve cyclability using objective interventions like developing biking infrastructure, it is necessary to have an evidence-based image of the factors that are associated with biking in the first place. The existing literature about cyclability shows that this term encompasses and is defined by a wide range of phenomena: modal split in order to choose policies, observed and estimated bicycle demand, bicycle levels of service, number of accidents, and physical and environmental benefits from biking (Berloco & Colonna, 2012). Jones and Novo de Azevedo (2013) observed that a "favourable climate, flat topography, fairly compact urban form and highly connected (gridded) street network appear to provide the fundamentals of a 'cyclable' city" but other cultural or human-related issues can support or weaken cyclability of a city or area. Parkin (2009) observes not only physical characteristics like road width, traffic flow and speed, average number of heavy vehicles and buses, gradient, bumpiness, lateral conflict, and aesthetics, but also human-related factors like overall feelings of safety, effort, and pleasure. Cyclability studies have a status like the general studies on the advantages and sustainability of biking. researchers take selected (not all) aspects and limit their studies only to some perpectives and viewpoints. For instance, Pirlone and Candia (2015) take socio-economic (social and economic sustainability) and environmental terms (environmental sustainability) for analyzing the sustainability of cycling. Examples of international efforts to improve cyclability can be seen in several high-income countries that invest in their biking infrastructures as a pull factor to reduce personal car use. In Spain, (Muñoz et al., 2016) collected data about cycling-related indicators of residents in the mid-sized city of Vitoria-Gasteiz by conducted an ad-hoc telephone mobility survey of 736 employees and students in 2012 and suggested some recommendations to transition the city to a more bike-friendly one. Their suggestions including "marketing campaigns to encourage non-commuting cycling trips, bicycle measures to target social groups as opposed to individuals, bicycle-specific programs such as "Bike-to-work Days", and cycling courses."

Data collected from interviews with 343 people in a district of Milan, Italy shows that improving the city's bike lane network could lead in a 34.4% increase in cycling in the district (Rebecchi et al., 2016). In Denmark, Nielsen et al. (2013) examined cyclability using information collected from the annual Danish National Travel survey. They used the data of 2009/2010 and 2010/2011 for a total of 39222 respondents – 9128 of whom cycled an average of 7.7 kms on the survey day – and concluded that there is a high probability of cycling for short distances. Another large Danish bikeability study was conducted from 2006 to 2014 on 59000 respondents living or working in cities with more than 9000 inhabitants. It observed several biking variables like trip stages, number of trips, journeys and the travel were associated with the socio-economic and demographic characteristics (Christiansen, 2012; Christiansen & Haunstrup, 2012; Nielsen & Skov-Petersen, 2018). Studies about cycling and cyclability have rarely been conducted in neighboring countries/regions with approximate similarities to the geographical and cultural situation of Pakistani cities. In India, bicycle ownership and trip data is available in census and many researchers have used this secondary data.

These studies have been conducted on the relationships between cycling and various environmental aspects, socio-economic status, and physical factors. Srivastavaa et al. (2017) established a relation between bicycle use and its environmental effects and concluded that using bikes could save significant amount of greenhouse gases. This research also concluded that low-income households use bicycles while middle- and upper-income households used motorized vehicles. Another study conducted by Majumdar and Mitra (2015) examined behavior of cycle users with respect to travel time and physical factors. Primary data was collected with a questionnaire survey in this study. In the Middle East and North Africa (MENA) region, research on cyclability mostly deals with topics of sustainable transport, urban road infrastructure, and efficient mobility. There is not enough work available on the opportunities and constraints of cycling and socio-economic factors.

Only a few studies have been done in some countries in the region: an empirical and analytical study to promote cycling among different age groups in Turkey (Tandogan & Ergun, 2013), and an urban cyclability assessment model in Doha, Qatar (Ferwati et al., 2017). Other works done on the neighboring region of the MENA include cycling as a part of mobility patterns as a whole and does not present the status of cycling and cyclability separately (Masoumi, 2013; Soltanzadeh & Masoumi, 2014). A review of the past studies on the similar topic reveals that the topic has mainly been explored through quantitative methods. Although there are indeed studies that investigate the various factors related to people's behaviors and perceptions toward cyclability through qualitative methods, they are fewer in number. There are also some studies who employed mixed-method techniques for data collection. Some of the studies specifically targeted cyclists, while others targeted all travelers using any travel mode or the area's residents. Of all the data collection methods employed in the studies, interviews via traveler-/commuter-intercept surveys were the most common method. Other methods consisted of web- or phone-based surveys, field observations, in-depth face-to-face resident interviews, expert interviews, and focus group discussions. Low response rates were often the main limitation for collecting data through web- and phone-based interviews: response rates generally ranged 20-60%. Response rates for traveler-intercept surveys were higher, with only one study reporting a rate of 19%.

Many of these studies used a variety of locations to perform the data collection. Some of them focused on particular districts in a city or the town/city as a whole, while others conducted surveys at key locations of trip routes e.g. commercial areas, cordon points, and (occasionally) residential areas. Response ratio (the sample coverage of overall city population in terms of percentage) ranged as low as 0.03% to a high of around 0.3%. Tab. 2 summarizes the results of some of the past studies on the same topic.

3 METHODOLOGY

This study explores cyclability on the Indian subcontinent using Lahore, Pakistan as a representative example. The term cyclability in this study refers to spatial issues like different socio-economic status of different urban districts as well as the individual and household characteristics and urban travel behaviors.

Study	Sample Size	Response Rate	Case-study areas	Response Ratio	Data collection method
Arora, 2013	574 bicycle users (109-124 at each location) and 82 cycle rickshaw pullers	Not available	All locations where National Highways intersect Delhi city border (05 in number)	0.01 (cyclists) and 0.02 (cycle rickshaw)	Video recordings of two-way traffic flows at various hours of the day and Personal interviews
Chatterjee et al., 2013	Qualitative sampling: 144 (12 in each Cycling City and Town)	Not available	12 Cycling City and Town in England	0.20	In-depth face-to-face interviews
Christiansen & Skougaard, 2015	2-Stage Stratified sampling (208 Strata): 16,465 persons	58.4%: 1,938 web and 7,666 telephone interviews	Danish residents belonging from 13 geographical groups	Not available	Web (self-administered) and telephone interviews in a year
Clifton et al., 2012	Random sampling: 1884 customers (Long surveys: 697 and short surveys: 1187)	19% (long survey) and 52 % (short survey	78 retail establishments in the Portland Metropolitan Area	Not available	Customers intercept survey (via handheld computer tablets) and Field observations of built environment in 2011
Gössling, 2013	Qualitative sampling	Not available	Copenhagen	Not available	Expert interviews
Jones & Novo de Azevedo, 2013	20 (2010) and 12 (2011) representatives, 12 participants of mass bicycle ride and 15 cycle commuters	Not available	Pelotas, Brazil	Not available	Focus group discussion, Field observations and random Interviews in 2010 & 2011
Majumdar & Mitra, 2015	50 potential respondents for expert interviews and Simple random sampling for travel survey: 575 responses	24.0% (12) for e-mailed survey	17 locations of substantial trip generation in Kharagpur, India	0.20	Expert interviews (AHP Questionnaire) sent out through emails and Travel intercept survey
Muñoz et al., 2016	736 employees and students	Not available	Vitoria-Gasteiz, Spain	0.30	Telephone survey in 2012
Nielsen & Skov-Petersen, 2018	9604 residents: The sample of Danish National Travel Survey	58.4%: 1,938 web and 7,666 telephone interviews	Danish residents belonging from 13 geographical groups	Not available	Secondary data of Danish National Travel Survey
Rebecchi et al., 2016	Random sampling of residents: 343 citizens	Not available	District 7, Milan	0.20	Web survey and Direct interviews

Tab. 2 Methodological considerations of similar past studies

This study was designed with the objective of creating a small but reliable dataset to link biking behavior with individual and household characteristics, travel behavior, and spatial factors. In Indian subcontinent especially in Pakistan, there is no reliable data available on bicycling. Therefore, descriptive statistics is yet a good contribution in this manuscript. The detailed statistical hypothesis or modelling will be presented in future work due to space limitation while referring to this manuscript.

3.1 CASE-STUDY AREAS

For the cyclability survey, Lahore is selected as it is the country's second biggest city and its population has increased at a high rate in recent years. Lahore's urban boundaries increased from 220 km in 1995 to 336 sq. km in 2005 and 665 sq. km in 2015 (Ibrahim & Riaz, 2018). The city's population grew by 3% from 5.20 million in 1998 to 11.13 million in 2017. This rapid growth of population translates into increased trip demand and has led to a shortage of available and effective transport. Fig. 1 shows Lahore's growth over the last two decades. In those two decades, the city grew southward in accordance with its master plan. This growth divided the city into areas populated by various socio-economic groups. The newly build residential sector housed middle- to high-income groups while the older developed areas housed mostly middle- and low-income groups. In the old parts of city, travel distances for activities like work, education, shopping, and leisure are generally shorter than in other parts of the city because land is used in a more mixed fashion. While on the other hand, segregation of land uses in the newly build residential areas increased the average length of trips and urban planning became car-based. Moreover, the policy of the last government regime was to promote signal-free corridors to facilitate the car users. The data shows Pakistan has experienced a massive increase (268%) in vehicle registration in the ten years between 2005 and 2015 (Gallup Pakistan, 2016). Bicycles are not included as there is no registration required for them. While it is thought that rapid transit systems in developed countries assist cities in their wealth creation by reducing car dependence, they are an expensive mode of travel in emerging countries (Newman & Kenworthy, 1999).

Two of the selected case sites in Lahore – Baghbanpura and Pakistani Bazar – are older sections of the city and have a mixed land-use urban texture. The internal road networks are largely composed of narrow and congested streets. Due to congestion, motor vehicle speed is reduced and it is safe to cycle in these areas. Baghbanpura and Pakistani Bazar are home to mostly low- to middle-income residents. Car ownership rates are lower in these areas than other parts of the city, but motorized vehicles like motorbikes and cars are still relatively common. Other selected sites – Liberty, Emporium Mall, and Packages Mall – can be considered high-income areas. Public transport routes are sufficiently developed that they can be effectively used by residents to access these shopping areas. Furthermore, all planning is oriented toward car-owners, such as large parking places and cheap parking prices. In these areas, bicycle-use is quite rare (mainly by servants in homes) as even students must commute with motorized vehicles because of long travel distances. Bicycle-use was completely ignored in road design and no parking is available for cyclists in these areas. The lack of infrastructure for cycling and the high average vehicle speed creates a dangerous environment for bike-users. The location of surveyed areas pointed out in Fig. 2.

3.2 DATA AND SAMPLE

The sample included 379 respondents spanning three socio-economic classes that correlated with their access to facilities to meet their needs. Respondents with lower incomes largely had access to traditional areas and older bazaars, while middle-income respondents accessed uptown bazaars and high-income respondents accessed pedestrian shopping malls. These bazaars and case-study markets are illustrated in Fig. 2.

The survey instrument was based on 21 questions focusing on spatial, individual and household characteristics, bike trip specifications, general mode choice, and causalities of bike-use. Tab. 3 summarizes the questionnaire including the variables and their types. Since most of the desired information was qualitative in nature, they were transformed into categorical and dummy variables suitable for discrete choice modeling. The questionnaire was kept as brief as possible so that the interviews could be completed quickly. The questionnaires were filled out during face-to-face interviews with residents living in various parts of the city.

The sample size provides only an exploratory look into residents' socio-economics, travel behavior, and cycling preferences; thus, no representativeness ratio or index is calculated for the survey. Tab. 4 summarizes the total number of respondents and valid responses for each question. In that table, "N/A" refers to either "No Response" or was applied when the question was not applicable to the respondent. This study's findings are presented in the form of frequencies and percentages for categorical and binary data as well as descriptive statistics for the two continuous variables. The two continuous variables were tested for normality via two methods: Kolmogorov-Smirnov and Shapiro-Wilk, where P-values of less than 0.05 indicate non-normality.

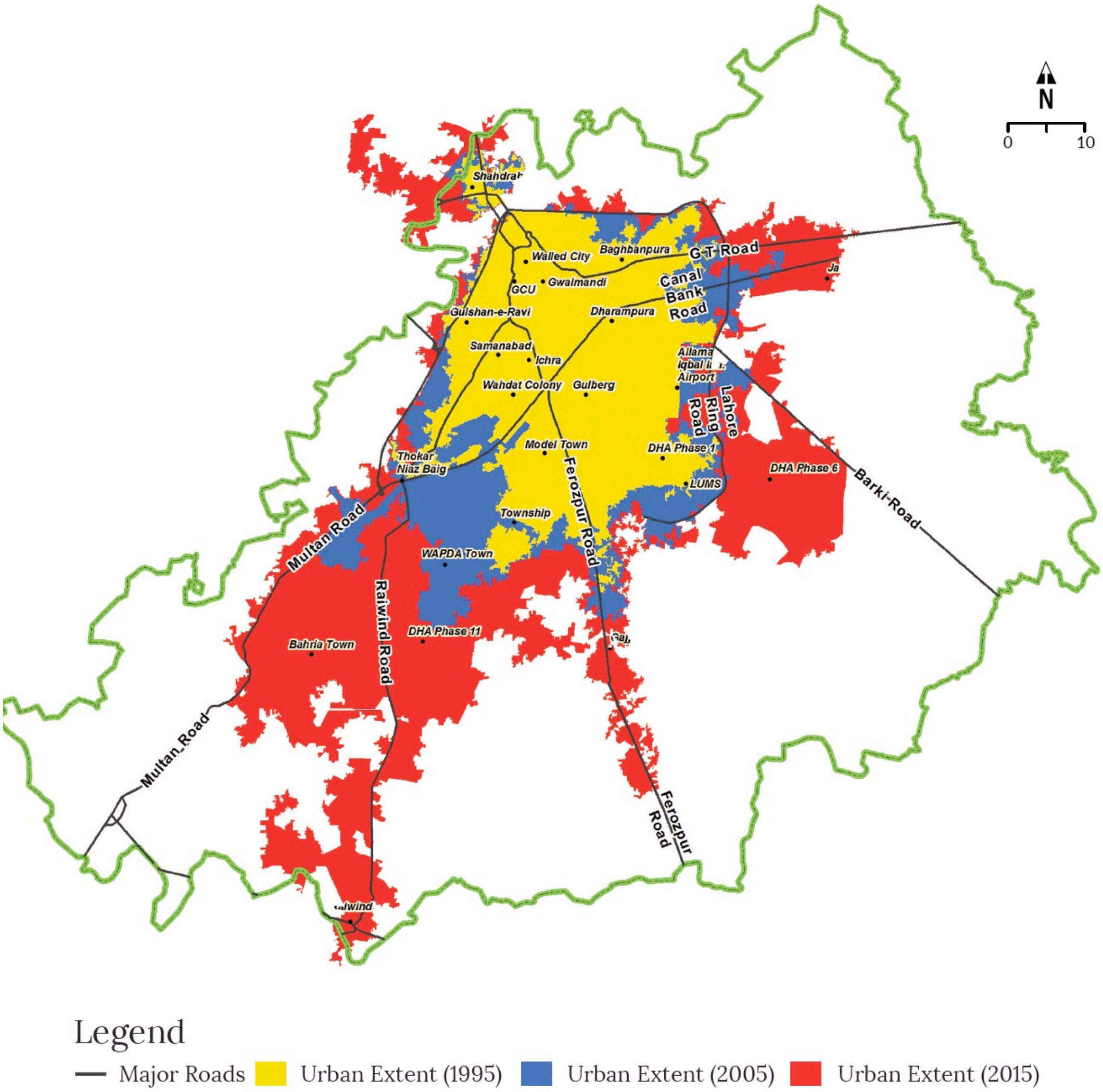


Fig. 1 Urban extent of Lahore (1995 to 2015).
Source: Ibrahim and Riaz, 2018

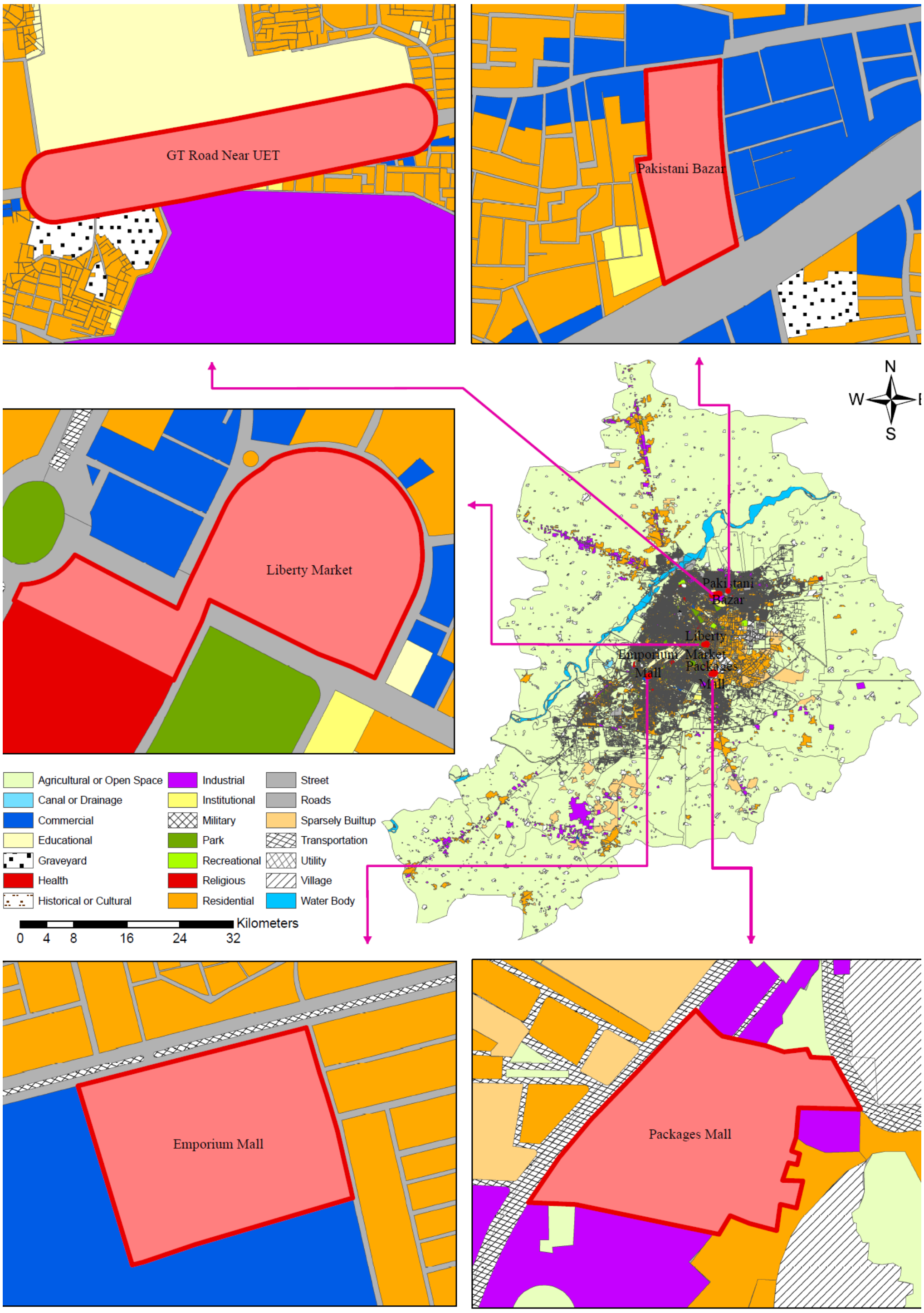


Fig. 2 Location of case study areas in Lahore City. Source (Authors, 2018)

Variable	Variable Type	Categories
Location	Categorical	Lower-Socio-Economics, Medium-Socio-Economics, and Higher Socio-Economics
Gender	Categorical	Male, Female, and Transgender
Age	Categorical	15-24; 25-54; 55-64; and >65
Income	Categorical	0-15,000; 15,000-50,000; 50,000 - 100,000; and >100,000

Education	Categorical	Under Matric, Matriculation, Under-Graduate, Graduate, and Post-Graduation
Know how to ride bicycle	Binary	Yes or No
If no why not?	Open-ended	-
Use for commuting	Binary	Yes or No
Cycling frequency	Categorical	Daily, Weekly, Monthly, Occasionally, and Need-Based
No. Of cycle user in house	Continuous	-
No. Of cycle owned in house	Continuous	-
Hindrance in bicycle use	Categorical	Health and Fitness, Weather and Environmental Condition, Culture, Gender, Family Dependency For Travelling, and Non-Availability Of Facilities I.E. Bicycle Lane
Purpose of majority trips	Categorical	Recreation, Educational, Work, Health, Fitness, and Wellbeing
Preferred mode of choice	Categorical	Walk, Cycle, Motorbike, Car, Public And Mass Transit, and Paratransit
Use cycle in addition or split of other mode	Binary	Yes or No
If not use cycle then reason	Open-ended	-
Preferred mode of choice irrespective of time	Categorical	Walk, Cycle, Motorbike, Car, Public And Mass Transit, and Paratransit
Preferred distance to travel using cycle	Categorical	0.25 Km, up to 5 Km, 5-10 Km, 10-15 Km, and More Than 15 Km
Preferred time to travel using cycle	Categorical	Under 15 Min, 15-30 Min, up to An Hour, and More Than 1 Hour
Preferred trip to travel using cycle	Categorical	Recreational, Educational, Shopping, Work, and Health-Fitness-Wellbeing
Aspect driving using cycle	Categorical	Affordability, Reliability, and Accessibility

Tab. 3 The survey instrument for quantification cyclability in Lahore, Pakistan

Category		Location	Gender	Age	Income	Education	Know how to ride bicycle
N	Valid	379	379	377	374	376	376
	N/A	0	0	2	5	3	3
Category		Use for commuting	Cycling Frequency	Hindrance in Bicycle use	Purpose of Majority Trips	Preferred mode of choice	Use Cycle in addition or split of other mode
N	Valid	341	176	364	372	374	353
	N/A	38	203	15	7	5	26
Category		Preferred mode of choice irrespective of time		Preferred Distance to travel using cycle	Preferred Time to travel using cycle	Preferred Trip to travel using cycle	Aspect driving using cycle

N	Valid	365	361	353	354	369
	N/A	14	18	26	25	10

Tab. 4 The sample size for each question

4 FINDINGS

Tab. 5 summarizes the non-continuous (categorical) findings of the overall sample by their frequencies and percentage shares. A large majority of the sample belonged to the lower socio-economic group (about 69%), while only 5% of the sample belonged to the middle socio-economic group. Due to cultural difficulties in interviewing, 71% of the respondents were male. Most respondents were in the age group of 25-54 years (66%). More than half of the respondents had an average monthly income of 15000 Pakistani Rupees (105€) to 50000 (351€)[1]. Between 24% and 28% of the sample had high school matriculation (graduation), or university degrees including under-graduate and graduate

The most popular modes of transportation in the sample were motorbike and car, each making up 33% of the responses, followed by bike at 11%. Nearly all of the respondents know how to ride a bike (97%), but less than one-third of respondents actually use it to commute. About 16% of the sample cycles daily and 14% cycles occasionally. The largest obstacles to biking are cultural issues (26%) and gender (24%) followed by other barriers related to the environment and infrastructure. Affordability, reliability, and accessibility are almost equally important for the respondent for the purpose of biking.

Another part of the findings is related to respondents' preferences regarding biking. Slightly more two-thirds of the all respondents reported that they prefer biking only short distances, i.e. up to 5 km. More than half (64%) prefer to bike less than 15 minutes, and 22% prefer biking up to 30 minutes. The travel purposes preferred for biking are recreation (21%), work (26%), and health, fitness, wellbeing (22%). The results are also graphically presented in Fig. 3.

Category		**n**	**%**	**Category**		**n**	**%**	**Category**		**n**	**%**
Location	Lower socio-economics	260	68.6	Know how to ride bicycle	yes	368	97.1	Education	under matric (less than a high school degree)	48	12.7
	Medium socio-economics	20	5.3		no	8	2.1		Matriculation (graduation)	92	24.3
	Higher socio-economics	99	26.1		N. A.	3	0.8		Under-graduate	105	27.7
Gender	Male	268	70.7	use for commuting	yes	116	30.6		Graduate	106	28.0
	Female	109	28.8		no	225	59.4		Post-graduation	25	6.6
	Transgender	2	0.5		N. A.	38	10.0		N. A.	3	0.8
Age	15-24	125	33.0	Cycling Frequency	Daily	62	16.4	Preferred Distance to travel using cycle	>1	19	5.0
	25-54	250	66		Weekly	27	7.1		0.25 Km	127	33.5
	>65	2	0.5		Monthly	11	2.9		up to 5 Km	131	34.6
	N. A.	2	0.5		Occasionally	52	13.7		5-10 Km	55	14.5

[1] Pakistani Rupees were converted to Euro based on the rate of 0.007€ for each Rupee (as of July 6, 2018).

Income	0-15000	82	21.6		Need Based	24	6.3		10-15 Km	29	7.7
	15000-50000	198	52.2		N. A.	203	53.6		N. A.	18	4.7
	50,000 - 100,000	78	20.6	Hindrances	Health and Fitness	48	12.7	Preferred Time to travel using cycle	under 15 min	242	63.9
	>100,000	16	4.2		Weather and Environmental Condition	55	14.5		15-30 Min	83	21.9
	N. A.	5	1.3		Culture	98	25.9		Up to an hour	28	7.4
Preferred mode of choice irrespective of time	Walk	41	10.8		Gender	91	24.0		N. A.	26	6.9
	Cycle	42	11.1		Non-availability of facilities	72	19.0	Preferred Trip to travel using cycle	Recreation	78	20.6
	Motorbike	124	32.7		N. A.	15	4.0		Education	71	18.7
	Car	123	32.5	Aspect driving using cycle	Affordability	123	32.5		Shopping	24	6.3
	Public / Mass Transit	31	8.2		Reliability	131	34.6		Work	99	26.1
	Paratransit	4	1.1		Accessibility	114	30.1		Health, Fitness, Wellbeing	82	21.6
	N. A.	14	3.7		N. A.	10	2.6		N. A.	25	6.6

Tab. 5 Categorical findings of the overall sample

It is also noteworthy to know how the results breakdown for different socio-economic statuses in the city. The overall share of male respondents was 71%. The dominant age group of 25-54 years ranged from 66% to 68% of respondents in the three socio-economic areas. A large portion of the sample in the lower- and middle-economic groups makes less than 15000 Rupees (105€) or 15000-50000 Rupees (105€ - 351€) per month, while less than half of respondents in the higher socio-economic group have a monthly income of 50000-100000 Rupees (351€ - 701€). There are more people with undergraduate (36%), graduate (36%), and postgraduate (10%) degrees in the case districts designated as higher socio-economic areas.

There is no large difference in biking skill levels in the three areas, but over half of respondents from middle socio-economic areas use bike to commute. The pattern of cycling frequency in middle socio-economic areas is slightly different from the other two areas. On average, people from these areas cycle occasionally (53%) based on needs (29%). The most-cited cycling barriers in the three socio-economic areas are culture (32%), gender (45%), and gender (26%) respectively. At 55.3%, 68.4%, and 64.8%, fitness, health, and wellbeing are the main reasons for biking in the three urban types. The preferred transport mode in the first group of areas is motorbike (45%), while in the second and the third groups of areas motorbike/car (25% and 25%) and car (60%) are the most popular choices. In the three socio-economic areas, 64%, 74%, and 75% use bike combined with other modes. The most preferred modes irrespective of time are motorbike and car in the first and second type of areas (combined: 69% and 60%), while car and walking are the most popular ones in the third type (combined: 69%). It is interesting that in higher socio-economic areas, 18% of people prefer to walk, compared to 9% and 5% in the other two urban types. Similarly, the tendency to bike in this area is 5% more than the other two. People in the middle socio-economic case sites have a stronger tendency to bike longer distances and for work (73%). Their most-cited biking-related issue is affordability (80%). Respondents from lower socio-economic areas prefer biking shorter distances. Accessibility is an issue for all three classes: one-fourth to one-third of the respondents from each type of area cited this problem. Fig. 4 presents the breakdown of the categorical findings for the three socio-economic areas.

There are two continuous variables: number of bicycle users per household and number of bicycles per household. Tab. 6 shows the descriptive statistics of these two variables for the whole sample. The number of bike users per household ranges from 0 to 5 with an average of 1.51, while bike ownership ranges from 0 to 4 with an average of 1.16. The distribution of these two variables was estimated by Kolmogorov-Smirnov and Shapiro-Wilk normality tests. The results show that the distributions are non-normal (P<0.001 as seen in Tab. 7). Although the number of bikes per household is lower in low socio-economic areas, the number of bike users is clearly higher in this urban type compared to the other two areas (Fig. 5).

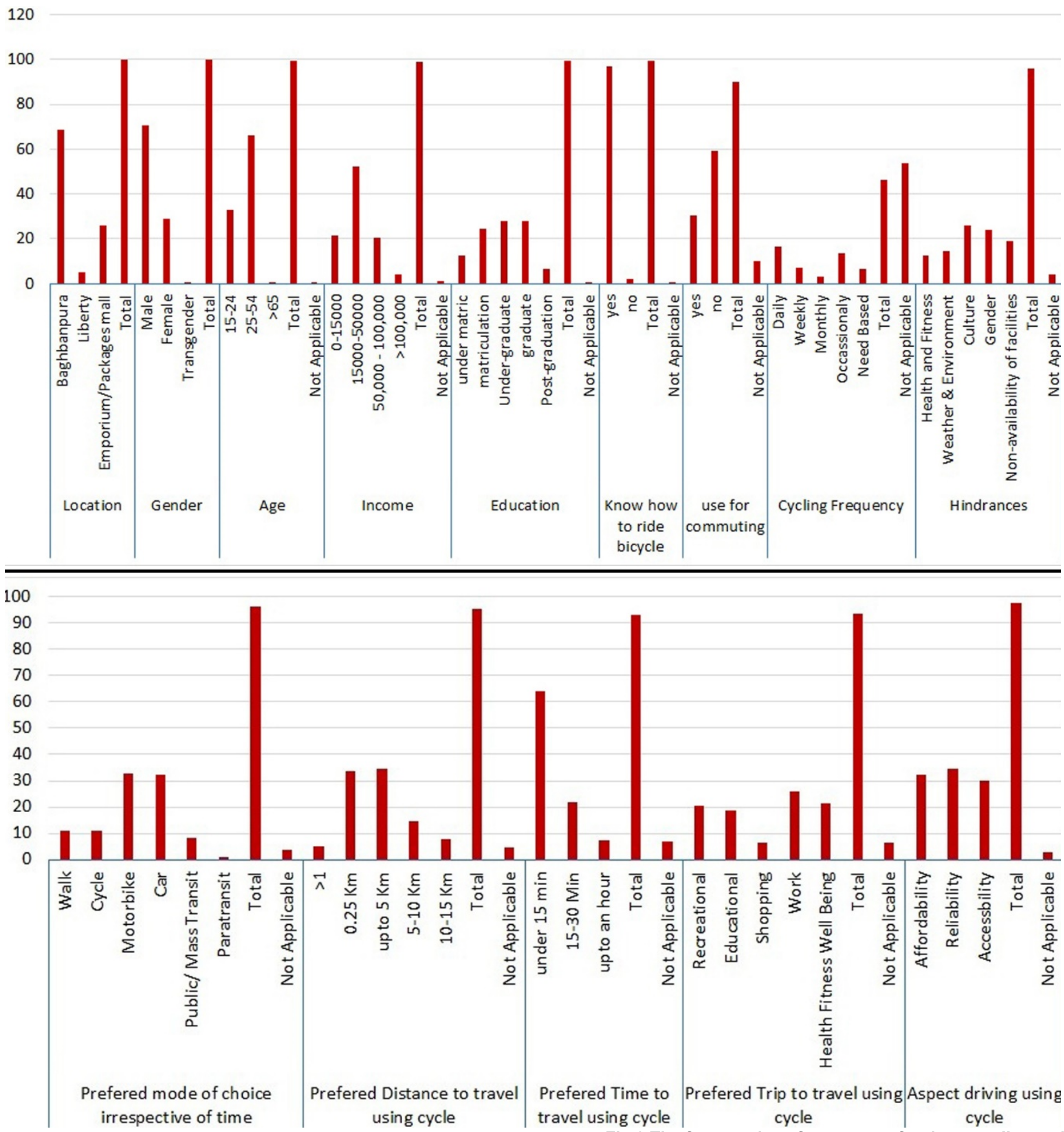
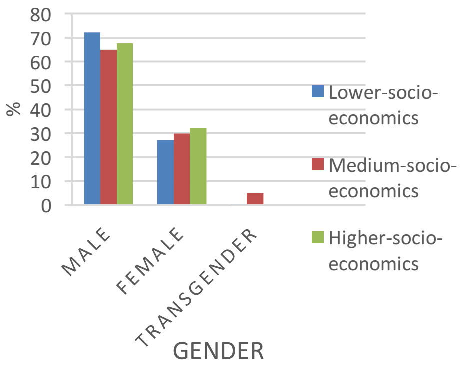
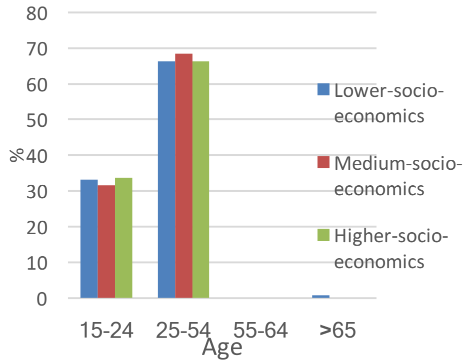
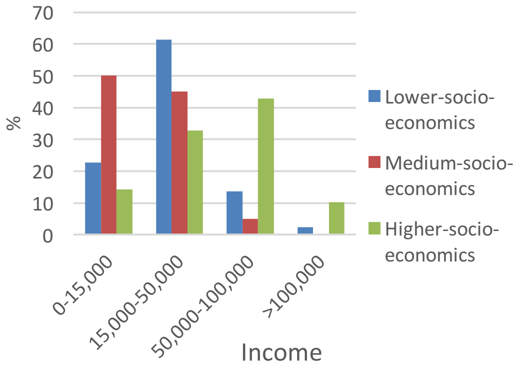
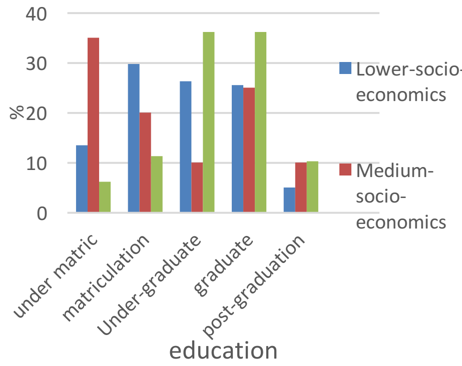


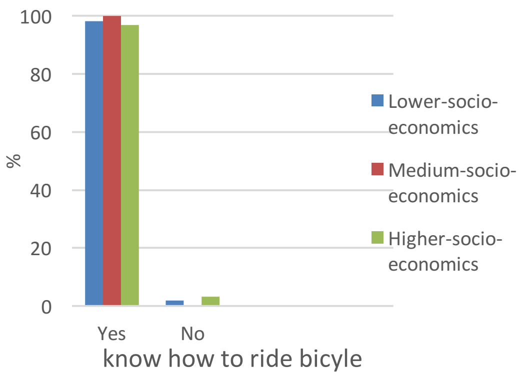
Fig.3 The frequencies of responses for the overall sample

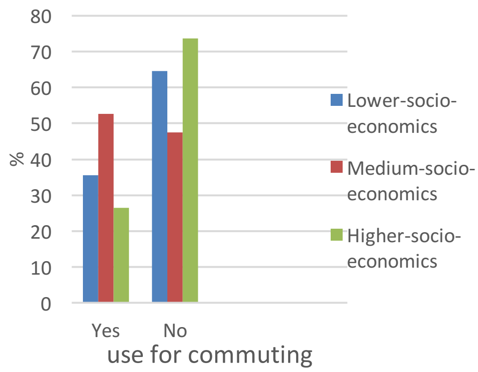

80
70
60
50
40
30
20
10
0
%
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics
MALE
FEMALE
TRANSGENDER
GENDER

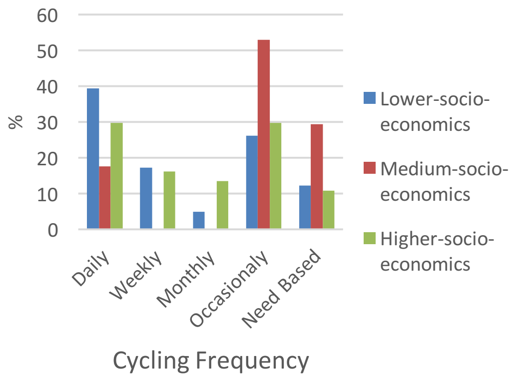

80
70
60
50
%40
30
20
10
0
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics
15-24
25-54
55-64
>65
Age

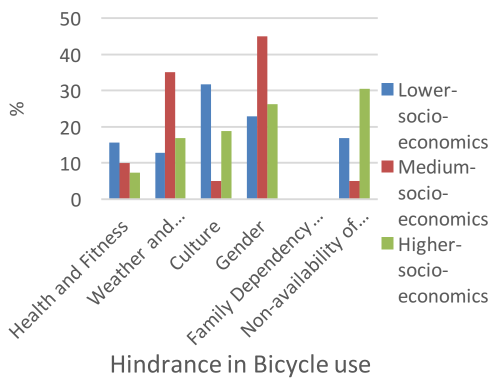

70
60
50
40
30
20
10
0
%
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics
0-15,000
15,000-50,000
50,000-100,000
>100,000
Income


40
30
%20
10
0
Lower-socio-economics
Medium-socio-economics
under matric
matriculation
Under-graduate
graduate
post-graduation
education


100
80
60
40
20
0
%
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics
Yes
No
know how to ride bicyle


80
70
60
50
% 40
30
20
10
0
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics
Yes
No
use for commuting


60
50
40
% 30
20
10
0
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics
Daily
Weekly
Monthly
Occasionaly
Need Based
Cycling Frequency


50
40
30
20
10
0
%
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics
Health and Fitness
Weather and...
Culture
Gender
Family Dependency...
Non-availability of...
Hindrance in Bicycle use

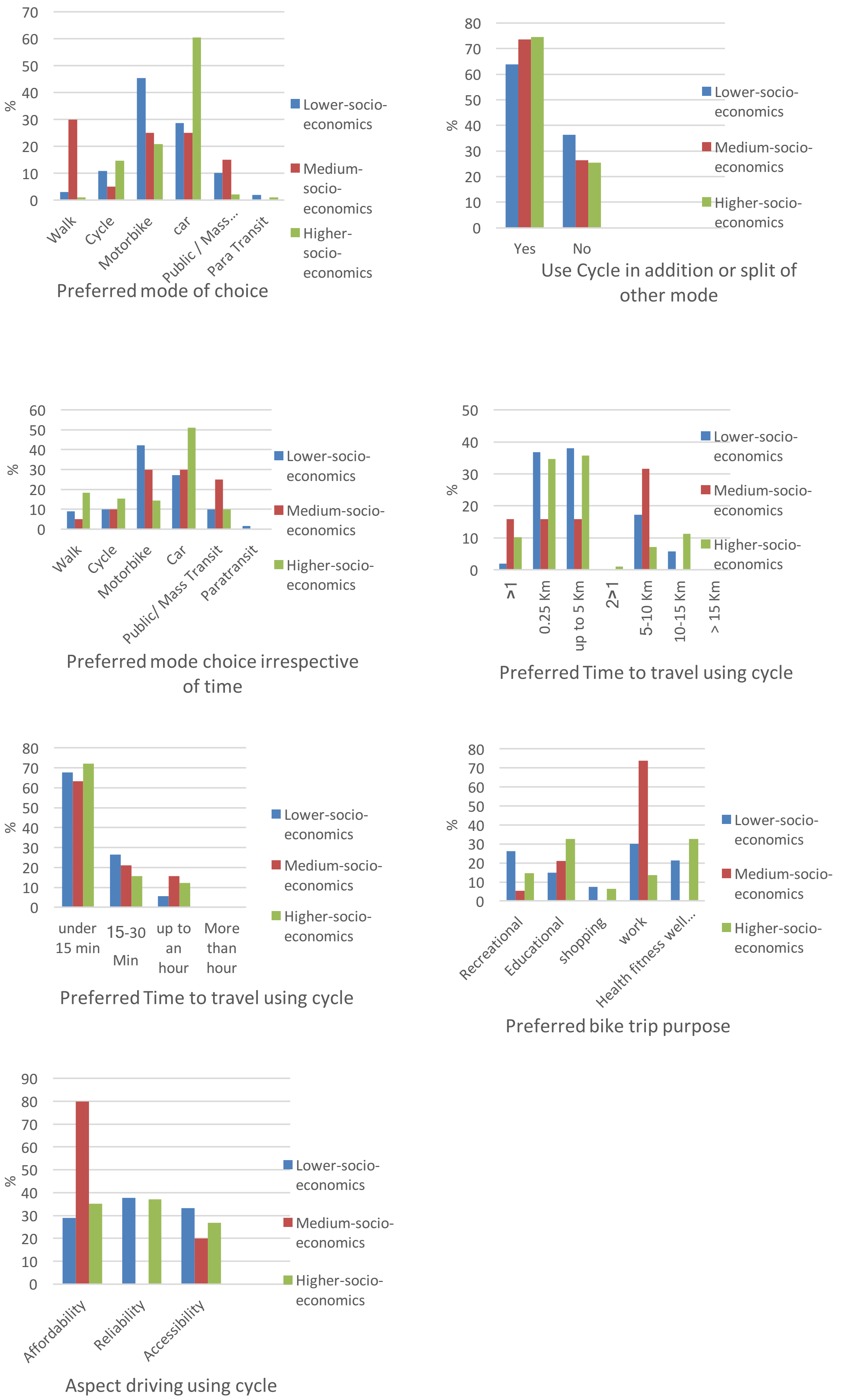


Fig. 4 Breakdown of the categorical findings for the three socio-economic areas

Variable	N	Minimum	Maximum	Mean	Std. Deviation	Variance
No of Cycle user in House5	181	0	5	1,51	1,214	1,474
No of Cycle owned in house	168	0	4	1,16	0,814	0,663

Tab. 6 Descriptive statistics of continuous variables

Variable	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	P-value	Statistic	Df	P-value
No of Cycle users in House	0,241	163	<0.001	0,889	163	<0.001
No of Cycle owned in house	0,319	163	<0.001	0,806	163	<0.001

Tab. 7 Normality test results for number of cycle users and owners per household

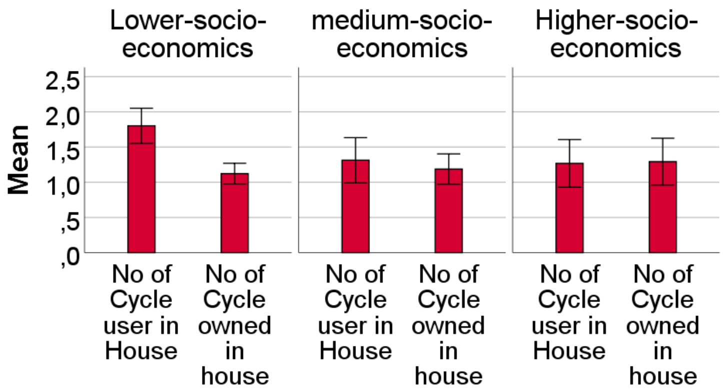


Fig. 5 Mean household bike ownership and use for three different socio-economic statuses of different districts

5 DISCUSSION

From the results above, this section discusses the standing of this research in comparison with global cycling practices. It is one of the first studies in Pakistan to explicitly include transgender residents in the survey sample, but the small number of transgender respondents makes it impossible to derive specific conclusions or recommendations based on their responses. The results showed that the middle socio-economic group was more inclined, flexible, and willing to cycle compared to lower and higher socio-economic-groups. Respondents from the lower socio-economic group frequently used bicycles compared to the middle socio-economic group. This might indicate a need-based cycling pattern and an obvious effect of socio-economic conditions of people on cycling. Bicycling is not that popular in Pakistan as in some of the other cities of Asian countries such as Singapore, Tokyo etc. who have recently developed their interest for cycling through the introduction of bike-friendly policies (Smethurst, 2015; Zhang et al., 2015).

According to the 1998 census (Government of Pakistan, 1998), around half the population of Pakistan is comprised of females and the other half is males. The results showed that culture and gender were the main hindrances that people of Lahore faced to bicycle, may be because it is perceived that the bicycle's emergence is a product of Western culture (Smethurst, 2015), which is generally not freely welcomed in parts of Lahore, even though Lahore is the second biggest and modernized city of Pakistan. It is interesting to note that respondents from lower socio-economic case sites cited culture-based hindrances more frequently, while respondents from middle socio-economic areas cited gender- and weather-based hindrances more frequently. Also, in low-cycling countries, cycling is not evenly distributed across all ages and genders (Aldred et al., 2016); the same pattern is observed in Lahore too. In Pakistan, there exists a significant geographical effect on the choice of mode of mobility as the residents of richer areas rely on automobiles (e.g. cars) and not on bicycles (or walking), slightly more than those of poor areas (Adeel, 2018). The results showed that higher socio-economic groups indicated that the lack of infrastructure is one of the causes to discourage cycling. Weather-related hindrances are another difficulty that the same respondents pointed out. The study also showed that highly educated respondents did not prefer cycling any more than less-educated respondents. This study gives evidence that a uniform cycling policy for all genders, age groups, and cultures through the provision of necessary infrastructure might not rectify barriers to cycling in Lahore.

A study from Belgium (Vandenbulcke et al., 2011) shows that commuting by bike in one neighborhood promotes commuting by bike in nearby neighborhoods. The results in this study showed that around half of the middle socio-economic group commutes by bike. This indicates an opportunity that introducing culture of commuting through bicycle in some of the neighborhoods of Lahore may impact other neighborhoods and can promote a cycling culture. This study showed that middle-socio-economic group was more active in commuting via biking compared to other two socio-economic groups. Therefore, if cycling is promoted in middle-income socio-economic groups, it may impact the same way (as discussed above) to encourage cycling in other two socio-economic groups as well.

Regardless of trip type, none of the groups significantly showed their preference towards cycling as a travel mode, indicating that cycling is not encouraged enough so far by both users and policy-makers. The reflections can be observed through non-availability of cycling infrastructure, lack of policy, plans, and practices (e.g. bicycle-sharing, bicycle and riding facilities through other mass-transit travel modes), non-integration with other travel modes (e.g. bus-transit). Other hindrances such as hot weather and socio-cultural barriers also need to be addressed to promote cycling. Countries that are most similar in circumstances to Pakistan (e.g. China) have already adopted bike-friendly policies and long-term urban transportation plans that integrate cycling as a travel mode (Zhang et al., 2015). Even in countries like America and Canada that are heavily dependent on motorized vehicles, infrastructure is designed to accommodate bikes and planners are now pushing for more bicycle-use and less car-use (El-Assi et al., 2017; Wray, 2015). This is done by implementing bike-friendly policies and redesigning infrastructure even through the existing land-use is not very conducive to cycling (El-Assi et al., 2017). Studies show that one important factor that dooms bicycling policies is a lack of willingness to cycle (Strömberg & Karlsson, 2016) whereas in this study results showed that considerable percentage of respondents were willing to use bicycle in addition to or in-split with other modes of travel. However, a responsive cycling policy to take care of their willingness (and needs) is missing which needs to be addressed through bicycle-friendly policies.

Time, distance, and purpose of trips are the important factors that influence mode choice and much published literature is available on this topic. The results of this study showed that, even if there is no time constraint, people of lower socio-economic group were less likely to prefer bicycle to commute to their work as showed by other studies too (Ji et al., 2017). It is found that they, along with higher socio-economic group would like to travel via motorbike and car. However, respondents from middle socio-economic areas opted for public transport in addition to motorbike and car. This shows that there are some other factors involved in mode choice e.g. distance and time constraints. Furthermore, respondents from lower and higher socio-economic groups preferred to travel by bicycle up to 5 km while middle socio-economic respondents showed more willingness to travel by bike up to 10 km. This is a very important figure to consider when planning urban transport systems for all modes of travel. In addition, the results also showed that, for shorter trips (especially under 15 minutes), respondents from all three socio-economic groups preferred to use the bicycle. Another influencing factor could be type of trip. This study showed that a significant percentage of respondents from middle socio-economic groups preferred to travel via bicycle to their work place because of the nature of trip e.g. studies show that work-stress (i.e. to reach to work place on time, type of work where repeated trips are to be made etc.) is one of the leading factors to choose travel mode to commute to work (Blanc & Figliozzi, 2016). The same group was also found to be more concerned about affordability.

The overall results show that there is a lot of potential to promote cycling practices in Pakistan among all socio-economic groups. There is need to introduce plans and policies to promote cycling in combination with other modes of transport like bike-sharing practices as in Denmark (Kaplan et al., 2015). Also, rather than solely relying on socio-economic parameters of cycling, other aspects necessary to be considered are improvement in the overall wellbeing, environment, health and urban-transportation related issues (Xiao-jiang, 2011). Some developing countries have already taken such initiatives by including cycling as a sustainable mode of travel into their policies, and recommendations to follow suit have been given in some of the literature available on Pakistan (Naeem et al., 2016). However, there is a need to take additional and more concrete steps in Pakistan, starting with the acknowledgment of biking as a viable and important mode of travel.

There is a general lack of academic studies and published research on bicycling in Pakistan, which makes it difficult to understand the perceptions and preferences of bike-users. This study has taken a leading step to address that issue by producing meaningful data on cyclability in Lahore. The study found that cycling and its benefits have previously been neglected by urban and transportation planners and policy-makers at local, regional, and national levels. It is clear from the results that people know how to ride the bike, there are active bike users, and people are willing to use the bicycle but are simply not encouraged to do so. There is a lack of planned strategies. There are social norms, weather conditions, gender- and culture-related hindrances with rectifiable effects that are not being challenged or addressed. There are many cost-effective solutions available that have been adopted by other low-income countries to integrate bicycle with other cost-effective and efficient mass transit modes (rail and bus) that can contribute to sustainable development of the country. However, such solutions have not been yet get due attention of the policy makers in Pakistan. The solution to this problem needs further in-depth understanding of the issues, a strong political will, initial capital, long-term planning, sustainable urban strategies, and inclusion of all stakeholders and modes of travel.

In terms of collected data, there was lower representation of respondents in the middle socio-economic group compared to the other two groups. Also, there was very little or no representation of the 55-64 and 65+ age groups in the data. Lahore itself is a metropolitan area with mixed land-use and mixed socio-economic distribution, so a larger sample with more defined socio-economic conditions/groups in relation with various land-uses can add further knowledge to the research question addressed in this study.

6 CONCLUSION

To conclude, this study has explored many aspects of bicycling in Pakistan (Lahore as a case study) with respect to three socio-economic groups. The overall reflection is that the bicycle is a desirable yet neglected mode of travel. It is a popular mode of travel (or/and have user) in all the three socio-economic groups that are analysed in this study which is very encouraging for the urban transport policy-makers. However, policy-makers have not embraced the bicycle as a critical opportunity to make environmentally sustainable and economically prudent policy solutions. There is a need to make bicycling more a viable and efficient mode of transport for all age groups, socio-economic classes, educational groups, cultures, and genders. The need for increased provision of bicycling infrastructure is highlighted, which would help to overcome some of the hindrances identified in this study. It will also encourage people to cycle longer distances, for longer time spans, and for multipurpose trips. The willingness of the users to bike to work can be thus further stretched to the other trip purposes too by implementing policies that encourage bicycling. In short, Pakistan can address future concerns in energy, economics, health and other sectors by including the bicycle as a mode of travel alongside other modes. There is a need to study Pakistani bicycling preferences in conjunction with different land uses e.g. commercial, residential, educational etc. in greater depth. This research can be further extended to collect large-scale data from other cities in Pakistan i.e. lower and higher income cities. This study presented the perspective of the cycle users, a similar study can be conducted by including the perspective of policy-makers to understand the opportunities, challenges, and potential of promoting bicycling in Pakistan.

REFERENCES

Adeel, M. (2018). Travel Behavior variations across urban and rural areas of Pakistan. *TeMA. Journal of Land Use, Mobility and Environment, Special Issue 1.2018*, 83-94. doi:http://dx.doi.org/10.6092/1970-9870/5456

Aldred, R., Woodcock, J., & Goodman, A. (2016). Does More Cycling Mean More Diversity in Cycling? *Transport Reviews*, *36*(1), 28–44. doi:https://doi.org/10.1080/01441647.2015.1014451

Anand, A., Tiwari, G., & Ravi, R. (2006). *The bicycle in the lives of the urban poor: Case study: Delhi*. Delhi, IN: Lecture.

Arora, A. (2013). *Non-Motorized Transport in Peri-urban Areas of Delhi, India*. Retrieved from https://www.researchgate.net/profile/Anvita_Arora/publication/317038954_Non-Motorized_Transport_in_Peri-urban_Areas_of_Delhi_India/links/5921bac8aca27295a8a63f63/Non-Motorized-Transport-in-Peri-urban-Areas-of-Delhi-India.pdf

Berloco, N., & Colonna, P. (2012). Testing and Improving Urban Bicycle Performance. *Procedia - Social and Behavioral Sciences*, *53*, 72–83. doi:https://doi.org/10.1016/j.sbspro.2012.09.861

Blanc, B., & Figliozzi, M. (2016). Modeling the Impacts of Facility Type, Trip Characteristics, and Trip Stressors on Cyclists' Comfort Levels Utilizing Crowdsourced Data. *Transportation Research Record*, *2587*, 100–108. doi:https://doi.org/10.3141/2587-12

Chatterjee, K., Sherwin, H., & Jain, J. (2013). Triggers for changes in cycling: the role of life events and modifications to the external environment. *Journal of Transport Geography*, *30*, 183–193. doi:https://doi.org/10.1016/j.jtrangeo.2013.02.007

Christiansen, H. (2012). *Documentation of the Danish National Travel Survey*. Lyngby. Retrieved from: https://core.ac.uk/download/pdf/13799137.pdf

Christiansen, H., & Haunstrup, B. (2012). *The Danish National Travel Survey-declaration of variables*. Lyngby. Retrieved from https://core.ac.uk/download/pdf/19183239.pdf

Christiansen, H., & Skougaard, B. Z. (2015). *Documentation of the Danish National Travel Survey (2015 version)*.

Clifton, K., Currans, K. M., Muhs, C. D., Ritter, C., Morrissey, S., & Roughton, C. (2012). *Consumer behavior and travel choices: A focus on cyclists and pedestrians*. Retrieved from https://www.ledevoir.com/documents/pdf/etudeportland.pdf

El-Assi, W., Salah Mahmoud, M., & Nurul Habib, K. (2017). Effects of built environment and weather on bike sharing demand: a station level analysis of commercial bike sharing in Toronto. *Transportation*, *44*(3), 589–613. doi:https://doi.org/10.1007/s11116-015-9669-z

Ferwati, M. S., Shafaghat, A., & Keyvanfar, A. (2017). Path cyclability assessment index model using design tree making method: A case of Doha-Qatar. *Malaysian Journal of Civil Engineering*, *29*. doi:https://doi.org/10.11113/mjce.v29.150

Gallup Pakistan. (2016). *Short roundup on transport infrastructure in Pakistan: Year 2000-2015. Based on Pakistan Economic Survey 2015-16 (Big data analysis series No. Paper 2)*. Retrieved from http://gallup.com.pk/wp-content/uploads/2016/11/Gallup-Pakistan-Big-Data-Analysis-Series-Edition-2-on-Transportation-Infrastructure-in-Pakistan-2000-to-20151.pdf

Gössling, S. (2013). Urban transport transitions: Copenhagen, City of Cyclists. *Journal of Transport Geography*, *33*, 196–206. doi:https://doi.org/10.1016/j.jtrangeo.2013.10.013

Government of Pakistan (1998). *Pakistan Census Report 1998*. Islamabad.

Government of Pakistan. (2017). *Provisional summary results of 6th population and housing census-2017*. Islamabad.

Guthrie, N., Davies, D. G., & Gardner, G. (2001). Cyclist's assessment of road and traffic conditions: The development of a cyclability index.*TRL Report 490*.

Hickman, R., & Banister, D. (2014). *Transport, climate change and the city*. London, UK: Routledge.

Ibrahim, M., & Riaz, S. (2018). Lahore growth - Past and future. Retrieved from http://urbanunit.gov.pk/Upload/Photos/Urban%20Gazette%20Issue%202018.pdf

Japan International Cooperation Agency (JICA) (2011). *The project for Lahore urban transport master plan in the Islamic Republic of Pakistan: Government of Punjab Project*. *Final Report*.

Ji, Y., Fan, Y., Ermagun, A., Cao, X., Wang, W., & Das, K. (2017). Public bicycle as a feeder mode to rail transit in China: The role of gender, age, income, trip purpose, and bicycle theft experience. *International Journal of Sustainable Transportation*, *11*(4), 308–317. doi:https://doi.org/10.1080/15568318.2016.1253802

Jones, T., & Novo de Azevedo, L. (2013). Economic, social and cultural transformation and the role of the bicycle in Brazil. *Journal of Transport Geography*, *30*, 208–219. doi:https://doi.org/10.1016/j.jtrangeo.2013.02.005

Kaplan, S., Manca, F., Nielsen, T. A. S., & Prato, C. G. (2015). Intentions to use bike-sharing for holiday cycling: An application of the Theory of Planned Behavior. *Tourism Management*, *47*, 34–46. doi:https://doi.org/10.1016/j.tourman.2014.08.017

Majumdar, B. B., & Mitra, S. (2015). Identification of factors influencing bicycling in small sized cities: A case study of Kharagpur, India. *Case Studies on Transport Policy*, *3*(3), 331–346. doi:https://doi.org/10.1016/j.cstp.2014.09.002

Masoumi, H. E. (2013). Modeling Travel Behavior Impacts of Micro-Scale Land Use and Socio-Economic Factor. *TeMA. Journal of Land Use, Mobility and Environment, 6*(2), 235-250. doi:http://dx.doi.org/10.6092/1970-9870/1484

Muñoz, B., Monzon, A., & López, E. (2016). Transition to a cyclable city: Latent variables affecting bicycle commuting. *Transportation Research Part a: Policy and Practice*, *84*, 4–17. doi:https://doi.org/10.1016/j.tra.2015.10.006

Naeem, M. A., Shamsuddin, S., & Sulaiman, A. B. (2016). *Policies and issues concerning urban sprawl and compact development paradigm adoption in Greater Kuala Lumpur, Malaysia*. Retrieved from https://malaysiacities.mit.edu/sites/default/files/documents/Naeem.pdf

Newman, P., & Kenworthy, J. (1999). *Sustainability and cities: overcoming automobile dependence*: Island press.

Nielsen, T. A. S., Olafsson, A. S., Carstensen, T. A., & Skov-Petersen, H. (2013). Environmental correlates of cycling: Evaluating urban form and location effects based on Danish micro-data. *Transportation Research Part D: Transport and Environment*, *22*, 40–44. doi:https://doi.org/10.1016/j.trd.2013.02.017

Nielsen, T. A. S., & Skov-Petersen, H. (2018). Bikeability – Urban structures supporting cycling. Effects of local, urban and regional scale urban form factors on cycling from home and workplace locations in Denmark. *Journal of Transport Geography*, *69*, 36–44. doi:https://doi.org/10.1016/j.jtrangeo.2018.04.015

Parkin, J. (2009). *The humps and the bumps: objective measurement using an instrumented bicycle*. Paper presented at the Research and Innovation Conference. Retrieved from https://www.researchgate.net/profile/John_Parkin2/publication/44789368_The_humps_and_the_bumps_objective_measurement_using_an_instrumented_bicycle/links/53e86ebd0cf21cc29fdc45bf.pdf

Pinto, F. & Sufneyestani, M. (2018). Key Characteristics of an Age-Friendly Neighbourhood. *Tema. Journal of Land Use, Mobility and Environment*, *Special Issue Elderly Mobility*, 117-132. doi:http://dx.doi.org/10.6092/1970-9870/5754.

Pirlone, F. & Candia, S. (2015). Cycle Sustainability. *TeMA. Journal of Land Use, Mobility and Environment, 8*(1), 83-101. doi:http://dx.doi.org/10.6092/1970-9870/2921

Rebecchi, A., Boati, L., Oppio, A., Buffoli, M., & Capolongo, S. (2016). Measuring the expected increase in cycling in the city of Milan and evaluating the positive effects on the population's health status: a community-based urban planning experience. *Annali di Igiene Medicina Preventiva e di Comunità*, *28*(6), 381–391. doi:http://dx.doi.org/10.7416%2Fai.2016.2120

Replogle, M. (1992). Bicycles and cycle-rickshaws in Asian cities: issues and strategies. *Transportation Research Record*, 76–84. Retrieved from http://onlinepubs.trb.org/Onlinepubs/trr/1992/1372/1372.pdf#page=82

Sagaris, L. (2015). Lessons from 40 years of planning for cycle-inclusion: Reflections from Santiago, Chile. *Natural Resources Forum*, *39*(1), 64–81. doi:https://doi.org/10.1111/1477-8947.12062

Smethurst, P. (2015). Mobility: The Practical and Cultural Impact of Bicycling in the West. In P. Smethurst (Ed.), *The Bicycle—Towards a Global History* (pp. 67–104). London, UK: Palgrave Macmillan. doi:https://doi.org/10.1057/9781137499516_3

Soltanzadeh, H., & Masoumi, H. E. (2014). The Determinants of Transportation Mode Choice in the Middle Eastern Cities: the Kerman Case, Iran. *TeMA. Journal of Land Use, Mobility and Environment*, *7*(2), 199-222. doi:http://dx.doi.org/10.6092/1970-9870/2518

Srivastavaa, A. K., Mishrab, S., & Chakravartyc, D. (2017). Analysis of Bicycle Usage in India: An Environmental Perspective. *International Journal of Innovations & Advancements in Computer Science, 6*(8), 27-37. Retrieved from http://academicscience.co.in/admin/resources/project/paper/f201708081502181251.pdf

Strömberg, H., & Karlsson, I. M. (2016). Enhancing utilitarian cycling: a case study. *Transportation Research Procedia*, *14*, 2352–2361. doi:https://doi.org/10.1016/j.trpro.2016.05.264

Tandogan, O., & Ergun, N. (2013). Assessment of the Child-Friendliness of the Küçük Ayasofya Neighborhood in Istanbul, Turkey. *Children, Youth and Environments*, *23*(3), 164. doi:https://doi.org/10.7721/chilyoutenvi.23.3.0164

Vandenbulcke, G., Dujardin, C., Thomas, I., Geus, B. de, … & Panis, L. I. (2011). Cycle commuting in Belgium: spatial determinants and 're-cycling'strategies. *Transportation Research Part A: Policy and Practice*, *45*(2), 118–137. doi:https://doi.org/10.1016/j.tra.2010.11.004

Wray, J. H. (2015). *Pedal power: The quiet rise of the bicycle in American public life*. New York, USA: Routledge.

Xiao-jiang, L. (2011). Thoughts on Urban Transportation Policy [J]. *Urban Transport of China*, *1*, 7–11. Retrieved from http://en.cnki.com.cn/Article_en/CJFDTOTAL-CSJT201101009.htm

Zhang, L., Zhang, J., Duan, Z.-y., & Bryde, D. (2015). Sustainable bike-sharing systems: characteristics and commonalities across cases in urban China. *Journal of Cleaner Production*, *97*, 124–133. doi:https://doi.org/10.1016/j.jclepro.2014.04.006

IMAGE SOURCES

Cover photo: Syed Farhan Ahmed (Final-year student of the Department of city and Regional Planning, University of Engineering and Technology Lahore, Pakistan. Location: GT Road, Lahore. Date: 27 Dec. 2018).

AUTHOR'S PROFILE

Atif Bilal Aslam is Assistant Professor in the Department of City and Regional Planning, University of Engineering and Technology Lahore, Pakistan. He holds PhD in urban development planning from Technical University of Dortmund, Germany. His main scientific interests include urban planning, urban mobility, sustainable development and international migration.

Houshmand E. Masoumi is senior researcher at Center for Technology and Society of Technische Universität Berlin, Germany. His research insterests include statistical modeling of urban travel behavior, land use - transportation interactions, urban sprawl and travel behavior, and the travel behavior analysis of special demographic and age groups.

Muhammad Asim is an urban and regional planner, PhD in Urban Engineering, assistant professor at the University of Engineering and Technology in City and Regional Planning Department, where he teaches urban land management, Disaster Management and Estate Management. His research interest deal with the study of socio-economic disparities in growing regions, vulnerability assessment and climate change adaptation.

Izza Anwer is transport engineer and is Assistant Professor in the Department of transportation engineering and management, faculty of Civil engineering, University of Engineering and Technology Lahore, Pakistan. She holds a PhD in the field of Intelligent transport system technologies integrated with transport systems and disasters from Institute for transport studies, University of Leeds, UK. Her research interests include Intelligent transport systems, disasters, community building, urban planning, multi-modal transport planning and engineering and multiple data analysis techniques.

Antonio Leone Carmela Gargiulo
Editors

Environmental and territorial modelling for planning and design

INPUT TeMA*Lab* Dicea UniNa

Federico II Open Access University Press

fedOAPress

TeMA

Journal of
Land Use, Mobility and Environment

TeMA 3 (2018) 345-360
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/5616

review paper received 4th June 2018, accepted 17th December 2018

www.tema.unina.it

How to cite item in APA format:
Varriale, R. (2018). Water Footprint Indicators for urban planning. *Tema. Journal of Land Use, Mobility and Environment*, *11*(3), 345-360. doi:http://dx.doi.org/10.6092/1970-9870/5616

WATER FOOTPRINT INDICATORS FOR URBAN PLANNING

ROSSANA VARRIALE

Department of Earth, Environmental and Resources Science (DISTAR)
University of Naples Federico II (Italy)
e-mail: rossana.varriale@unina.it

ABSTRACT

Compared with the great number of studies carried out on virtual water, the Urban Water Footprint - UWF, has been object of less attention from researchers, probably because only in the last decade city water shortage has presented itself as global problem.
The study analyses the issue of the water value as a non-renewable resource, subjected to pressures that influence its quality and quantity. The "value" of water therefore indicates the measure of a resource used as an indispensable element of urban complexity, subtracted from its ecosystem and transformed from a natural resource to an anthropic resource.
Two indicators of the Water Footprint Network-WFN are proposed to analyze the water footprints of urban areas. The blue water indicator, generally used by the WFN to assess the stress of water bodies, where in this study is calculated as urban water consumption. The green water indicator used by the WFN to assess the rainfall uses of an regional area is analyzed here as an ecosystem element of the urban territory.

KEYWORDS:
Urban Water Footprint; Planetary Boundaries; Urban Water Planning

TeMA 有关土地使用、交通和环境的杂志

TeMA 3 (2018) 345-360
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/5616

review paper received 4th June 2018, accepted 17th December 2018

www.tema.unina.it

How to cite item in APA format:
Varriale, R. (2018). Water Footprint Indicators for urban planning. *Tema. Journal of Land Use, Mobility and Environment*, *11*(3), 345-360. doi:http://dx.doi.org/10.6092/1970-9870/5616

水足迹，城市规划指标

ROSSANA VARRIALE

Department of Earth, Environmental and Resources Science (DISTAR)
University of Naples Federico II (Italy)
e-mail: rossana.varriale@unina.it

摘要

与对虚拟水资源进行的大量研究相比，城市水足迹(UWF)一直是研究人员关注较少的主题，这可能是因为在过去的十年中，城市水资源短缺已经成为全球性的问题。
本研究分析了作为一种不可再生资源，水资源价值所面临的影响其质量和数量的压力问题。因此，水的“价值”指的是一种资源的衡量，被用作城市复杂性的一个不可或缺的因素，从其生态系统中消减，并从一种自然资源转换为一种人为资源。
提出了水足迹网站(WFN)的两个指标用以分析城市地区的水足迹。蓝色水指标，通常被WFN用来评估水域的应力，在本研究中是作为城市用水量计算。绿色水指标被WFN用来评估本文分析的某一区域的降水利用，将其作为城市地域的生态系统要素。

关键词:
城市水足迹，地球界限，城市水规划

1 INTRODUCTION

The international community considers the urban systems as the physical form where it will be possible to reach the objective to share the benefits resulting from the actual level of development of the technological systems and from the use of the natural resources. The document New Urban Agenda - NUA, approved after the United Nations conference "Housing and Sustainable Urban Development" in October 20/10/2016, underlines that cities could be the source of resolution rather than the cause of the challenges that our world is facing (Habitat III, 2016). The NUA aims to be a tool for decision making and the stakeholders for urban planning and design, based on the needs of a civil society; it has to be able to imagine and realize the great structural transformations determined by footprint of human systems in each city. The NUA outlined new skills for urban planning, to support the role and enhanced capacity of national and local governments in data collection, mapping, analysis and dissemination and in promoting evidence-based governance. The objective is to promote a shared knowledge about the "geographic" data also through censuses, household surveys, population registers, and to develop economical - environmental indicators to urban plans. This study aims to evaluate how water shortage can constitute a drivers in the targets of urban re-planning. The World Economic Forum (2017) shows that in consideration of the fact that more than 3,5 billion of people lives currently in urban areas, water shortage will constitute in a brief period, one of the greatest risks that the national and local governments must face. This study aims to evaluate how water shortage can constitute a drivers in the targets of urban re-planning. The World Economic Forum (2017) shows that, due to the fact that more than 3,5 billion people currently live in urban areas, water shortage will soon constitute one of the greatest challenges that national and local governments must face. Water shortage is the subject of several studies carried out by Water Footprint Network, which has implemented a method to measurement anthropic uses of the water, substantially based on three indicators: *green water* determined by the rainfall; *blue water* which is water's employment from rivers and groundwater bodies, *grey water* is calculated as the volume of water that is required to dilute pollutants to such an extent that the quality of the water remains above agreed water quality standards. The WF indicators are largely used by the scientific community in particular in the studies directed to measure the *virtual water* that "travels" with products. The virtual water conceived by Allan in 1998, it refers to the volume of water consumed or polluted for producing the product, measured over its full production chain (Allan, 1998). When nation exports/imports such a product, it exports/imports water in virtual form. The virtual water isn't submitted to the regulation that concern the right to "to use the water" (unlike the Emissions Trading - Prohibition Act that regulating the emission in the atmosphere in according to Protocol of Kyoto). This permits to the economic operators "to transfer" the flows of water throughout the continents without any logic, except economic. These flows of products released in the great urban areas to satisfy billion people, are out of control of the local governments and can result in a biological impoverishment of their areas, and in shortage of their aquifer. This is one of main worries of the international organizations, first the Fao (FAO, 2011). According to Hoekstra and Mekonnen (2012) the main focus of the water planning is to satisfy the increasing water need, both local and regional level without over questioning whether consumptions was actually necessary. There isn't a complete vision of the national, of the domestic and of the industrial consumptions. The authors show that the WF of the average water consumer is of 1.385 m3 /y, the average consumer in the United States has a WF of 2.842 m3 /y, while China and India have a WF of 1.071 and 1.089 m3 / y respectively. Compared with the great number of studies carried out on virtual water, the Urban Water Footprint - UWF, has been object of less attention from researchers, probably because only in the last decade city water shortage has presented itself as global problem. It clearly a very different phenomenon, because water shortage in urban areas, doesn't mean a total lack of water as occur in the regions afflicted by intensive irrigation. What worries researchers of the UWF, is the relationship between the great quantity of water used in the cities and the effects that this can have on the hydrological local environment in terms of quality/quantity of water and extreme weather. This study investigates the possibility of using the water footprint indicators in order to have common values on the uses of water in urban areas, where "value" means a measurement of water used and subtracted from the natural environment for anthropic uses. First of all, a general framework will be made of the studies that have dealt with "value" to water flows in the urban and non-urban context. In paragraphs 3 and 4, footprint indicators have been proposed to assess the variability of water consumption within urban territories. Then, the Blue Water Footprint and the Green Water Footprint were calculated only for the water flows consumed in the Italian cities, like drinking water and domestic water. In paragraph 5, it was argued on the links between UWF values and urban planning instruments and how the UWF indicators can address urban transformations towards sustainable approaches.

2 THE URBAN ENVIRONMENT AS FLOW OF RESOURCES IN/OUT

The footprint that the human systems leaves on natural ecosystems is conditioned by the process of mutual adaptation between vegetable and animals species. These biochemical dynamics modify the ecosystems, and at the same time have create a state of dynamic equilibrium in which every element belongs to a whole. This scientific knowledge has developed over the last decades starting from Lovelock's Gaia Theory (Lovelock & Margulis, 1974) and has accompanied the scientific optimism which have led to the growing use of natural resources. The studies of the ecological footprint (Wackernagel & Rees, 1998; Wackernagel et al., 1999), have supported the necessity to introduce suitable indicators to measure the anthropic pressure on natural systems. These Indicators must be defined not on the basis of environmental characteristics affected by human systems, but calculated on the basis of the consumptions of natural resources used in anthropic processes. According to researchers the purpose of these indicators, is contributed to determinate the coefficient of biocapacity with which the natural systems succeed in restarting the states of equilibrium compromised by human footprint. In fact the biological times of resilience required by natural ecosystems, are not compatible with the aggressive nature of the anthropic footprint, (Tiezzi et al., 1992). The resources consumed by the cities has been object of studies on the urban metabolism, in which the urban environment is described as a hybrid system, where the cycles ecosystemics "intertwine" with the technological system create by the man (Baccini et al., 2012; Gisotti, 2006; Kennedy et al., 2007). In particular the in / out water flows that cross the city, develop dynamics that upset the pre-existing ecological characteristics, determining in the majority of cases, new cycles of ecosystem (Varriale, 2017). As shows the Fig.1, in the anthropic cycle of water there are many alterations in the environmental process and the consequent risks for the urban environment, among which:

- extraction from underground water with the risk of stress of reservoirs, and the aquifers lowering;
- collecting rainwater in mixed systems grids for disposal, with risks of urban flooding;
- unauthorized water withdrawals by private, and the risk of illegal disposal of industrial waste in the sewer system;
- risk of increased leaks from the distribution networks due to the obsolete state of the net.

In the cycle anthropic water is occurs the breakup of natural cycles of elements of ecosystem, where particularly in urban environments, vast volumes of water are lost. Many researchers are questioned on those broken cycles and on the way to recompose it beginning with a detailed analysis in the city. The metabolic flow of the water crosses the city for "to feed it" in all the natural and anthropic elements and when it flows out of the city it is then returned to its natural environment in different qualitative and quantitative states. In the first studies of the Water Footprint, it was made clear that to measure the total volumes of these flows, there was the difficulty to measure a dynamic flow prone to continuous variations. The section of a riverbed in fact could give different readings of its flow according to the season. Furthermore in the Footprint approach the water measure doesn't show exactly the existing volume but the "employed volume", in other words that part of the flow used for anthropic purposes. That volume in the anthropic usage is a different from that the natural level. In Seyam et al. (2003), the value water flow is defined as the missing link between the measurement of the water and the hydrology.

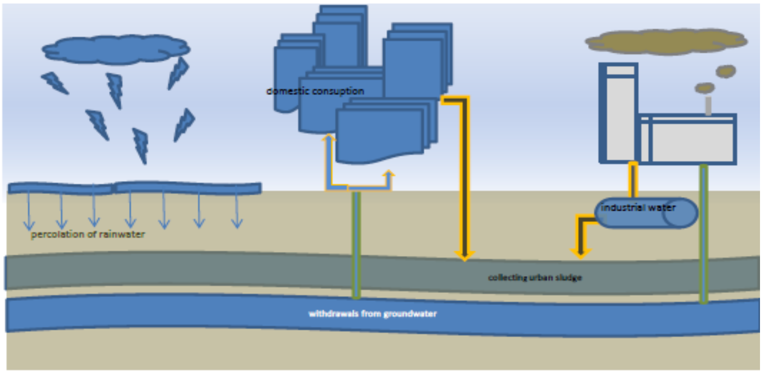


Fig. 1 Cycle of anthropic water

The hypothesis of the researchers is that the value of a molecule of water depends on the path that it follows inside the hydrologic cycle and from the values produced along this path. As a result, the resiliency of the water resource is based on quantity of rainfall of area refill. As a consequence, the emptying of the river basins for hydrologic services of urban distribution, without consider the rainfall, it cause a loss of the value of flow of the water. In the studies conducted by Costanza et al. (2014), the attribution of the value of an ecosystem resource is necessary when it needs to make some objective choices on the consequential benefits from its use. Generally the evaluation of the costs and benefits of environmental resource is poorly quantified because it is necessary to evaluate a wide range of benefits that include ecological sustainability, efficiency, social equity. But it is only the latter, according to researcher, that promote the definition of the value of the resource, through a governance that aims to share the resource for the public good. The demand to share globally the value of the water, is sustained also by Vörösmarty et al. (2015), who indicate the necessity of taking actions to deal with the dangers of the water shortage and pollution with laws which promote universally the sustainable use of water. Terms of sustainable consumption (Chapagain et al., 2012). In the study conducted in the Basin of the Zambesi, the researchers calculated the whole value of water use, included the "geographical transfer" of the water in the global commerce. Clearly, hydrological value of the water varies: the WF of regions or hydrographic basins has a different meaning from that in urban areas. In fact the scale to which the urban water footprint refers to, is that of the hydrographic basin that develops itself in the limits or inside the semi-urban borders. The studies that underline the problem of the scale o appraise the water footprint are different. Ma et al. (2015), for instance, in the analysis of WF in Bejing, shows that water consumptions of the mega-cities is ten times more elevated in comparison with the volume of available resources in the semi-urban area, which is inevitably translated in a meaningful external water reliance. Rushforth and Ruddell (2015), in the city of Phoenix in Arizona, estimate as WF is wider than regional track, going towards other nations, with consequence to have to face the right to the water, with different groups of political interest. Other studies focus new indicators for measuring WF in urban area. Fialkiewicz et al. (2014) suggests to analyze all structures that produce water consumptions in urban area using an approach bottom up that to gives evidence of the behavior of the human systems in the water use. The study of Wolfgang et al. (2016), proposes a methodology to estimate water use an urban scale, quantifying the consumptions of the drinkable water for different urban districts. The indicators are developed for the blue, green and grey footprint, in terms both the volumes of domestic - sewer nets line, and of rainfall flux. According to Agudelo-Vera et al. (2011), only starting detailed analysis of the consumptions is possible to develop a planning for domestic use of water. Monstadt (2009) furnishes an interesting contribution on new perspectives of WF analyses in urban planning. The author underlines the crucial importance of urban infrastructures grid for ecological sustainability of the cities. The technological nets manage the resources flows and model in essential way the environmental practices in the cities. The author thinks that the complex interdependences among cities and urban infrastructures widen our understanding of the ways in which we can develop, to govern and to renew the cities in sustainable way. In this approach, technological networks are not the keys of the "smart cities", instead represent an instrument towards urban sustainability. According to Papa et al. (2013), the technologies are one of the fundamental drivers for the construction of a sustainable city based on: technologies, people and governance. The footprint analysis have rarely been reproduced in urban planning analysis, while analysis of the urban people behaviors has been object of a broad seam of studies. The study Gargiulo and Russo (2017) investigate on the energetic consumption and the issues of CO2. The study shows that many studies have been developed on the relationship between the physical characteristics of the urban form and the energy consumption, while the focus of the search rarely compares the issues of CO2 with other urban characteristic as the functional, geographical and socioeconomic aspects. The city in many studies continues to be a bidimensional physical form, the search hardly faces the urban territories as process of the social behaviors. In the next paragraphs we bring some evaluation of water footprint conducted with new indicators implemented for measure the urban water consumptions beginning from some behaviors of the users.

3 THE CONSUMPTIONS OF DRINKABLE WATER

The first challenge that planning of water consumptions must face is due to the uncertainties of the data on the people behaviors. The behavior of the consumers in Italy it has been analyzed with data from Istituto Italiano di Statistica that referred only to domestic and industrial water use. From the Istat data of period 2000 -2011, on 116 cities of Italy we observed a period of substantial reduction of the domestic consumptions procapita, with an average reduction of -6.9%, with two level extremes: -30.54 % and +8.19 %. The distribution of the rate reduction of the consumptions between 2001/2011, shows that the reductions higher than 20% are very frequent. In the Fig. 2 the trend of the reduction in water consumption 2004/2011, is compared to the average values. In the same period the average increase of people is +4.5%. This trend has been compared with the demographic evolution each municipality. So we have that the rate of reduction of water use is enough distributed both in the Provinces with an increase of the population and in those with a decrease. In some cases (Tab.1), where the population is decreased in meaningful way, there are meaningful increases of the water consumptions.

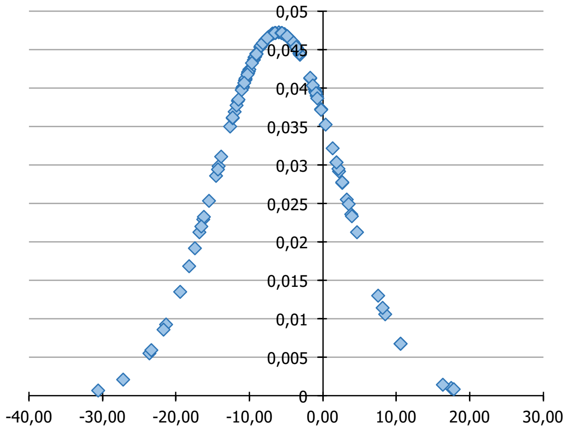


Fig.2 Trend of reduction value of the water consumptions 2004/2011 estimated with mean values

The demographic data doesn't seem meaningful for definition of tendencies of water consumptions, as is already shown in a study on the negative correlation between the energetic consumptions and density of population (Gargiulo & Russo, 2017). The estimates on water requirements are based on water supplies that quantify the population according to some categories, such as:

- uses from private residences, about the consumptions of the private sphere of the families, of which: personal cleaning, feeding, washing laundry, cleaning of the house, care of the private gardens and spaces condo etc.;
- uses from public buildings or collective institutes what: hospitals / clinics private, schools / university, markets, penitentiary, public and private offices, religious institutes, etc.;
- uses from public services what: management of the urban green, of the urban spaces, washing of the roads, fireproof service, etc;
- commercial and tourist uses: hotels, restaurants, business generally, etc.

Cities	Consumption reduction rate	Demographic balance
Trieste	0.99	-10,061
Treviso	5.89	3,382
Cremona	2.65	-1,298
Isernia	5.4	873
Caserta	0.71	552
Benevento	4.51	-337
Nuoro	11.87	-204
Sassari	5.31	3,053
Oristano	1.73	488
Catanzaro	2.99	-5,887
Crotone	2.46	-1,129
Reggio Calabria	6.14	464
Catania	1.66	-19,208
Caltanissetta	11.39	300
Messina	11.56	-8,764

Tab.1 Variations population and water consumptions 2001/2011

Obviously many of these consumptions depend on processes that could be overestimated or underestimated, and vary in the time according to the choices of the socio-economic players. The water endowment should be based on the behaviors of the consumers rather than on the numerousness of the various samples. Actually some regions are already developed Regional Waters Plans where underlined to deepen the data on the socioeconomic characteristics that form the demand of water in a specific area. For instance, the seasonality is considered as a fundamental parameter for the evaluation of the water supply, because there could be different habits referred to water use between seasons. In a study conducted on the Water Footprint of Sant Antonio Abate (south Italy) in 2017, the variations in the seasonality of the water consumptions are exclusively been imputed to the behaviors of the economic players that are represented by the industries of the canning sector of the tomato, that is active only in the summer months in that areas (Varriale, 2017). The seasonality and the demographic dynamics are fundamental parameters to value water endowment pro capita by planner, but according to an analysis more deepened, seem to be less determinants as thought. Among the water consumptions of the Italian families, there is for instance, the distrust of the consumers on the quality of the waters of the public nets. In the survey have not been advanced questions on the possible risks on the water quality due to the bottling in plastics or to the industrial risks of the bottling process, but it is evident that the 75.3% of the interviewed ones have motivations that overcome every risks because in the period 1995/2016 the consumptions of bottle of water are increased of around 9%. Obviously, the water consumed has a different value "social" from the natural right to the water, and in Italy the total of the footprint of the water in bottle included the exports, corresponds to 11.570.000 L / year (Tab.2). We have quantify the consumption of drinkable water-taking into account the data that we have examined, the water that the Italian consume in domestic use and for personal uses is given by the following (express values m^3/y):

$$W_{ci} = W_p + W_b = 5.411.580 + 11.570 = 5.423.150 \text{ x } 1000 = 5.42 \text{ x } 10^9 \ m^3/y \qquad (1)$$

Where:

Wci Drinkable water Consumption is given from:

Wp = volumes accounted by the Utility (Istat, 2012) and Wb = consumptions bottled water.

Consumption type	2016
Consumers bottled water	54,721,800
Consumption in l/year/p.c.	206
Water bottles in mgl *	12,700
Export l in mg	1,130
Consumption Italy l/mg	11,570

Tab. 2 Statistics of plastic bottles on Censis data (Censis, 2018) (*) Thousands of liters

The families that declare not to trust to drink the water of the faucet still represent a considerable percentage despite the progressive improvement of the last fifteen years: from 40,1% in 2002 to 29.1% in the 2017. The families that declare not to trust drinking the tap water represent a considerable percentage, (despite the improvement of water supply of last fifteen years): from 40,1% in 2002 to 29,1% in the 2017. There are 7,4 million families that consume water bottle, with a marked territorial variability. The fact that people doesn't have a clear awareness of its own water footprint is confirmed by a survey in USA in 2017, with a sample of 1020 people. The results of the survey shown that majority of the questioned, indicated the water saving as a solution to the excessive consumption (for instance choosing showers briefer, alternate water when it washes us the teeth, etc.), rather than suggest improvements of the efficiency (i.e. technologies soft to guide dosing or recovery plants). Water is perceived therefore as a good that belongs to private sphere of individual, submitted to personal choices in which founds the inalienable right to the water.

4 BLUE WATER FOOTPRINT

The consumptions of drinkable water calculated in the previous paragraph, constitutes only a part of the volume of the blue Waters in urban environment. Indeed, the supplied volumes to consumers are always below the water's volumes introduced in the water nets that in the Italian municipalities they are average of around 145 m^3 /y for inhabitant, in comparison to the provided volume of 89.3 m^3/year. Therefore part of volume introduced in the water work then is loss, during the activities of disbursement and distribution. The leakage of drinkable water caused for, piping losses, mistakes of measurement, and not-authorized consumptions, they are equal to 38,3%, for a volume of 3,4 billion/m3, Istat (2017). The leakage volume has a strong impact on the volumes of water withdraw from the water basins in the cities (Fig. 3). The leakage have an obvious territorial variability that depends on the efficiency of the local water supply network. The accounts of urban water supply is conceived as an incomplete accounting in how much what enters the flow in terms of volumes, it doesn't correspond to what it goes out. The actual leakage are defined as a volumes that remain after all the components of consumption (measured and not measured) have been taken away by the volume of drinkable water that enters into the net. The volume not measured, it corresponds to consumptions not invoiced and authorized (i.e., consumption for urban parks) and the apparent losses (water's theft, measurement failures) represent the water consumed but not paid by the clients. The water management service often complain that is accounted in the consumptions represents only a part of the water flow managed in urban area, and that the principle "who pollutes pay", confirmed by the Dir UE 60/2000, is not honoured. Therefore, calculations on the losses in the water budgets are indirect evaluations with limits of uncertainty, rather than direct measurements (European Union, 2015). The global water volumes entered in the supply system to provide all urban distribution water grid are crucial to understand the type of pressure on peri urban area. For this reason we have analyzed the water volumes introduced in the distribution water grid of 20 Italian regions.

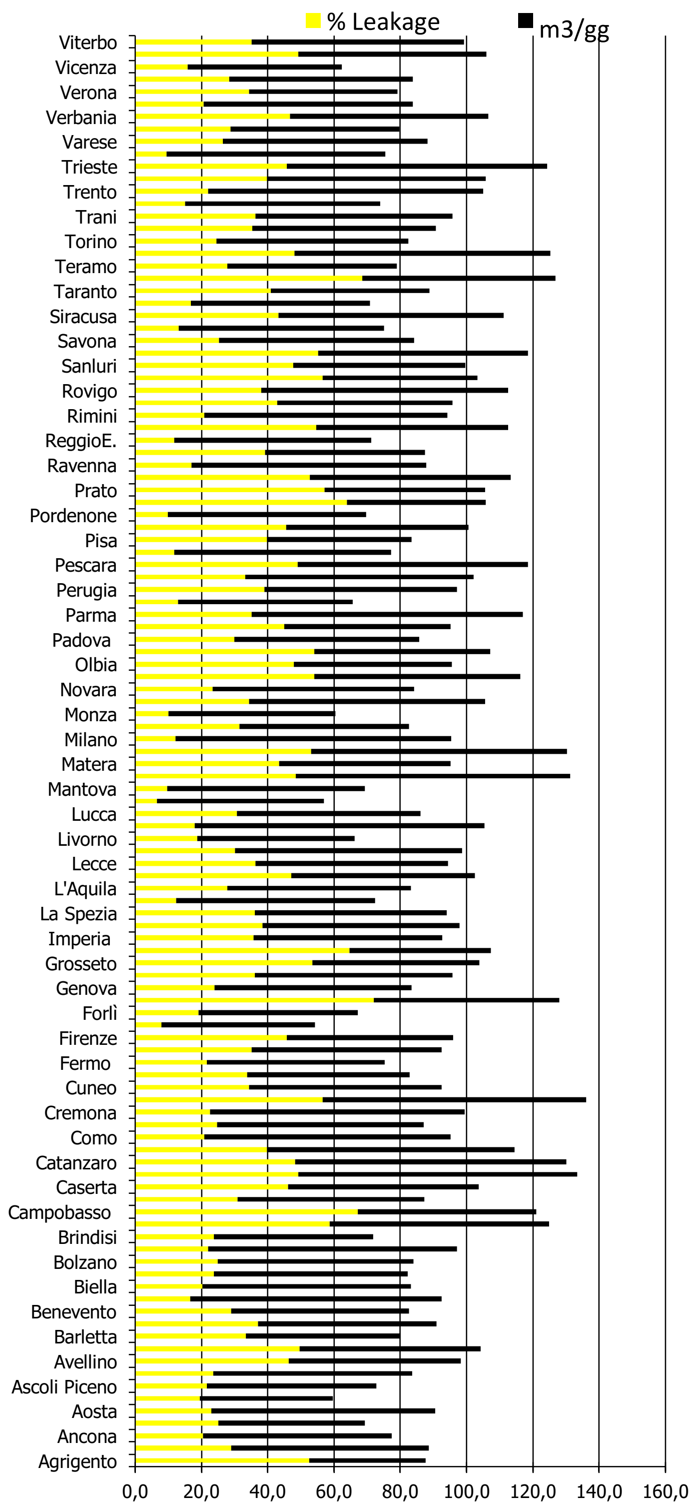


Fig. 3 Volumes disbursed and volumes lost in the water networks of the Italian provinces, Istat 2017

We have divided the period 1999-2012 (Istat data) in three principal spans 1999-2005; 2005-2008, 2008-2012 to consider the regional variations in the entered volume of water by utilities. The objective isto verify growth or reduction trend of the water volumes for region. As shown in Fig. 4, it is possible to observe that the volumes entered in water net vary in the incoherent way in all the regions, for all three periods. For instance in Marche the introduced volumes are in growth in the third period from 1999 to 2012, while in Campania the volumes introduced into the net decrease in the second period for then to increase in the third one 2008/2012.

In Calabria instead in the third period there is a reduction of the volumes introduced in comparison to the previous periods. These variations can be explained in terms of processes out of control such as:

- the consume not measurable because made for public activities of the municipalities (cleaning roads, construction sites, etc.);
- unauthorized consumption that occur in urban suburbs in illegal supply for domestic, industrial or agricultural;
- visible losses of the water distribution, that employ time in the phases of identification and reparation.

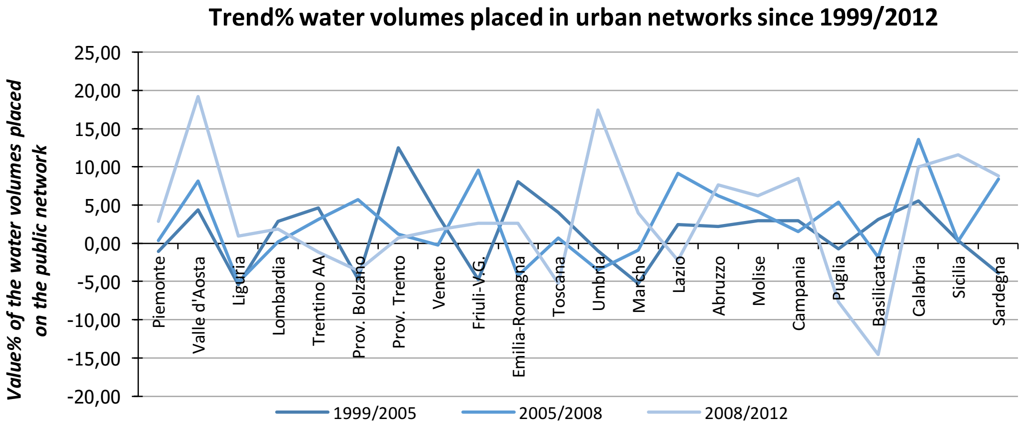


Fig.4 Volumes entered in the network for each Region expressed as difference % in between periods

These "chaotic" trends of the volumes introduced into the water nets during the period 1999/2012 show how much is difficult to effect precise forecasts of the urban water consumptions, and how much these uncertainties could increase in reason for the obsolescence of the urban water infrastructures, with an WF that could begin to take shape as a "water sprawl" on the territory. The analysis of the water footprint in urban areas should in fact take into account the fact that the sources of water do not always insist within the peri-urban boundary, so often it's necessary draw water from other neighboring basins. Therefore the urban water footprint spills over other urban areas, and the catchment networks sometimes stretch for thousands of km in and out of the river district with a sprawl difficult to contain. Furthermore, the volume supplied to urban distribution network, could also be lower than the actually volume provided by catchment area with losses also on that network. But unfortunately there are no certain data about this, despite these activities in Italy are managed exclusively by the regional authorities. In order to have an accurate impression of water consumption in urban areas, it would be necessary to include volumes of water imported and exported into the regional networks whit the relative losses of these. It would be necessary develop accounting for volumes transferred between subsystems also defining acceptance limits for loss level of each system (European Union, 2015). A factor to be considered in the analysis of the urban water monitoring concerns the sources from which the volumes of water are withdrawn. The principal sources of extraction in Italy are: sources, underground aquifers, basin artificial, lake and superficial waters. The wells pumping averagely represents the withdrawn more used in the Italian regions (Tab. 3). The wells containing waters of high quality and have times of resilience undefined because they are determined by the depth of groundwater, by the characteristics of the ground and by the precipitations. Therefore, this represent a critical step from the point of view of the ecosystem. Collecting water from wells is practice the most widespread in Italy, and as points out the Tab.3. In the majority of the regions both of high consumption and low - satisfies more than the 50% of its requirement, with the Basilicata exclusion that mainly collect from superficial waters. Water's collecting directly from sources are distributed in this way: from wells 48.6% (with an evident water stress from underground waters), 36% from source, 5% from superficial waters, 10.5%, from artificial basins or lakes and 0.2% from brackish waters. Regarding the import / export of water, it should be noted that Basilicata and the Marche collection around 90% more of what they consumed, and that export almost 50% of the volumes of water in other regions. So, from analysis of the local hydrographic districts, it is possible to highlight the value of the transported volumes through the regional areas and obtain an account of ecosystem water flow.

Italian Region	Water Source	Water well	Surface waters	Lakes	Brackish waters	Total
V. d'Aosta	47,063	5,640				52,703
	89.3	*10.7*				
Liguria	29,760	132,764	34,155	47,386		244,065
	12.19	*54.4*	*13.99*	*19.42*		
Lombardia	264,711	1,200,996	1,577	46,186		1,513,470
	17.49	*79.35*	*0.1*	*3.05*		
Piemonte	293,108	337,726	20,741	2,746		654,321
	44,8	*51,61*	*3,17*	*0.42*		
Veneto	230,330	418,943	63,142	2,385		714,800
	32.22	*58.61*	*8.83*	*0.33*		
Friuli V.G.	59,613	163,863	9,614	1.010		234,100
	25.46	*70*	*4.11*	*0.43*		
Emilia	41,461	310,655	108,318	46,117		506,551
	8.18	*61.33*	*21,38*	*9,1*		
Marche	110,698	36,930	6,208	21,745		175,581
	63.05	*21.03*	*3.54*	*12.38*		
Umbria	43,738	71,212				114,950
	38.05	*61.95*				
Toscana	89,509	236,792	130,225	4,219	1,094	461,839
	19.38	*51.27*	*28.2*	*0.91*	*0.24*	
Lazio	858,371	300,014	3.592	24,126		1,186,103
	72.37	*25.29*	*0.3*	*2.03*		
Abruzzo	232,150	59,716	11.288			303,154
	76.58	*19.7*	*3,031.54*			
Molise	114,489	42,671	13,854			171,014
	66.95	*24.95*	*8.1*			
Campania	470,269	457,594	58	25,002		952,923
	49.35	*48.02*	*0.01*	*2.62*		
Basilicata	40,145			286,632		326,777
	12.29			*87.71*		
Puglia	560	88.481		89,827		178,868
	0.31	*49.47*		*50.22*		
Calabria	194,311	170,930	46,723		10,027	421,991
	46.05	*0.41*	*11.07*		*2.38*	
Sicilia	169,735	419,456	4,631	113,350	6.853	714,025
	23.77	*58.75*	*0.65*	*15.87*		
Sardegna	39,655	40,818	3,521	246,026		330,020
	12.02	*12.37*	*1.07*	*74.55*		
Totale	3,330,374	4,495,948	460,782	956,962	17,977	9,257,255

Tab.3 Received volumes (thousand m^3/y) by type withdrawl, our elaboration, ISTAT, 2012

5 GREEN FOOTPRINT

The green water is calculated with the volume of the meteoric waters used in the activities of irrigation, particularly is calculated as virtual water contained in the zootechnical and agricultural products and traded at global level. This flow of water in the WF account is defined renewable, given that, under natural conditions of the meteorological events, the rain flow is distributed in the ground for percolation and subsequently in the atmosphere by evapotranspiration, in according to a natural cycle of the water. Instead in this study, the calculation of the Urban Green Footprint - UGW has been considered that the waterproofed of the urban territories is the cause of the "consumption" of the meteoric waters, that are subtracted to the natural cycle of the water. Indeed it deals with waters that falling on the waterproofed grounds of the urban territories, that are conveyed toward the nets of collection of water, and sometime they are mixed with wastewater.

Therefore, the anthropic activity of waterproofing of the urban ground is considered as the cause of the loss of water volumes of rainfall. Obviously, widest is the asphalted surface, greatest is the water that is subtracted by the natural environment. According to these considerations we have calculated therefore the Urban Green Water following (expressed in m^3/y):

$$UGW = A_p - A_v * I_{rf} = 8{,}424{,}924 \times 1{,}000 = 8.42 \times 10^9 \qquad (2)$$

Where: UGW = urban green water; Ap = Area Province (County), Av = green area; Irf = Index of rainfall. The green area has been calculated as the value % of green areas on the total provincial area, ISTAT 2016.
The calculation of the index of rainfallsis based on the so called pluviometric height, where a millimeter of accumulation is equal to 1 liter water fallen on a surface of 1 square meter. For every province there has been so identified the relative UGW, given from the areas constructed and the green areas, for the rainfall index of the province.

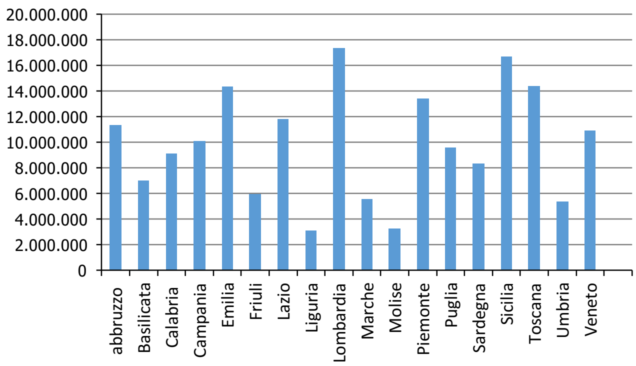


Fig.5 Green footprint for Italian Regions, our elaboration, Istat 2015

The collected data for regions are reported in the Fig. 5, where the Lombardia, Emilia Romagna, Sicilia and Toscana are the most UGW.

6 WATER INTELLIGENCE: THE BORDERS OF THE URBAN WATER FOOTPRINT

The indicator UBW and UGW proposed in this study are mainly based on some observations:

- not all the anthropic applications of the water are kept under control by the national water accounting, particularly the water used economic operators;
- the calculation of the withdrawals from underground reserves and from superficial water bodies doesn't keep in mind of all the collecting obtained for the agricultural compartment, industrial, tourism and of the leisure time service;
- dirty water's volumes entered in the companies' accounts don't always correspond to the volumes of dirty waters really delivered to the water bodies after treatment, where there are rain water and unauthorized withdrawals.

The two Indicators calculated, blue UBW and green UGW - indicate two impressive ecosystem problems (stress of the basins caused by collecting of superficial / underground waters; the waterproofing process of the ground) that the cities cannot transform in the brief period if not with combined actions of water intelligence. A governance of all players and stakeholders must be able to put together technological, economic, social and eco-compatible factors of water management, for an urban planning that sees in the sustainability the critical element of the urban quality and a decisive factor of the competitiveness and of the ability to attract resources, know how and investors (Papa et al., 2016). We must to take into account the fact that funding of many projects of sustainability water will be out of financial range of the public administrations. Nowadays, a lot of political decisions are turned to improve the drinkable water nets through technologies adept at self-regulation referenced to losses and relative pressures of the flows, to the purpose to reduce water wastage that the service of distribution records in Italy (De Paola et al., 2017). But also the implementation of these soft technologies records the financial difficulties of the administrators. According to Aldaya et al. (2012), all this makes to think that for the future the governance of the water will not be an exclusive domain of a regional government or however public. According to the author, even if the water remains a public resource, this suggest that the role of the companies and the investors can become fundamental in the management of the water resources and that the urban planning must be compared with a plurality of players and tools of governance more effective. Furthermore, the ambitious projects of Smart City financed and realized only by big private investors as the project Masdar in Abu Dhabi, have been the failures from the point of view of competitiveness of the urban areas. In fact, the project of urban sustainability must be accompanied by the incremental growth of the social capital, that is based on great scale of cooperation and interaction among the stakeholders of the cities, (Papa et al., 2013). The water intelligence cannot be understood only as new technologies to restore the waters of urban anthropic cycle. The great transformations of the urban areas can be realized rather with a new to governance putting together the pieces of a highly complex social action, as the ability to coordinate actions, projects and to integrate technologies that are still separately developed the ones by the others, but that they have clear synergies in their operation and they must be shared by their users (Gargiulo & Russo, 2017). Finally, the calculation of the urban water mark here proposed, can be identified as an early-warning systems (Steffen et al., 2011). In fact, according to the authors, the nature of Earth-system dynamics - the nonlinearities, tipping elements, thresholds / abrupt changes strongly, suggests that humanity needs to system to warn us when we are approaching such potentially catastrophic points. An early-warning system is a prerequisite for being able to recognize and steer away from such thresholds. Every edge is situated inside a zone of uncertainty that scientific researches can reduce, to reset or to put in further alarm. So, all depends from the ability to assimilate new scientific information about the terrestrial system, on the ecosystems, on the urban systems. It's necessary calibrate again the objectives of sustainability toward new and necessary dynamic equilibriums. The same occurred with the borders of the climate, first included within the limit of 450 ppms of CO_2, then redefined under the threshold level of 350 . Everything suggests that the anthropic footprint on the planet must be managed in concert with a research capable of analyzing and quantifying the phenomena of our dynamic systems, indicating the limits, the threshold values beyond which our footprint cannot be pushed. And it is on these borders that water intelligence will have to work.

7 CONCLUSION

The purpose of the study was to investigate a little in-depth study of WF's research on urban consumption. We have seen how the consumption data often entrusted to the water service operators, do not give evidence of all the phenomena that compete to the urban water footprint. The blue and green footprint in Italians' cities was calculated, with indicators that could be replicated in other national or local contexts for comparison. The indicators proposed and elaborated according to the Water Footprint methodologies, present two substantial innovations in the studies on anthropic pressures, among which:

- in first place the characterization of the anthropic use of the natural resource starting from the behavior of the networks of social actors – ANT;
- secondly the urban dimension of the green footprint. The GWF in the WF account is defined as the renewable resource that is subtracted from its ideal cycle to enter the virtual cycle of trade in agricultural and zootechnical goods. In our opinion this approach is not sufficient for the characterization of urban territories, because the waterproof surfaces of the city, represent a real consumption of green water that are subtracted from urban soil.

With the use footprint Indicators it's necessary a reflection about how to set a limit to the collecting of water from the hydrographic basins, that implicates the necessity to save the water, keeping in mind of a multiplicity of factors, among which:

- the water in the urban areas is a limited resource, that in the urban territory is imported often for purposes that are not only linked to the drinkable water;
- the urban soil requires "waterways" that can contain the effects of climate change in terms of scarcity and extreme events. Water is therefore called upon to play its role in contributing to the sustainability of the urban territory;
- water quality plays a fundamental role in the quality of life of all animal and plant species that live in the urban area. Therefore, the dilution criterion used to make acceptable the chemical footprint, will lead us in the short term to an appalling emergency caused by enormous volumes of water polluted not usable;
- the water sprawl with which urban areas try to grab the available water resources, could generate huge problems of governance in the future, in which the claim to the right to water could go beyond technical-economic aspects, causing great conflict in the territories. Water sprawl should therefore become the object of study and further study of water footprints in urban areas.

Urban planners need to be equipped to handle these macro processes. The calculation of the footprints of each process and of limit of resources' uses, can support dialogue with stakeholders to manage the major structural transformations of everyday life, which inevitably the management of the anthropic cycle of water will entail in the future. Traditionally the urban planning of the water resources was effected on valuations of variation of the population and the relative demographic dispersion on the urban territory and peri-urban. This study suggests that it is not the number or the density of population that it determines a water footprint. Not only: the urban planning of the cycle of the water has had as objective that to define the volumes to withdraw, little have been investigated the real consumptions and on the relative stress of the hydrographic basins. The characterization of the urban water footprint asks for an analysis of the behaviors the trends to the consumption of the population, as example the distrust of the European consumers towards the waters of net and also the increasing consumption of waters in plastic bottles. As the development of the aquatic parks, a phenomenon in growth both in Europe that in Italy, that strongly engrave on the water stress. It would be necessary to analyze what the consumers want, and to wonder why the ANT nets privilege for the fun the equipped places rather than natural places. The social sciences should investigate more in depth on what we could define a desire of affiliation to an "anthropic landscape", and therefore in some way a "virtual and technological landscape". A territory that is perceived as safe, compared to emerging vulnerability of the urban territories, afflicted by climatic events, drought, atmospheric pollution. It results therefore evident as the urban transformations must pick up these trends of the human behaviors and in the same time they must transforming the cities beginning from the subjects that choose them. The studies of WF can help to stimulate the planners to rely themselves to new paradigms of planning about the available resources in urban area, keeping in mind of the "concept of limit". The indicators developed by the Ecological Footprint from 1999 have had a decisive role in the seeding into the environmental sustainability vision the concept of limit, that necessarily implicates the creation of new tools to plan the anthropic spaces and the activities beginning from what it is indeed available, and that can technologically be improved for a sustainability of the footprint. The urban transformations should for instance integrate the problems of the water losses of the urban nets with the reuse of volumes of used waters, for new projects for the urban sustainability of the next decades. Furthermore, methodologies developed for the Carbon Footprint – CF, the energetic efficiency, and for the Water Footprint - WF, the hydro efficiency, have a scientific value of which is important to take into account into the setting of a new paradigm for the urban constructions, because they represent a tools that are developed of the description of the complex systems. The Indicators already consolidated of CF and WF, represent a method to describe behaviors in which social actors, biochemists agents and physical (partly still to us strangers) process, contemporarily compete with unpredictable courses. What we can do in multivariate contexts as those of the urban territories, is to contribute to the identification of the attributes to describe a process, and it is really this the objective of the CF and WF studies: to describe the phenomena that happen, to quantify them, to select them and categorize to the purpose to improve our knowledge about the holistic systems that surrounds us. The studies of Footprint can contribute to the construction of the objectives of transformation toward the smart cities, because they represent de facto the databases on the dynamics of the processes, on the manner how consumers use the energy rather than the water, but also about their perception of the *value* of the resource they employ. Because if on one side we can agree with the fact that the value of a resource depends on the use that we do of it (Costanza et al., 2014), on the other hand it is also true that the use that we make of a resource, determines also of its value, inexorably.

ACKNOWLEDGMENTS

I want to thank Carmela Gargiulo for the months that she dedicated me to develop the idea of a social utilization of water resources, for directing me towards a new water footprint calculation.

REFERENCES

Agudelo-Vera, C. M., Mels, A. R., Keesman, K. J., & Rijnaarts, H. H. (2011). Resource management as a key factor for sustainable urban planning. *Journal of environmental management*, *92*(10), 2295-2303. doi:https://doi.org/10.1016/j.jenvman.2011.05.016

Aldaya, M. M., Chapagain, A. K., Hoekstra, A. Y., & Mekonnen, M. M. (2012). *The water footprint assessment manual: Setting the global standard*. London, UK: Routledge.

Allan, J. A. (1998). Virtual water: A strategic resource global solutions to regional deficits. *Groundwater*, *36*(4), 545-546. doi:https://doi.org/10.1111/j.1745-6584.1998.tb02825.x

Baccini, P., & Brunner, P. H. (2012). *Metabolism of the anthroposphere: analysis, evaluation, design* (2nd ed.). Cambridge, USA: MIT Press.

Censis. (2018). *Il valore sociale rilevato del consumo di acque minerali*. Retrieved from http://www.centromarca.it/media/186291/consumi-acqua-censis.pdf

Chapagain, A. K., & Tickner, D. (2012). Water footprint: help or hindrance? *Water Alternatives*, *5*(3), 563. Retrieved from http://www.water-alternatives.org/index.php/all-abs/186-a5-3-2/file

Costanza, R., de Groot, R., Sutton, P., Van der Ploeg, S., Anderson, S. J., Kubiszewski, I., ... & Turner, R. K. (2014). Changes in the global value of ecosystem services. *Global environmental change*, *26*, 152-158. doi: https://doi.org/10.1016/j.gloenvcha.2014.04.002

De Paola, F., Giugni, M., Pugliese, F., & Romano, P. (2017). A decision support system for urban stormwater drainage management. *European Water*, 57, 115-121. Retrieved from http://www.ewra.net/ew/pdf/EW_2017_57_16.pdf

European Union (2015). *EU Reference document Good Practices on Leakage Management WFD CIS WG PoM Case Study document*. Retrieved from https://circabc.europa.eu/sd/a/ec13ae01-7800-4114-8d72-98827b509e18/Good%20Practices %20on%20Leakage%20Management%20-%20Case%20Study%20document._Final.pdf

FAO (2011). *The state of the world's lands and water resource for food and agriculture. Managing systems at risk*. Rome, IT and London, UK: Food and Agriculture Organization of the United Nations, Earthscan.

Fiałkiewicz, W., Czaban, S., Kolonko, A., Konieczny, T., Malinowski, P., Manzardo, A., ... & Haida, C. (2014). Water footprint as a new approach to water management in the urban areas. In Z. Dymaczewski, J. Jez-Walkowiak and M. Nowak (Eds.), *Water Supply and Water Quality* (pp. 431-439). PZITS Poznan. ISBN:9788389696932

Gargiulo, C., & Russo, L. (2017). Cities and energy consumption: a critical review. *TeMA. Journal of Land Use, Mobility and Environment*, *10*(3), 259-278. doi:http://dx.doi.org/10.6092/1970-9870/5182

Gisotti, G. (2007). Ambiente urbano. Introduzione all'ecologia urbana. Palermo, IT: Dario Flaccovio Editore.

Habitat III (2016). *New Urban Agenda*. Retrieved from http://habitat3.org/the-new-urban-agenda/

Hoekstra, A. Y., & Mekonnen, M. M. (2012). The water footprint of humanity. *Proceedings of the national academy of sciences*, *109*(9), 3232-3237. doi:https://doi.org/10.1073/pnas.1109936109

Kennedy, C., Cuddihy, J., & Engel‐ Yan, J. (2007). The changing metabolism of cities. *Journal of industrial ecology*, *11*(2), 43-59. doi:https://doi.org/10.1162/jie.2007.1107

Lovelock, J. E., & Margulis, L. (1974). Atmospheric homeostasis by and for the biosphere: the Gaia hypothesis. Tellus, 26(1-2), 2-10. doi:https://doi.org/10.3402/tellusa.v26i1-2.9731

Ma, D., Xian, C., Zhang, J., Zhang, R., & Ouyang, Z. (2015). The evaluation of water footprints and sustainable water utilization in Beijing. *Sustainability*, *7*(10), 13206-13221. doi:https://dx.doi.org/10.3390/su71013206

Manzardo, A., Loss, A., Fialkiewicz, W., Rauch, W., & Scipioni, A. (2016). Methodological proposal to assess the water footprint accounting of direct water use at an urban level: A case study of the Municipality of Vicenza. *Ecological indicators*, *69*, 165-175. doi:https://doi.org/10.1016/j.ecolind.2016.04.016

Monstadt, J. (2009). Conceptualizing the political ecology of urban infrastructures: insights from technology and urban studies. *Environment and planning A*, *41*(8), 1924-1942. doi:https://doi.org/10.1068%2Fa4145

Papa, R., Gargiulo, C., & Galderisi, A. (2013). Towards an urban planners' perspective on smart city. *TeMA Journal of Land Use, Mobility and Environment*, *6*(01), 5-17. doi:http://dx.doi.org/10.6092/1970-9870/1536

Papa R., Gargiulo C., Russo L., Franco C. (2016). On The Relationship Between The Promotion Of Environmental Sustainability And The Increase Of Territorial Competitiveness: The Italian Case. *Urban Regeneration & Sustainability*, 295. doi:https://doi.org/10.2495/SDP-V12-N4-655-666

Rushforth, R. R., & Ruddell, B. L. (2015). The hydro-economic interdependency of cities: Virtual water connections of the Phoenix, Arizona Metropolitan Area. *Sustainability*, *7*(7), 8522-8547. doi:https://dx.doi.org/10.3390/su7078522

Seyam, I. M., Hoekstra, A. Y., & Savenije, H. H. G. (2003). The water value-flow concept. *Physics and Chemistry of the Earth, Parts A/B/C*, *28*(4-5), 175-182. doi:https://doi.org/10.1016/S1474-7065(03)00028-7

Steffen, W., Rockström, J., & Costanza, R. (2011). How Defining Planetary Boundaries Can Transform Our Approach to Growth. *Solutions: For A Sustainable & Desirable Future*, *2*(3), 59-65. Retrieved from https://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1036&context=iss_pub

Tiezzi, E., Commoner, B., & Conti, L. (1992). *Tempi storici, tempi biologici*. Milan, IT: Garzanti.

Varriale, R. (2017). *The Urban Footprint in urban territories* (Doctoral dissertation). University of Naples Federico II, Naples, Italy.

Wackernagel, M., & Rees, W. (1998). *Our ecological footprint: reducing human impact on the earth* (Vol. 9). Gabriola Island, CA: New Society Publishers.

Wackernagel, M., Onisto, L., Bello, P., Linares, A. C., Falfán, I. S. L., Garcıa, J. M., ... & Guerrero, M. G. S. (1999). National natural capital accounting with the ecological footprint concept. *Ecological economics*, *29*(3), 375-390. doi:https://doi.org/10.1016/S0921-8009(98)90063-5

World Economic Forum (2017). *The Global Competitiveness Report 2017-2018*. Retrieved from http://www3.weforum.org/docs/GCR2017-2018/05FullReport/TheGlobalCompetitivenessReport2017%E2%80%932018.pdf

Vörösmarty, C. J., Hoekstra, A. Y., Bunn, S. E., Conway, D., & Gupta, J. (2015). Fresh water goes global. *Science*, *349*(6247), 478-479. doi:https://doi.org/10.1126/science.aac6009

AUTHOR'S PROFILE

Rossana Varriale, Sociologist and Ph.D. in Environmental Systems Analysis at the Department of Earth Sciences (DISTAR) - University of Naples Federico II, (UNINA). She is environmental researcher for companies and public organisms (Montedison Ferruzzi Group - Rome, Ministry of the Environment, Paris, Castalia Group, Rome). She has conducted activities of design and teaching (Ecology Footprint and Environmental Communication) at University Course Energy and Environment, CIRAM, Interdepartmental Center for Environmental Research, University of Naples Federico II.

TeMA

Journal of
Land Use, Mobility and Environment

TeMA 3 (2018) 361-383
print ISSN 1970-9889, e- ISSN 1970-9870
doi: http://dx.doi.org/10.6092/1970-9870/5957

REVIEWS PAGES

THE RESILIENCE CITY/THE FRAGILE CITY. METHODS, TOOLS AND BEST PRACTICES 3(2018)

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. During the last two years a particular attention has been paid on the Smart Cities theme and on the different meanings that come with it. The last section of the journal is formed by the Review Pages. They have different aims: to inform on the problems, trends and evolutionary processes; to investigate on the paths by highlighting the advanced relationships among apparently distant disciplinary fields; to explore the interaction's areas, experiences and potential applications; to underline interactions, disciplinary developments but also, if present, defeats and setbacks.

Inside the journal the Review Pages have the task of stimulating as much as possible the circulation of ideas and the discovery of new points of view. For this reason the section is founded on a series of basic's references, required for the identification of new and more advanced interactions. These references are the research, the planning acts, the actions and the applications, analysed and investigated both for their ability to give a systematic response to questions concerning the urban and territorial planning, and for their attention to aspects such as the environmental sustainability and the innovation in the practices. For this purpose the Review Pages are formed by five sections (Web Resources; Books; Laws; Urban Practices; News and Events), each of which examines a specific aspect of the broader information storage of interest for TeMA.

01_WEB RESOURCES
The web report offers the readers web pages which are directly connected with the issue theme.

author: Rosa Morosini
Tema Lab – University of Naples Federico II, Italy
e-mail: rosa.morosini@unina.it

02_BOOKS
The books review suggests brand new publications related with the theme of the journal number.

author: Gerardo Carpentieri
Tema Lab - University of Naples Federico II, Italy
e-mail: gerardo.carpentieri@unina.it

03_LAWS
The law section proposes a critical synthesis of the normative aspect of the issue theme.

author: Maria Rosa Tremiterra
Tema Lab - University of Naples Federico II, Italy
e-mail: mariarosa.tremiterra@unina.it

04_UBAN PRACTICES
Urban practices describes the most innovative application in practice of the journal theme.

author: Gennaro Angiello
Tema Lab - University of Naples Federico II, Italy
e-mail: gennaro.angiello@unina.it

05_NEWS AND EVENTS
News and events section keeps the readers up-to-date on congresses, events and exhibition related to the journal theme.

author: Andrea Tulisi
Tema Lab - University of Naples Federico II, Italy
e-mail: andrea.tulisi@unina.it

TeMA

Journal of
Land Use, Mobility and Environment

TeMA 3 (2018) 361-383
print ISSN 1970-9889, e- ISSN 1970-9870
doi: http://dx.doi.org/10.6092/1970-9870/5957

评述页：

提高城市系统对自然及人为变化顺应能力的方法、工具和最佳实践

TeMA 从城市规划和流动性管理之间的关系入手，将涉及的论题逐步展，并始终保持科学严谨的态度进行深入分析。在过去两年中，智能城市（Smart Cities）课题和随之而来的不同含义一直受到特别关注。
学报的最后部分是评述页（Review Pages）。这些评述页具有不同的目的：表明问题、趋势和演进过程；通过突出貌似不相关的学科领域之间的深度关系对途径进行调查；探索交互作用的领域、经验和潜在应用；强调交互作用、学科发展、同时还包括失败和挫折（如果存在的话）。
评述页在学报中的任务是，尽可能地促进观点的不断传播并激发新视角。因此，该部分主要是一些基本参考文献，这些是鉴别新的和更加深入的交互作用所必需的。这些参考文献包括研究、规划法规、行动和应用，它们均已经过分析和探讨，能够对与城市和国土规划有关的问题作出有系统的响应，同时还对诸如环境可持续性和在实践中创新等方面有所注重。因，评述页由五个部分组成（网络资源、书籍、法律、城市实务、新闻和事件），每个部分负责核查 TeMA 所关心的海量信息存储的一个具体方面。

01_WEB RESOURCES
网站报告为读者提供与主题直接相关的网页。

author: Rosa Morosini
那不勒斯菲里德里克第二大学民用建筑与环境工程系 TeMA 实验室 e-mail: rosa.morosini@unina.it

02_BOOKS
书评推荐与期刊该期主题相关的最新出版著作。

author: Gerardo Carpentieri
那不勒斯菲里德里克第二大学民用建筑与环境工程系 TeMA 实验室 e-mail: gerardo.carpentieri@unina.it

03_LAWS
法律部分提供主题相关标准方面的大量综述。

author: Maria Rosa Tremiterra
那不勒斯菲里德里克第二大学民用建筑与环境工程系 TeMA 实验室 e-mail: mariarosa.tremiterra@unina.it

04_URBAN PRACTICES
城市的实践描述了期刊主题在实践中最具创新性的应用。

author: Gennaro Angiello
那不勒斯菲里德里克第二大学民用建筑与环境工程系 TeMA 实验室 e-mail: gennaro.angiello@unina.it

05_NEWS AND EVENTS
新闻与活动部分让读者了解与期刊主题相关的会议、活动及展览。

author: Andrea Tulisi
那不勒斯菲里德里克第二大学民用建筑与环境工程系 TeMA 实验室 e-mail: andrea.tulisi@unina.it

01

THE RESILIENCE CITY/THE FRAGILE CITY.
METHODS, TOOLS AND BEST PRACTICES 3(2018)

REVIEW PAGES: WEB RESOURCES

ROSA MOROSINI
TeMALab – Università degli Studi di Napoli Federico II, Italy
e-mail: rosa.morosini@unina.it

In this number

GREEN AREAS GET SWALLOWED BY DESERTS: THE DESERTIFICATION PHENOMENON

Desertification is defined as "land degradation in arid, semi-arid and dry sub-humid areas, resulting from various factors, including climatic variations and human activities" (Rio, 1992). This is the innovative definition of the phenomenon (which is increasingly growing in the north Mediterranean countries) given by the United Nations Conference on Environment and Development (Rio, 1992). Its innovative nature is linked to several reasons, including that of considering desertification as the consequence of the overlapping of both anthropic and natural factors. In fact, until the last decade, this phenomenon was linked to periods of severe drought and only in the eighties it became a global problem (Iannetta, 2007).
Furthermore, desertification is one of the effects of climate change since it has increased in recent years, especially in areas affected by simultaneous precipitation and temperature variations (ISPRA, 2017). Climate change affects desertification in two different ways: on the one hand, it influences the expansion of natural deserts, on the other the increase in extreme weather events (such as floods and periods of severe drought) favours soil erosion.
To date, desertification is a widespread phenomenon, considering that the more desertified lands are vast, the faster they grow because space is removed from the natural resources that in the climate system have the function of reducing the presence of carbon dioxide in the atmosphere (which is the cause of rising temperatures), such as soil, that represents the second carbon tank after the oceans (Zucaro & Morosini, 2018).
This section presents three websites that provide data and documents to investigate the extent, causes and impacts of desertification: WAD (World Atlas of Desertification), soil maps and United Nations Environment. The World Atlas of Desertification aims to provide maps on the phenomenon of desertification and the map layers compiled using the convergence of evidence concept can be interrogated in an interactive way by the users. The soil map is a website managed by a working group belonging to the Council for Research in Agriculture and the Analysis of Agricultural Economics (CREA), which aims to provide digital databases and cartography of soils through the use of Geographic Information Systems (GIS). The third website is the United Nations Environment Programme, which is the main global environmental authority that sets the global environmental agenda and promotes sustainable development.

European Commission

World Atlas Desertification
https://wad.jrc.ec.europa.eu/

The World Atlas of Desertification is an atlas composed of maps constructed from the digital cartography base of the world and Lovell Johns' maps. This atlas is an assessment of land degradation at a global level; it is the result of scholarly collaborations among various experts from institutions and universities around the world, who were able to address the phenomenon of desertification thanks to their extensive experience and knowledge. The website is easy to consult, since the home page has six sections which can be accessed by clicking directly on the reference image:

- introduction;
- global patterns of human domination;
- feeding a growing global population;
- limits to sustainability;
- convergence of evidence;
- solutions.

At the bottom right side of the home page there are three more links that give access to information about the atlas and authors and allow the users to download the full version of the Atlas. Each of the sections listed above is in turn organized into subsections that group the different maps and documents, which can be viewed digitally. The "Global patterns of human domination" section provides snapshots that illustrate the dynamic human footprint on Earth and its potential impact on the soil resource.

The snapshots are organised into two groups: human presence and globalisation. The "Feeding a growing global population" section, instead, organises the maps into three subsections, where the global expanse of agriculture and the crucial aspects of the dynamics food productions in relation to land degradation are illustrated. The "Limits to sustainability" section is divided into six subsections which contain the maps monitoring the status of soils to understand the various processes of change that can lead to land degradation, in order to define the environmental thresholds within which human actions must be maintained to avoid future catastrophes.

In the "Convergence of evidence" section there are many documents (always articulated in subsections) which illustrate the complex human-environment interactions in order to evaluate the causes and consequences of degradation, because only a good understanding of the causes and the effects of the phenomenon can provide a guidance to control or reverse desertification. Maintaining and/or improving the productive capacity of land requires a step towards land degradation neutrality.

For this purpose, in the last section, called "Solutions", there are documents which envisage actions to preserve or improve the ability of natural resources to support ecosystem functions and services. In fact, sustainable management of soil and water play a fundamental role. In each subsection there are links which give access to all the maps and the possibility to download for free the maps and the various documents of the Atlas. At the top right side of the home page there are four links which give access to the Privacy statement and to the section "Search", which is the most interesting since users are directly connected to the website of the European Commission by clicking on it.

Soil Map
http://www.soilmaps.it/en/

The soil map is a website of the Centro Nazionale Cartografia Pedologica (CNCP), which is the Italian National Center for Soil Mapping. It is well articulated and rich in data on the soils of Italy, and can be a valid support for the assessment of the risk of desertification at national level since data recovery often represents the longest part of a work aimed at measuring a phenomenon; for this reason, the assessment cannot exclude the use of existing databases. This site is organised into six sections that are easily accessible from the first page of the site:

- home, with a drop-down menu on the left side that allows access to different areas. Through this menu it is possible to find the objective of the work of the research group, the location of the research center and information about the staff. In addition, from the same drop-down menu users can access two more pages, one that displays the various technological platforms, and the other – the "Publications" section – that collects volumes and maps easy to consult and download. To the right side of this section there is a box that allows the user to make a cartography search by entering the reference city;
- soil maps; in this section, after a brief presentation (as for the previous section) users can connect through a drop-down menu - on the left side - to pages that deal with specific topics, such as the Italian Pedological Regions and Land systems. Moreover, from the same menu, other three pages are accessible: the page that provides a list of the referents for each specific theme and for each Italian region, the "Publications" page (where all the documents are available for free download) and the page directly connected to the WebGis;
- database, in which the menu on the left side displays links to different pages where users can download data and publications, always in open version;
- pedoclimate, a section which structure is similar to the previous one;
- projects, a section that presents all the projects activated by the research center, divided by macro-topics, which can be accessed from a menu on the top left side of the section itself. Among the projects in progress, there is the project "Predisposition of a National Atlas of the areas subject to desertification" which proposes to identify, on a national scale, the areas currently desertified and those that, for the climatic and anthropic processes in progress, are more at risk of desertification. The result will be a first approximation of a database of desertified areas and at risk of desertification of Italy: the areas will be classified by type of desertification process and by the presence of mitigating or aggravating conditions of the process, with a 1:100,000 scale of the reference topographic cartography;
- deposits, the last section on the top left side, which contains two links: Presentation and Publications. On the page accessed by clicking on the Presentation, after a brief description of the section, there is a link that can be used to report a deposit, including the contacts of each referent.

Moreover, on the first page of the site, in the upper right corner, there are four more sections:

- downloads, where you can download data and documents in pdf format as well as software, made available under open licenses;
- links, a section which contains the sites focused on land use and on the phenomenon of desertification of Italian regions. In addition to the regional sites, there are links to Italian associations of soil science, research institutes and links to databases on these issues;
- contacts, where users can find the references of the managers of the various CNCP projects;
- site map, a useful modeling of the articulation and the contents of the site.

United Nation Environment Programme
https://www.unenvironment.org/

The United Nations Environment Programme is a United Nations website that aims to raise awareness among all EU countries in caring for the environment, through information campaigns aimed at improving people's quality of life without compromising that of future generations.

The site is organized in different sections, available by clicking on the links at the top of the home page: Regions, About us, Work with us, Languages, Resources and Events. The "Resources" section gives access to a page where all the publications, reports and newsletters related to the topics of interest are listed on the right side with the relative links. At the top left of the page, instead, there is a box for Advanced search, where the user can search by keywords, category and resource type or by topics. It is also possible to narrow down the search field by selecting several options at the same time or adding other types of information such as the region, the country and the tags. The scrolling list on the right side is easy to consult: by clicking on the title, users are connected directly to the linked page, where they can consult and download the material of interest for free. Desertification is one of the topics covered: users have just to enter the keyword "desertification" in the box on the left to access the different articles and reports focused on this type of phenomenon, which has aroused much interest especially in the last year, considering that the first report is dated February 2017 and the last one exactly one year later. By clicking on a report users access a page where they can download the material. In addition to the link of the report download, there are links through which it is possible to access other studies of possible interest for the user who is consulting that particular report. Lastly, to the left side of each page there are links to social networks: Facebook, LinkedIn, Twitter and AddThis - email a friend.

REFERENCES

Iannetta, M. (2007). Interazioni tra i camiamenti climatici e desertificazione. *Accademia Nazionale delle Scienze detta dei XL Memorie di Scienze Fisiche e Naturali*, *41*(125), 277-297. Retrieved from http://media.accademiaxl.it/memorie/S5-VXXXI-P2-2007/Iannetta277-295.pdf

Ispra, (2017). A*nnuario dei dati ambientali 2017*. Retrieved from https://annuario.isprambiente.it/sites/default/files/pdf/ 2017/ integrale/10_Geosfera%20II%20finale_ter.pdf

United Nations Conference on Environment and Development (1992). *Earth Summit*. Rio de Janeiro. Retrieved from https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

Zucaro, F., & Morosini, R. (2018). Sustainable land use and climate adaptation: a review of European local plans. *TeMA. Journal of Land Use, Mobility and Environment*, *11*(1), 7-26. doi:http://dx.doi.org/10.6092/1970-9870/5343

IMAGE SOURCES

The images are from: https://www.cosepercrescere.it/la-desertificazione/; https://wad.jrc.ec.europa.eu/; http://www.soilmaps.it/en/; https://www.unenvironment.org

02

THE RESILIENCE/THE FRAGILE CITY.
METHODS, TOOLS AND BEST PRACTICES 3(2018)

REVIEW PAGES: BOOKS

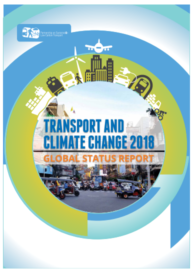
GERARDO CARPENTIERI
TeMALab – Università degli Studi di Napoli Federico II, Italy
e-mail: gerardo.carpentieri@unina.it

In this number

TOWARDS SUSTAINABLE AND RESILIENT SOCIETIES

Addressing climate change is one of the major global challenges of our time. We live in a world of increasingly unpredictable and complex risks. Trends such as demographic change, rural–urban transitions, technology change and climate change are reshaping our region (Ramachandra et al., 2014). We need to be much better prepared to deal with the interlinked impacts of long-term trends, and deal with the inevitable changes the future will bring. It is increasingly urgent to understand how best we can realize the transformations that will ensure that we achieve the Sustainable Development Goals. The 2030 Agenda for Sustainable Development states global leaders' determination to "take the bold and transformative steps needed to shift the world on to a sustainable and resilient path". Transformation requires breaking through the 'path dependency' that defines the way things are done. In particular, the transport sector is a major contributor to greenhouse gas emissions; responsible for 23% of global energy-related carbon dioxide emissions. The rate of emissions from transport is increasing faster than from any other sector. Transport activity, in turn, drives transport emissions, which grew by 31% from 2000 to 2016. The growth of absolute transport emissions between 2000 and 2016 was highest in Asia (92%), Africa (84%) and Latin America (49%), driven by growth in prosperity and in passenger and freight transport activity in these regions. The technology is playing an increasing role in low carbon transport plans and target from countries, states and provinces, cities, and companies (Angelidou, 2017). In last decade, the political and corporate leadership on transport and climate change is growing in scope and intensity, within and outside of global agreements (De Gregorio et al., 2015). The actions required to strengthen resilience can be understood in terms of inter-related and complementary resilience capacities: Anticipatory capacity, the ability of human systems to anticipate and reduce the impact of shocks through preparedness and planning; Absorptive capacity, the ability of human systems to absorb and cope with the impacts of shocks and stresses; Adaptive capacity, the ability of human systems to change in response to multiple, long-term and future risks, and to learn and adjust after a shock materializes; Transformative capacity, the ability to take deliberate steps to change systems that create risks, vulnerability and/ or inequality.

According to these themes, this section proposes three works that help to better understand the topics of this number: Open Data Infrastructure for City Resilience. A Roadmap, Showcase and Guide; Transformation towards sustainable and resilient societies in Asia and the Pacific; and Transport and Climate Change Global Status Report 2018.



Title: **Transport and Climate Change Global Status Report 2018**
Author/editor: Partnership on Sustainable, Low Carbon Transport (SLoCaT)
Publisher: German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the William and Flora Hewlett Foundation
Publication year: 2018
ISBN code: -

This first edition of the Transport and Climate Change Global Status Report is intended to help ensure that low-carbon transport is a fundamental strategy in climate action at global, regional, national, and sub-national levels. Considering the implementation of the Paris Agreement on climate change, transport must inevitably play its part if global targets are to be met. The report describes recent trends in transport demand emissions, illustrates recent policy targets and measures across a number of transport sub-sectors, and sets a baseline from which to demonstrate the potential of transport to make a proportional contribution to the 1.5-degree Celsius scenario. This report is intended primarily as a resource for policy-makers to raise ambition on climate mitigation and adaptation in sustainable transport plans and programs by countries, cities, states and provinces, and private sector companies; thus, the report provides a central repository on transport and climate change data which can help to support policy-makers in setting transport planning targets. In addition, the report offers trends analyses supported by peer examples to help increase coherence among low carbon transport policies for actors at different levels of government.

In the first part, the report consists of a global overview comparing current trends in transport and climate change across three dimensions: passenger and freight transport, international aviation and shipping, and global regions with respect to transport demand, transport emissions, and low-carbon transport policy measures. In the second part, it describes recent trends in transport demand and transport emissions and illustrates potential Paris Agreement-compliant mitigation pathways. This part is divided into three parts: Part A discusses the various drivers of transport demand, considering recent trends in passenger and freight transport demand, and reports on global development of transportation infrastructure; Part B reviews transport emissions growth by mode and region, and explores transport energy intensity, carbon intensity of fuel, and other impacts; and Part C discusses transport emissions projections and mitigation potential. In the third part, it describes frameworks for transport and climate change planning through the United Nations Framework Convention on Climate Change mitigation and adaptation planning processes, along with low carbon transport policy targets and measures across eight major policy areas, which are illustrated by recent examples from a range of global regions including extensive case studies from the Global South. In the four part, it summarizes global investment in the transport sector and examines the current level of investment from four sources: the public sector, the private sector, official development assistance (ODA), and climate finance. The funding gap between the current level of investment and projected future needs in the transport sector is highlighted as well. This report is not intended to make policy recommendations, nor does it advocate the use of any particular low carbon transport measure, mode, or technology. Data are drawn from the most recent publicly-available source to populate a set of key indicators, which are to be refined and expanded in the future. As available data are not consistently robust for each of the eight policy areas, the report maintains indicators to highlight existing gaps with the goal to support future data collection efforts. Mode shift and emission reduction impacts for implemented measures in each of the eight policy areas are quantified where possible, data sets are currently limited for most of this policy areas.

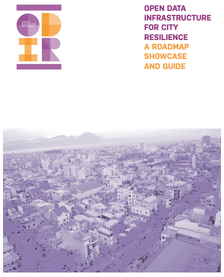
Title: **Transformation towards sustainable and resilient societies in Asia and the Pacific**
Author/editor: The Economic and Social Commission for Asia and the Pacific (ESCAP)
Publisher: United Nations and Asian Development Bank
Publication year: 2018
ISBN code: 978-92-9261-115-6

This report takes stock of the changing nature of risk in Asia and the Pacific, and the stresses, shocks and opportunities that are affecting a diverse region's prospects for achieving the SDGs. It quantifies the effects of selected natural hazards, commodity shocks and pollution shocks on the region's fundamental human systems. It highlights practical efforts being made by citizens, civil society, government and the private sector to build resilience capacities. This study identifies three barriers to transformation that make change difficult. The first is inadequate human and institutional capacity; the second is institutional rigidity, which diminishes institutions' capacity to evolve; and the third is inadequate social momentum for change. Socio-cultural factors, gender and other dimensions of inequality, and imbalances in access to decision-making also affect prospects for transformation.

The report contributes to regional and global dialogue on the theme of the 2018 high-level Political Forum on Sustainable Development, "*Transformation towards sustainable and resilient societies*", from an Asia-Pacific perspective. It explores how resilience thinking can strengthen public policy to enable the transformation towards sustainable societies envisaged by the 2030 Agenda for Sustainable Development.

- Chapter 1, sets out the relevance of the theme for achieving the 2030 Agenda in the Asia-Pacific region, and the steps needed to build the four key resilience capacities: absorptive, adaptive, anticipatory and transformative. It presents a three steps approach for incorporating resilience into policymaking that: (1) identifies risks; (2) explores the potential impacts on human systems and vulnerable groups; and (3) identifies policies and institutional responses that build these resilience capacities.
- Chapter 2, explores the first two steps, reviewing the main underlying sources of risks in the region. It assesses the impacts of various types of recurrent shocks on human systems in the region, with a focus on the most vulnerable people in society;
- A Special Feature of the report takes stock of the situation in the region with respect to the SDGs that explicitly refer to resilience;
- Chapter 3, supports the final step: the identification of policy and institutional responses. It shows how each of the four different types of resilience capacity can be built, presenting a range of examples of policies and programmes, from across the region, that have proven effective. It draws conclusions on the key characteristics that individuals, organizations and societies need to become resilient;
- Chapter 4, concludes the report by considering opportunities to support transformation for resilience, particularly through regional cooperation.

It shows how capacity-building and institutional interventions – from the household level through the community level to the national level – can increase resilience. It underlines that the likelihood of achieving some of the most urgent transformations advocated by the 2030 Agenda can be increased by better understanding the context of risk and focusing on resilience-building. It has stressed opportunities to support transformations that can support more resilient development, including through a focus on learning, deeper stakeholder engagement, innovative partnerships and financing for resilience.



Title: **Open Data Infrastructure for City Resilience. A Roadmap, Showcase and Guide**
Author/editor: Resilience Brokers, GeoSUMR, OpenNorth and Esri
Publisher: UNISDR Making Cities Resilient Campaign
Publication year: 2018
ISBN code: -

This publication contributes to the Making Cities Resilient campaign, launched by the United Nations Office for Disaster Risk Reduction (UNISDR) 2015-2030 at the local level and partners since 2010. It has been developed as a resource for cities that include urban planning, risk reduction, resilience building and civil contingency. It has been designed to help cities to integrate open data policies and infrastructure into their wider city data strategies and the development of their resilience action plans. The Roadmap, Showcase and Guide have a particular focus on open data, risk analysis and response that resilience action planning requires. This publication also highlights how investments in open data-based approaches combined with the use of geospatial data and geographic information systems (GIS) software can generate strong resilience benefits for city authorities. Also, the publication is a part of a suite of new tools that are oriented toward the 10 aspects essentials for making cities resilient, a ten-point checklist developed for the making cities resilient campaign by leading urban resilience experts.
The structure of the publication is composed of three section Roadmap, Showcase and Guide. The section A, two key assessment tools for understanding the level of data maturity of a city are presented, alongside a set of tried and tested approaches. In the section B, it includes use cases from a range of developed and developing country cities. In the last section C, it covers cross-cutting issues such as how to develop crowdsourced mapping, data standards, open innovation and risk communication.

REFERENCES

Angelidou, M. (2017). Smart city planning and development shortcomings. *TeMA. Journal of Land Use, Mobility and Environment, 10*(1), 77-94. doi:http://dx.doi.org/10.6092/1970-9870/4032

De Gregorio Hurtado, S., Olazabal, M., Salvia, M., Pietrapertosa, F., Olazabal, E., Geneletti, D., … & Reckien, D. (2015). Understanding How and Why Cities Engage with Climate Policy: An Analysis of Local Climate Action in Spain and Italy. *TeMA. Journal of Land Use, Mobility and Environment, Special Issue ECCA 2015*, 23-46. doi:http://dx.doi.org/10.6092/1970-9870/3649

Harvey, M., Eltinay, N., Barnes, S., Guerriero, R., & Caffa, M. (2018). Open data infrastructure for city resilience: A roadmap showcase and guide. Retrieved from: https://www.unisdr.org/campaign/resilientcities/assets/documents/guidelines/ODIR%20Publication%20Final_16042018_opt.pdf

Jacob, A., Tiwari, B. N., Rankine, H., Beerepoot, M., Dacanay, M. L., Jiwanji, M., ... & Schandl, H. (2018). Transformation towards sustainable and resilient societies in Asia and the Pacific. Bangkok, TH: United Nations, Asian Development Bank, United Nations Development Programme. doi:http://dx.doi.org/10.22617/TCS189274-2

Partnership on Sustainable, Low Carbon Transport (2018). Transport and Climate Change Global Status Report. Retrieved from http://slocat.net/sites/default/files/slocat_transport-and-climate-change-2018-web.pdf

Ramachandra, T., Aithal, B., & Beas, B. (2014). Urbanisation Pattern of Incipient Mega Region in India. *TeMA. Journal of Land Use, Mobility and Environment, 7*(1), 83-100. doi:http://dx.doi.org/10.6092/1970-9870/2202

03

THE RESILIENCE CITY/THE FRAGILE CITY.
METHODS, TOOLS AND BEST PRACTICES 3 (2018)

REVIEW PAGES: LAWS

MARIA ROSA TREMITERRA
TeMALab – Università Federico II di Napoli, Italy
e-mail: mariarosa.tremiterra@unina.it

In this number

TOWARDS INTEGRATION BETWEEN DISASTER RISK REDUCTION AND CLIMATE CHANGE ADAPTATION IN THE EUROPEAN UNION

Climate change, urbanization, population growth, and environmental degradation strongly affect the urban capacity to effectively respond to severe natural events. At the international level, the Sendai Framework for disaster risk reduction 2015-2030, adopted by United Nations (UNISDR, 2015), try to provide a first common policy reference and a basis for the development of a resilient sustainable development agenda for better managing the consequences of these issues. Furthermore, one of the issues addressed by the Sendai Framework refers to the link between Disaster Risk Reduction and Climate Change Adaptation. In the past Climate Change Adaptation and Disaster Risk Reduction were considered different and separate concepts. In particular, while Climate Change Adaptation meant to increase the social and infrastructural capacity of the territories to respond to the future climate changes, Disaster Risk Reduction was addressed to act on the three components of the risk concept – hazard, exposure and vulnerability – and reduce them, and especially the vulnerability, for adverse events. However, several researchers (i.e. Balaban & Şenol Balaban, 2015; Norton et al., 2015) and policy documents highlight that Climate Change Adaptation and Disaster Risk Reduction are strictly linked. As highlighted by the Hygo Framework in 2007, indeed, risk reduction is a means to adapt to climate change impacts since climate variability represents a source of risk. In this perspective, Climate Change Adaptation can be considered a component of the broad Disaster Risk Reduction agenda (ProAct Network, 2008). It is possible to identify various relationships between Climate Change Adaptation and Disaster Risk Reduction (ProAct Network, 2008). For examples, both aim to build resilience in the face of hazards and have to be integrated into relief, recovery and development plans and policies and thus require multi-stakeholder participation. Furthermore, from an operative viewpoint, in order to achieve the common goal of Climate Change Adaptation and Disaster Risk Reduction, they recognize:

- the need to define and implement measures at the local level;
- a starting point in the knowledge of existing conditions of risk and climate variability;
- the benefits of environmental management measures for future risk reduction;
- the importance of the risk analysis for defining effective actions.

Nevertheless, Disaster Risk Reduction and Climate Change Adaptation have also differences. For example, while Disaster Risk Reduction has a well-defined theoretical profile, Climate Change Adaptation is mainly based on practical local applications. Besides the Sendai Framework, other international documents pay attention to the Disaster Risk Reduction and Climate Change Adaptation' integration, including the UNFCC Paris Agreement and the UN Sustainable Development Goals, both adopted in 2016.

In this context, considering the increase of disasters in its territories, the European Union has started to take into account this need to adapt to climate change in order to reduce the disaster risks. In particular, since 2001 the European Union has adopted a set of documents that put in relationships these two aspects. They are the EU Climate Adaptation Strategy (2013), the EU Civil Protection Mechanism (2001), the EU Action Plan on the Sendai Framework for Disaster Risk Reduction (2016), the EU Floods Directive (2007) and the EU Green Infrastructure Strategy (2013). In order to understand in which way the European Union is addressing the integration between Climate Change Adaptation and Disaster Risk Reduction with a specific reference to the urban planning implications, in this issue two European legislative framework are described. The first one is the Commission Staff Working Document "Action Plan on the Sendai Framework for Disaster Risk Reduction 2015-2030. A disaster risk-informed approach for all EU policies". Since the European Union played a key role during the negotiations for the definition of the Sendai framework, the Action Plan includes a set of operative addresses for the implementation of the Sendai priorities. Secondly, the European Commission's Communication "Strengthening EU Disaster Management: rescEU Solidarity with Responsibility" is illustrated. This document integrates the EU Civil Protection Mechanism established in 2001 for supporting Member States during disaster events.

ACTION PLAN ON THE SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION 2015-2030

The Sendai Framework is a voluntary instrument that was adopted by the United Nations in 2015 and aims at preventing new and reducing existing disaster risks by using an integrated approach. In particular, the adoption of its "priorities" can have effects in the reduction of vulnerability and increase of resilience of a territory. This instrument is the result of a policy concertation at the international level during which the European Union played a leading role.

In order to pursue the international targets and develop a "disaster risk-informed approach" to take forward the EU disaster risk management agenda and to reinforce efforts to increase resilience to shocks and stresses in Member States, in 2016 the European Union adopted the Action Plan on the Sendai framework.

According to the Sendai Framework, the Action Plan takes into account the four priorities as a starting point:

- Sendai Priority 1. Understanding disaster risk;
- Sendai Priority 2. Strengthening disaster risk governance to manage disaster risks;
- Sendai Priority 3. Investing in disaster risk reduction for resilience;
- Sendai Priority 4. Enhancing disaster preparedness for effective response to "Build Back Better".

In a fragmented way, several EU initiatives have already contributed to implement these four priorities. However, the Action Plan identifies a new approach that consists of four key areas based on the Sendai framework:

- Key Area 1. Building risk knowledge in EU policies;
- Key Area 2. An all-of-society approach in disaster risk management;
- Key Area 3. Promoting EU risk informed investments;

- Key Area 4. Supporting the development of a holistic disaster risk management approach.

The Key Area 1 responds to the Sendai Priority 1 and provides the following "implementation priorities": the promotion of the collection and sharing of baseline loss and damage data; the use of scenarios and risk assessments for better preparedness to existing or possible risks; the engagement with the research community in order to address disaster risk management and encourage "the science-policy interface in decision-making". Instead, in order to respond the Sendai Priority 2, the Key Area 2 is characterized by three main "implementation priorities" that are: the improvement of risk awareness and education, as a mean for reducing disaster risks and better managing their impacts; the active engagement of authorities, communities and civil society for developing inclusive local and national disaster risk reduction strategies; finally, the strengthening of the links among disaster risk management and climate change adaptation. In particular, with regards to this last priority, the Action Plan highlights the key role that urban policies and initiatives assume for a better integration of disaster risk management and climate change adaptation. However, this role seems to be also shared with the implementation of "biodiversity strategies". According to the Sendai Priority 3, for the Key Area 3 the Action Plan defines five implementation priorities that are mainly related to the promotion of risk-informed investments and risk insurance but includes also the implementation of ecosystem-based approaches for disaster risk reduction. Finally, the Key Area 4, related to the last Sendai Priority, considers the ex-post disaster actions and defines as main implementation priorities: the integration of cultural heritage in the national risk reduction strategies; the improvement of the preparedness and response capacities for disasters that can have health consequences; the support to a better integration of transnational detection and early warning and alert systems for improving the disaster preparedness and response action; finally, the promotion of the "Build Back Better" that means a stronger, faster, and more inclusive post-disaster reconstruction in order to avoid or reduce future disaster risk (Hallegatte et al., 2018).

With regards to each implementation priority, the Action Plan identifies specific activities to carry out until 2020. In particular, in order to improve the "*understanding of disaster risk management in urban settings and enhanced support and contribution to disaster-resilient towns and cities*", the main activities identified by the Action Plan are the following ones:

- develop guidance and methodologies, learn from good practices and address the needs of vulnerable groups in communities in order to define urban resilience policy and practices;
- support cities in partner countries that are mainly exposed to risks in order to strengthen their capacities in addressing disaster risks at the local level and in developing and implementing national disaster risk reduction and climate change adaptation strategies;
- integrate disaster risk management policy and practices into the European Urban Agenda and in the several European initiatives that refer to cities (e.g. Covenant of Mayors for Climate and Energy, Smart Cities, etc.).

STRENGTHENING EU DISASTER MANAGEMENT
RESCEU SOLIDARITY WITH RESPONSIBILITY

In recent years, the European Union is facing heavy impacts due to intense and unpredictable extreme natural events. These events have different consequences in terms of loss of life, destruction of properties and cultural heritage. Furthermore, the current climate variability, better known as "climate change", plays an important role in exacerbating the magnitude of natural disasters. Therefore, starting from 2001 all the Member States were included in the EU Civil Protection Mechanism that aims at fostering cooperation among national Civil Protections. However, considering the increase of natural and weather disasters in Europe, in 2017 the EU Commissions publishes the Communication "Strengthening EU Disaster Management: rescEU Solidarity with Responsibility" which states the need of a review to the current EU's civil protection response in order to strengthen it. As defined in the Communication, the main changes will refer to the following objectives:

- "Reinforce the EU's and Member States' collective ability to respond to disasters, and address recurrent and emerging capacity gaps, by putting in place a dual system of response capacity: a dedicated reserve of response capacities with command at control at Union level, to be known as rescEU; and a more effective and dynamic contribution from Member States through a European Civil Protection Pool";
- "Strengthen the focus on prevention action as part of the disaster risk management cycle, as well as reinforce coherence with other key EU policies acting, inter alia, in the field of climate change adaptation, disaster prevention and disaster response";
- "Ensure the Union's Civil Protection Mechanism is agile and effective in its administrative procedures in support of emergency operations".

In order to respond to these objectives, seven key actions are identified. They include greater coordination between the European Commission and Member States in order to increase prevention and preparedness during disasters and endorse a more cross-sectoral approach in this field. Furthermore, the European Commission highlights the need to coordinate the disaster management with other EU policies among which the climate change adaptation. Indeed, the EU Strategy on Adaptation to Climate Change can work in synergy with disaster risk management since climate change adaptation represents a "mean" to prevent the externalities of disasters. This integration has to take into account various tools and instruments that Member States have at their disposal, including specific EU funds. About the improvement of the Civil Protection mechanism, the Communication identifies nine key actions that include various tasks, among which:

- the launch of a Communication and an Advocacy Campaign on disaster prevention "with a particular focus on forest fires, heat waves and other climate-induced extreme weather events, to improve awareness of preventive action";
- the promotion of a more systematic collection and dissemination of loss data, the enhancement of the loss data collection and the use of loss data for optimising prevention and climate adaptation planning.

REFERENCES

Balaban, O., & Şenol Balaban, M., (2015). Adaptation to Climate Change: Barriers in the Turkish Local Context. *TeMA. Journal of Land Use, Mobility and Environment*, Special Issue ECCA 2015, 7-22. doi: http://dx.doi.org/10.6092/1970-9870/3650

Hallegatte, S., Rentscheler, J., & Walsh, B., (2018). *Building Back Better. Achieving resilience through stronger, faster, and more inclusive post-disaster reconstruction*. Washington, USA: International Bank for Reconstruction and Development/The World Bank. Retrieved from https://www.gfdrr.org/sites/default/files/publication/Building%20Back%20Better.pdf

Norton, J., Atun, F., & Dandoulaki, M., (2015). Exploring Issues Limiting the Use of Knowledge in Disaster Risk Reduction.. *Tema. Journal of Land Use, Mobility and Environment,* Special Issue ECCA 2015, 135-154. doi: http://dx.doi.org/10.6092/1970-9870/3032

ProAct Network, (2008). Climate Change Adaptation and Disaster Risk Reduction. Retrieved from https://www.unisdr.org/files/8877_drrcaapolicypaper.pdf

IMAGE SOURCES

The images are from: Fig.1 http://unfccc.int/files/adaptation/groups_committees/adaptation_committee/application/pdf/techpaper_adaptation.pdf; Fig.2 https://goo.gl/images/zVB69T; Fig. 3 https://goo.gl/images/pyJCC8

04

THE RESILIENCE CITY/THE FRAGILE CITY. METHODS, TOOLS AND BEST PRACTICES 3(2018)

REVIEW PAGES: URBAN PRACTICES

GENNARO ANGIELLO
TeMALab – Università degli Studi di Napoli Federico II, Italy
e-mail: gennaro.angiello@unina.it

In this number

PLANNING FOR RESILIENCE IN SOUTH AMERICA: TWO CASE STUDIES

With a greater concentration of people and assets in urban areas, cities need to address an increasingly complex range of shocks and stresses to safeguard development gains and well-being. Managing disaster risk and the impacts of climate change have long been an important focus of urban resilience (Galderisi, 2014; Galderisi et al., 2016), but recent examples have shown how economic crises, health epidemics, and uncontrolled urbanization can also affect the ability of a city to sustain growth and provide services for its citizens, underscoring the need for a new approach to resilient urban development.
In response of these concerns, in the last few decades, researchers from different disciplines have started investigating the meaning, aspects and elements of urban resilience, suggesting that resilience is a complex and multifaced concept with wide implications for planning practices (Salat & Bourdic, 2012), also arguing that achieving resilience in urban areas requires a strong partnership between local governments, research centres, the non-profit sector, businesses, and communities (Stumpp, 2013).
Within this context, several initiatives involving both public and private stakeholders have been created in the last few years, aimed at fostering resilience in urban areas. A notable example in this direction is the *100 Resilient Cities* initiative, pioneered by the Rockefeller Foundation. The initiative represents one of the most remarkable effort to helping cities around the world become more resilient to the physical, social and economic challenges that are a growing part of the 21st century.
The *100 Resilient Cities* programme defines urban resilience as "the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience".
Based on this definition, a "City Resilience Framework" (CRF) has been established. The framework provides an innovative model for the local authorities to develop a holistic city strategy in collaboration with adjacent municipalities, local academic institutions, private stakeholders, and communities of the city and represents the foundation for the developments of a city resilient strategy. The programme has been established in 2013, in honour of Rockefeller's 100th anniversary and had initial funding of $100 million (although the level of funding support has grown since the programme was launched). Since then, 102 cities worldwide have joined the programme, and 37 Resilience Strategies (with nearly 1,900 concrete actions and initiatives) have been developed. This contribution presents two relevant Resilient Strategies, developed in two South-American capitals, within the 100 Resilient Cities framework: i) the Quito (Ecuador) Resilient Strategy and ii)

the Santiago (Chile) Resilient Strategy. Beside pertaining to the same geographic area, the two cities have been selected because they share a great portion of physical, social and economic challenges, including:

- an inadequate transportation system;
- sprawl and uncontrolled urban growth;
- environmental degradation;
- persistent social inequalities.

Furthermore, both cities have faced in the past (and might face in the future) volcanic and hearth-quake hazards.

Quito is the capital city of Ecuador and has an urban population of 2.67 million inhabitants. The city not only boasts a rich history and cultural patrimony, represented by its word-famous historic center (that received recognition as the first UNESCO World Heritage Site in 1978), but also an incredible wealth of biodiversity. The city has been exposed in the recent years to a wide range of acute shocks including earthquakes, volcanic eruptions and economic crises. Beside these shocks, there are other, smaller-magnitude and more frequent shocks like floods and forest fires. At the same time, the city continues to be affected by chronic stresses such as social exclusion, environmental degradation, lack of an efficient transportation system, and lack of a diversified economy that provides job opportunities. In order to face these and other relevant urban challenges, on October 2017, the city of Quito released its Resilience Strategy with the support of the *100 Resilient Cities* initiative. The strategy is based on 5 main pillars, 16 goals and 64 tangible actions:

- *Pillar A, Inclusive and empowered citizens* - This pillar is in response to the need to consolidate participatory processes as vectors of democracy, validate the public administration’s work, and facilitate processes of co-responsibility between citizens and the municipality. To reach these aims several coordinated actions are considered in the strategy, ranging from the development of a digital platform aimed at supporting citizens participation in the decision-making process, to the activation of public areas regeneration projects finalized at creating safe and functional public spaces trough the collaboration of citizens, private stakeholders and the Quito municipality.
- *Pillar B, Robust and Sustainable Environment* - This pillar concern with the environmental dimension of urban resilience and proposes developing efficient, participatory administration mechanisms aimed at managing natural and seminatural areas and urban parks while increasing citizen environmental awareness. To address these objectives the strategy includes a green infrastructure program aimed at regenerate and create new green areas within the city, giving particular attention to deprived neighborhoods. It also includes a communication campaign in which citizens themselves can experience the benefits of nature and understand the importance of personal and collective contributions to reducing the city’s environmental footprint.
- *Pillar C, Integrated and Compact City* - Scattered and uncontrolled urban sprawl is a problem that makes Quito segregated and inefficient. This third pillar controls urban sprawl, maximizes the positive impact of building the first Quito metro line, and creates an integrated and efficient mobility system

that favors active mobility. A number of coordinated actions are proposed to meet this goal. These include: i) the development of a comprehensive plan for transit-oriented development (TOD), finalized at organizing and maximizing the benefits associated with public transportation by creating dense, mixed-use settlements in the areas surrounding the new metro line stations; ii) the development of a technological tool that makes it possible to monitor dynamics involving real estate development (height and extension) using satellite images; iii) the implementation of the Urban Partial Plan for the Quito Historic City Center aimed at maintain and improve the quality of life for city center residents and visitors, coordinate different means of transport and all associated development, and develop conservation, participation, and occupancy plans and iv) the development of a new low environmental impact construction regulation finalized at incentivizing real estate projects to incorporate environmental efficiency principles into construction through regulations.

- *Pillar D, Resourceful and Solid Economy* - Building economic resilience begins by strengthening productive sectors and diversifying lines of business, all with an environment-friendly focus. This fourth pillar creates an economic environment conducive to strengthening job supply and demand, with a special focus on youth. It fosters a diverse, sustainable, and innovative economy, and promotes the food-related economy as the backbone of development. Several actions are included within the pillar D, ranging from the creation of Special Economic Development Zone (ZED) in the proximity of the city's airport aimed at attracting new investments through tax incentives, to the development of industrial parks where incentivize the location of new business companies while regulate areas where residential, commercial, and industrial land uses coexist through zoning and city planning regulations. Emphasis furthermore is given within this pillar to incentivize urban and rural agriculture by developing specific mechanisms to improve both the quantity and the quality of production in urban gardens as well as the demand for such products;
- *Pillar E, Reflective and Safe Territory* - This pillar seeks to avoid creating new risks, mitigate existing ones, and prepare the city to confront potential natural and man-made disasters. In particular, to avoid new risk the strategy proposes the development of guidelines for new construction and reinforcing existing construction in low-income areas. For mitigating existing risks, the strategy proposes a new program to strengthen mechanisms for evaluating existing buildings and critical infrastructures. Finally, in order to prepare the city and its citizens to confront potential disasters, the strategy includes programs to i) promote neighborhood preparedness, ii) create disaster response neighborhood volunteer networks and iii) extend insurance against natural and manmade disasters.

SANTIAGO

Santiago is the capital city of Chile and has an urban population of 5.61 million inhabitants. Over the last decades, Santiago has undergone an explosive development characterized by a steady economic and a significant reduction in the levels of poverty. However, the built city has consolidated with a scenario of limited urban planning tools, resulting in disperse settlements and social and geographical segregation. The city has faced several shocks in the recent past related to its geography and climate including earthquakes, barrages, floods, thermal inversion and droughts.

At the same time, Santiago continues to be affected by chronic stresses such as security, transport and pollution, where social inequality is a factor that transcends all of these stresses. In response, the city of Santiago released its Resilience Strategy on June 2017. The Strategy is framed by 7 pillars, 21 objectives and 75 actions:

- *Pillar I, Urban Mobility: Connected Santiago -* The main objective of this pillar is to promote the use of public transport and encourage active mobility as a means to achieve a more sustainable and resilient transportation system. To meet this objective, the strategy presents a number of coordinated initiatives, including: i) the definition of a Metropolitan Authority to better meets the needs of a complex and evolving mobility system; ii) the definition of an Intermodal Development Plan, aimed at identifying the region's relevant transfer points; iii) the implementation of a fare integration model for the region's urban-rural transport system.; iv) the development of smart urban logistic solutions aimed at minimizing costs for businesses and reducing the environmental impacts of transportation and v) the renovation of pedestrians and cycling spaces through greenway projects.
- *Pillar II, Environment: Green and Sustainable Santiago* - This pillar is aimed at reducing the shortage of green areas within the city by integrating natural systems into the urban fabric, fostering a sustainable waste-management system and establishing a sustainable and equitable energy system. In particular, the City intends to target investment into green infrastructure and nature-based solutions especially in the most vulnerable neighborhoods. A sustainable waste management system is also envisioned in the strategy and is supported by the development of a waste recovering program, as well as investments in applied research. Finally, in order to establishing a more sustainable energy system, the city will lunch different initiatives targeting the reduction of energy consumption in the public sector as well as in the commercial and residential sector;
- *Pillar III Human Security: Safe Santiago -* The third pillar promotes the peaceful coexistence of Santiago inhabitants and addresses the multi-causality of crime in a collaborative, coordinated, strategic and intelligent manner. Action included in this pillar are mainly targeted toward the realization of situational prevention projects such as tele-protection systems, providing lights in unsafe areas with high public rates, renovation of empty lots, bus stops, stands, street furniture, among other things; as well as self-care promotion and citizen education;
- *Pillar IV, Risk Management: Prepared Santiago* - This pillar is devoted at design intelligent systems to mitigate risks and face emergencies, recognize and anticipate existing risks in the metropolitan area and prepare the citizenship against threats and disasters. To meet these objectives the strategy proposes the creation of the Integrated Emergency and Disaster Management Centre for monitoring, collecting, analyzing, and sharing information among institutions and for prioritizing actions in times of crisis and disasters. Furthermore, the strategy proposes the development of three specific programs: the Seismic Risk program, the Hydro-meteorological Hazard program and the Fire Prevention and Control program. Finally, the strategy proposes the creation of a network of volunteers that will be activated in case of natural or man-made disasters;
- *Pillar VI, Economic Development and Competitiveness: Global and Innovative Santiago*. This pillar is aimed at positioning Santiago as a global city by strengthen the regional ecosystem of innovation and entrepreneurship. To this end a coordinated mix of action will take place, including: i) the development of a Strategic Plan to promote the Santiago City brand; ii) the creation of an international convention center, which will attract business and thematic tourism to the region; iii) the creation of mechanism to fund startups, research and small and medium enterprises within the city-region;
- *Pillar VII, Social Equity: Inclusive Santiago -* This pillar addressed the social dimension or urban resilience ad aims at generating inclusion opportunities for those at social risk or in situations of violence. It also aims at guarantee access and standard to urban goods and services to all the

inhabitants of the region. Different programs are thus envisioned, targeting specific vulnerable social groups including children and adolescents, immigrants, and the elderly. The strategy furthermore includes an update of the Santiago Metropolitan Zoning Plan for the promotion of socio-spatial equity.

REFERENCES

City of Quito (2017). Quito Resilience Strategy. Retrieved from https://www.100resilientcities.org/strategies/quito/

City of Santiago de Chile (2018). Santiago Resilience Strategy. Retrieved from https://www.100resilientcities.org/strategies/santiago-de-chile/

Galderisi, A., (2014). Climate Change Adaptation. Challenges and Opportunities for a Smart Urban Growth. *TeMA. Journal of Land Use, Mobility and Environment, 7*(1), 43-68. doi:http://dx.doi.org/10.6092/1970-9870/2265

Galderisi, A., Mazzeo, G., & Pinto, F. (2016). Cities dealing with energy issues and climate-related Impacts: Approaches, strategies and tools for a sustainable urban development. In R. Papa & and R. Fistola (Eds.), *Smart Energy in the Smart City. Urban Planning for a Sustainable Future* (pp. 199-217). Cham, CH: Springer International Publishing. doi:https://doi.org/10.1007/978-3-319-31157-9_11

Salat, S., & Bourdic, L. (2012). Systemic resilience of complex urban systems. *TeMA. Journal of Land Use, Mobility and Environment*, *5*(2), 55-68. doi:http://dx.doi.org/10.6092/1970-9870/918

Stumpp, E. M. (2013). New in town? On resilience and "Resilient Cities". *Cities*, *32*, 164-166. doi:https://doi.org/10.1016/j.cities.2013.01.003

IMAGE SOURCES

The image shown in the first page is from: www.100resilientcities.org. The images shown in the second page is from: www.naturegalapagos.com. The image shown in the third page is from: www.hellomagazine.com.

05

THE RESILIENCE CITY/THE FRAGILE CITY.
METHODS, TOOLS AND BEST PRACTICES 3(2018)

REVIEW PAGES: NEWS AND EVENTS

ANDREA TULISI
TeMALab – Università degli Studi di Napoli Federico II, Italy
e-mail: andrea.tulisi@unina.it

In this number

FROM URBAN RESILIENCE TO "EVERY MAN FOR HIMSELF" STRATEGIES

At the Resilent cities 2019 conference, which for years has been one of the most important events on this topic, another theory on the evolution of the concept of resilience appeared in the "innovation for resilience" section: it is the urban tinkering, title of a paper released this year; according to the authors of the paper urban tinkering is "a mode of operation, encompassing policy, planning and management processes, that seeks to transform the use of existing and design of new urban systems in ways that diversify their functions, anticipate new uses and enhance adaptability, to better meet the social, economic and ecological needs of cities under conditions of deep uncertainty about the future" (Elmqvist et al., 2018).

This theory comes from the analysis of the studies of François Jacob. In his essay "Evolution and Tinkering," published in Science in 1977, the scientist argues that a common analogy between the process of evolution by natural selection and the methods of engineering is problematic. Instead, he proposes to describe the process of evolution with the concept of bricolage (tinkering). In this essay, Jacob does not deny the importance of the mechanism of natural selection in shaping complex adaptations. Instead, he maintains that the cumulative effects of history on the evolution of life, made evident by molecular data, provides an alternative account of the patterns depicting the history of life on earth.

Urban tinkering is supposed to be the application of evolutionary thinking to urban design, engineering, ecological restoration, management and governance in order to "substantially complement and augment conventional urban development, replacing predictability, linearity and monofunctional design with anticipation of uncertainty and non-linearity and design for multiple, potentially shifting functions" (Elmqvist et al., 2018).

The capacity of being able to live in uncertainty, the main theme of the Taleb theory of antifragility (Angiello et al., 2018), is reached in the urban tinkering principles through new multifunctional elements able to solve a problem by themselves.

In an attempt to disengage from the determinism of the last century, unable to cope with the unpredictability and rapidity of change in the socioeconomic phenomena of contemporary society, the current scientific landscape tends to successfully welcome theories that make the ability to live in indeterminacy the main value to build the future; although they pose interesting issues, the feeling is that these theories shift attention from the city as an interconnected organism to the city as a sum of elements. But the city as a collective phenomenon must be imagined, shared and finally the tools must be created so that this image becomes real. Furthermore, in this way the scientific community seems to raise the white flag by renouncing to make a real contribution to the development of the cities of the future. The only way to build cities that survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience, is taking responsibility for imagining the future rather than preparing places and people to face it whatever happens, by offering in other words "every man for himself" strategies.

Therefore, the selected conferences deliberately deal with different issues not necessarily related to the theme of resilience, but which basically question on the future of cities.

URBAN CHALLENGE CONFERENCE 2019

Where: Copenhagen, Denmark
When: 25 April 2019
http://www.urbanchallengealliance.com/new-index-1/#conference

European Union, with its long experience on academic mobility, plays an important role in the construction of a scientific network built on shared experiences essential to create broad and multi-cultural visions of the future cities.

One of such kind of project founded by EU is the Urban Challenge Programme where academic institutions, municipalities, and corporations converge and cooperate to address urgent challenges and sustainability issues across urban settings by offering courses to graduate students enrolled at one of the six partnering Universities-Aalto University, Copenhagen Business School, University of Edinburgh, HafenCity Universität, University of Latvia, and Sapienza Università di Roma.

Part of the program is the Urban Challenge Conference, that will take place in Copenhagen on April 25th, 2019. It will be a day to showcase results from the Urban Challenges partnerships together with influential renowned practitioners such as Justin Kliger, member of Future Cities Catapult's Digital Planning and Standards Team, Bruce J. Kats, co-Founder of "New Localism Advisors", and Aleksandra Kazmierczak, an expert in urban climate change adaptation at the European Environment Agency of Copenhagen.

URBANISM NEXT
UNIVERSITY OF OREGON

URBANISM NEXT CONFERENCE 2019

Where: Portland, USA
When: 7-9 May 2019
https://www.urbanismnext.com

In all the vision of the cities of the future, technology plays a fundamental role (Papa et al., 2015). Is not a case that, the first annual Urbanism Next Conference, held in March 2018, bringing together over 500 planners, architects, landscape architects, developers, technology experts, elected officials, academics, and many others, was focused on the topic "how technology is changing cities".

The topic was so successful that one year later technology is still the leading actor of the conference: on 7th of next May the debate will focus on the ways that technological innovations can be harnessed to achieve desired outcomes. What has been tried? What has worked? What has not worked? What should we try next?

How can the private and public sectors collaborate to ensure that desired outcomes drive technological innovation rather than the other way around?
Advances in technology such as the advent of autonomous vehicles (AVs), the rise of e-commerce, and the proliferation of the sharing economy are having profound effects not only on how we live, move, and spend our time in cities, but also increasingly on urban form and development itself. Researchers are working with leaders from the public, private, and academic sectors across North American and Europe to better understand the secondary impacts of emerging technologies on cities and ensure that governments from the local to federal level have the information they need to make informed decisions that improve equity and health outcomes, as well as help achieve community goals related to the economy and the environment.

URBAN FUTURE 2019

Where: Oslo, Norway
When: 22-24 May, 2019
https://www.urban-future.org/

Technology is not the only key to a sustainable future of our planet. The Urban Future global conference offers a different point of view on this issue: what is most important for solving the urban challenges are the people driving positive change. It is the world´s largest meeting dedicated exclusively to "city changers" – decision makers who actively, passionately and effectively make cities more sustainable. In this edition the thematic areas are changed slightly from the last year, taking into consideration all the discussions with stakeholders who are sharing their view on the most relevant topics for the future of cities.
Among the 10 tracks proposed this year, divided in 4 thematic focus (Urban Mobility, Built Environment & Architecture, Leadership and Green Business & Innovation) the following are strictly connected with the urban resilience:

- car-free City Life;
- cutting Carbon Emissions;
- green Public Procurement;
- electrification.

ECCA 2019

Where: Lisbon, Portugal
When: 28-31 May 2019
https://www.ecca2019.eu/

The Ecca 2019 Conference offers a more concrete and structured approach to the discussion about the future of cities more focused on the climate risk management. Data, co-productions and communication are the main topic driving the discussion together with the following themes:

- institutions, governance, citizens and social justice;
- global climate challenges;

- climate risk management and resilience.

Each theme is articulated around specific questions that will drive the discussion in order to return a detailed picture of the research in these issues. Some of the more interesting questions of the conference are shown below:

- what are the examples on using seasonal forecasting and regional climate change projections in climate change vulnerability and risk assessments?
- how should we evaluate the success of adaptation options?
- how can we involve citizens to improve and implement adaptation solutions?
- what tools are available to access useful and credible climate data, information and knowledge on climate vulnerability and risk?
- how can we increase trans-boundary collaboration and solutions?
- what are the roles of climate change adaptation and disaster risk reduction in facing this century's societal challenges?
- what are current and needed innovative solutions to increase climate resilience in cities?

REFERENCES

Angiello, G., Carpentieri, G., Morosini, R., Tremiterra, M., & Tulisi, A. (2018). Review Pages: The Resilience City/The Fragile City. Methods, Tools and Best Practices 2 (2018). *TeMA. Journal of Land Use, Mobility and Environment, 11*(2), 247-269. doi:http://dx.doi.org/10.6092/1970-9870/5784

Elmqvist, T., Siri, J., Andersson, E., Anderson, P., Bai, X., Das, P.K., … & Vogel, C. (2018). Urban Tinkering. *Sustainability Science*, 100(6), 1549–1564. doi:https://doi.org/10.1007/s11625-018-0611-0

Papa, R., Gargiulo, C., Cristiano, M., Di Francesco, I., & Tulisi, A. (2015). Less Smart More City. *TeMA. Journal of Land Use, Mobility and Environment, 8*(2), 159-182. doi:http://dx.doi.org/10.6092/1970-9870/3012

IMAGE SOURCES

The image shown in the first page is taken from:

https://www.keepcalm-o-matic.co.uk/p/keep-calm-and-every-man-for-himself-2/

AUTHORS' PROFILES

Gennaro Angiello

Engineer, Ph.D. in Civil Systems Engineering at the Federico II University of Naples. His research interests are in the field of accessibility analysis and modeling, land-use and transport interactions and sustainable mobility. He is currently involved in the research project Smart Energy Master and in the COST Action TU1002 accessibility Instruments for Planning Practice in Europe.

Gerardo Carpentieri

Engineer, Ph.D. in Civil Systems Engineering at University of Naples Federico II. Research Fellow of Land Use Planning at the Department of Civil, Architectural and Environmental Engineering at University of Naples Federico II. He received a master's degree in Environmental and Land Engineering with a thesis on "The integrated government of land use and mobility for environmental sustainability in the metropolitan areas: evaluation techniques of different scenarios for the city of Rome". In July 2013 he won a scholarship within the PRIN project on the "Impacts of mobility policies on urban transformability, environment and property market". He is currently involved in the research project "Smart Energy Master" at the Department of Civil, Architectural and Environmental Engineering – University of Naples Federico II and in the COST Action TU1002 Accessibility Instruments for Planning Practice in Europe.

Rosa Morosini

Engineer, Ph.D. student in civil systems engineering at University of Naples Federico II. Her research topic concerns the urban planning transformations and soil consumption. The purpose is to identify supporting tools for the local authorities with the aim of minimizing the use of this resource and make it a sustainable use.

Maria Rosa Tremiterra

Engineer, Ph.D. student in Civil Systems Engineering at University of Naples Federico II. She received a master's degree in Architecture and Building Engineering with a thesis on sustainable mobility in the European cities. In 2014, she won a one-year grant for post-lauream education and research within the Project Smart Energy Master at the Department of Civil Engineering, Building and Environmental Engineering, University of Naples Federico II.

Andrea Tulisi

Architect, graduated in Architecture from the University Federico II in Naples in 2006. In January 2014 holds a PhD in Environmental Technology with a research focused on rehabilitation strategies for semi-enclosed spaces in the "Compact City". He is currently involved in the project Smart Energy Master at the DICEA department of the University of Naples Federico II. His research activity is focused on the link between urban open spaces and energy consumption.