TeMA

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Land Use, Mobility and Environment

There are a number of different future-city visions being developed around the world at the moment: one of them is Smart Cities: ICT and big data availability may contribute to better understand and plan the city, improving efficiency, equity and quality of life. But these visions of utopia need an urgent reality check: this is one of the future challenges that Smart Cities have to face.

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SMART CITIES CHALLENGES

SMART ENVIRONMENT FOR SUSTAINABLE RESOURCE MANAGEMENT

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EDITORIAL PREFACE:

SMART CITIES CHALLENGES: SMART ENVIRONMENT FOR SUSTAINABLE RESOURCE MANAGEMENT

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There are a number of different future-city visions being developed around the world at the moment: one of them is smart cities. Gary Graham, coordinator of the Future Transport and Smart Cities Network in University of Leeds, in one of his recent articles published on “The conservation”, affirms that these visions of utopia need an urgent reality check and that smart cities ideas are in some cases too far away for people real needs and tries to give an answer to the provocative question: is anyone asking people what they want from the smart cities of the future?

This is one of the main challenges of smart or not smart cities should face in the near future, and this is one of the themes of this volume 7 of TeMA Journal of Land Use, Mobility and Environment. Volume 7 is in fact dedicated to the challenges of the Smart City and will focus during the three issues of the volume on three different challenges aspects. In this first issue the main theme is smart environment for sustainable resource management. The second issue will focus on the process of planning for smart cities, dealing with new urban challenges, while the third issue will be focusing on the smart communities between e-governance and social participation.

The first article of this issue is named “Considering Resilience: Steps Towards an Assessment Framework” by James Kallaos, Gaell Mainguy and Annemie Wyckmans, an international research group from France and Norway, identifies resilience characteristics in order to inform the eventual development of a resilience framework with which to assess architecture and infrastructure resilience. The aim of the work is to determine the conditions under which architecture and infrastructure resilience can be defined and measured, in order to guide the consideration of attributes and determine suitable criteria to select and elaborate indicators to help guide future actions and investments.

The second article titled “New Technologies for Sustainable Energy in the Smart City: the WET Theory” by Rosa Anna La Rocca and Romano Fistola develops a new approach to the sustainable planning for the smart

city based on the assumption that the relationship between new technologies and urban system could be developed in a new way considering the WET theory.

The third article by Adriana Galderisi is titled “Climate Change Adaptation. Challenges and Opportunities for a Smart Urban Growth” and explores strengths and weaknesses of current adaptation strategies in European cities. First the main suggestions of the European Community to improve urban adaptation to climate change are examined; then, some recent Adaptation Plans are analyzed, in order to highlight challenges and opportunities arising from the adaptation processes at urban level and to explore the potential of Adaptation Plans to promote a smart growth in the European cities.

The forth article titled “Limits to Ecological-based Planning in Zimbabwe. The Case of Harare” by Archimedes Muzenda and Innocent Chirisa, explores the feasibility of adopting ecological based planning in low-income residential development. In particular the case study of Hatcliffe residential area in Harare proposed in the article shows that there are many challenges to overcome uncoordinated planning approaches, ineffective policies and legislative frameworks, weak institutional settings, financial constraints, outdated planning standards and regulations, poverty, lack of environmental stewardship and lack of political will among others. The study findings call for robust environmental conservation strategies, strong environmental stewardship, responsive institutional and funding mechanism backed by realistic legislative frameworks and robust policy rectification.

The section Land-use, Mobility and Environment collects four general article of the theme of integration between mobility, urban planning and environment. The article “Urbanisation Pattern of Incipient Mega Region in India” by T. V. Ramachandra, Bharath H. Aithal, Barik Beas, focuses on the analysis of the spatial patterns of urbanization and sprawl in Pune city, India, using temporal remote sensing data. The analysis suggests that urbanization has caused fragmentation with adjacencies in buffer zones. Spatial metrics substantiate rampant sprawl at the peri-urban regions and infilling at city center. However, this value has reduced in 2013 indicating of reaching the threshold of urbanization. This research provides the details of land use and its development for guiding scientific-based decision support and policy making.

The article by Laura Russo, titled “The Effectiveness of Planning Regulation to Curb Urban Sprawl. The Case of Striano (NA)”, aims to assess the ability of Campania’s Planning regulations and tools in checking urban sprawl. The analysis was conducted in the town of Striano, within the complex urban conurbation of the Metropolitan Area of Naples. The case study results show a disconnection between the current legislation and the new planning tools which are pending approval, therefore, the paper suggests the need to update Campania’s Planning legislation to the new guidelines, which are much more effective in terms of land protection.

In the same section, the article by Silvia Alam titled “Prediction of Mymensingh Town Future Expansion Using Space Syntax”, aims to identify the influence spatial configuration exerts on the location of different types of commercial activity in terms of land use. The results of this study help to interpret and predict the future commercial land use related to its road network. In this paper the process was conducted through a field survey to collect data regarding locations of commercial activity, some land-use maps analysis and the application of Space syntax theory to simulate the data to analyze the relationship.

Finally the Review Pages define the general framework of the theme of Smart City Environmental Challenges with an updated focus of websites, publications, laws, urban practices and news and events on this subject.

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CONSIDERING RESILIENCE

STEPS TOWARDS AN ASSESSMENT FRAMEWORK

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ABSTRACT

As threats from climate change related hazards increase in cities around the world, communities are faced with an urgent requirement for self-evaluation. It is essential to expose and assess potential hazards facing cities, as well as to consider potential impacts and responses. While the promotion of efficiency and promise of protection have been common approaches to hazards in the past, recent events have exposed weaknesses in existing tactics. It has also become more apparent that existing mitigation efforts will be insufficient to prevent some level of climate change, associated hazards, and impacts. Complete protection against all threats is not only impossible but potentially hazardous, as extreme or unanticipated events can exceed the capacity for defence, potentially resulting in catastrophic failures.

From this realization of the fallibility of the existing paradigm, resilience has emerged as a useful concept for framing the response of cities to an expanding collection of potential threats. The aim of this article is to consider resilience as it applies to cities, their architecture and infrastructure systems, subsystems, and components, as well as their inhabitants. Resilience characteristics are identified and considered in order to inform the eventual development of a resilience framework with which to assess architecture and infrastructure resilience. This state of the art is instrumental to determine the conditions under which architecture and infrastructure resilience can be defined and measured, in order to guide the consideration of attributes and determine suitable criteria to select and elaborate indicators to help guide future actions and investments.

KEYWORDS:
Resilience, Vulnerability, Adaptation, Climate Change, Cities, Adaptation

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关于恢复性建筑和基础设施的指标

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摘要

本文旨在鉴别和分析目前可用于评估建筑和基础设施恢复力的恢复特性、框架和相应指标。此最新的技术发展水平将有助于确定：
对建筑和基础设施恢复力进行定义和测量的条件。
能够为行动和投资提供指导的适当的指标属性。
对这类指标进行选择和/ 或详细描述的适用标准。
在本文对城市建筑和基础设施的恢复力定义及框架和相应要求的鉴别和讨论过程中，重点参阅了科学、经济和规划等领域中的专家文献，同时还涉及气候变化适应和成本核算。通过对文献的审阅、分析、归类和仔细评估，总结出了各类恢复力特性。在针对利益相关人和研究专家分别进行的两次研讨会中，将这些特性和主要信息提出并进行了讨论，以找出目前恢复力定义和特性的缺漏之处、在各类城市评估方法中比较优势和劣势、并就城市建筑和基础设施的恢复力指标的优先顺序进行讨论。

关键词
气候变化；建筑环境；建筑；城市设计和规划；适应；恢复力

1 CLIMATE CHANGE AND CITIES

Cities are urban agglomerations, consisting not only of clustered structural, physical and natural artefacts, but the resident population itself, as well as the social structures and governance which provide cohesion and organization. Physical artefacts include not only architectural elements such as residential and commercial buildings that provide homes for people and facilities for business and government activities, but the physical infrastructure networks connecting and servicing these buildings and facilities - with overhead, surface, and buried elements. People live, work, communicate, and travel, in, around and between these different architecture and infrastructure networks on a daily basis, while a generally less visible network of norms, rules, and regulations coordinates and maintains order and functionality.

Climate change is now considered unequivocal, and includes atmospheric and ocean warming, diminishing snow and ice, rising sea levels and increasing greenhouse gas (GHG) concentrations (IPCC, 2013). These changes in the basic elements of Earth's support systems are expected to alter many of the historical patterns that societies and communities have come to rely upon. In many cases, these changes and alterations will result in an increasing quantity and magnitude of hazards: changes in average climate variables, along with changes in the frequency and severity of extreme weather events, can be expected to have stark consequences for the built environment in the form of flooding, heatwaves, water scarcity and other impacts. The confluence of impacts and settlements leads to increasing numbers of "natural disasters" (UNISDR, 2012, p. 15).

Climate change related hazards threaten cities around the world, confronting communities with an urgent requirement for self-evaluation. In order to properly address these potential threats, cities will need to not only expose and assess potential hazards, but consider the exposure, sensitivity, and vulnerability of the different systems that comprise the urban fabric. Beyond vulnerability assessment, the reaction of these systems becomes important - resilience has emerged as a useful concept for framing the response of cities to an expanding collection of potential threats.

2 WORKING DEFINITIONS

The wide variety of actors involved in climate change bring with them different understandings, making it is essential to attempt to define the terminology surrounding climate change and find the proper role for resilience. The presentation of definitions for the different terms central to the climate change discourse is by no means intended to imply that there is complete agreement surrounding them. Many of the terms invoke different meanings within different fields, and the ensuing semantic battles within the different fields involved in climate change science have become a mainstay of academic journals worldwide. The definitions presented may be considered some of the more popular or best accepted definitions, though this claim is likely to bring criticism as well. These terms are presented to provide a central basis for the discussion that ensues, without implication that these represent the correct or final definition.

2.1 EXPOSURE

With regards to climate change, the external risk associated with the spatial arrangement of a system potentially at risk is referred to as exposure. The Intergovernmental Panel on Climate Change (IPCC) has defined exposure as "the presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected" (IPCC, 2012, p. 5).

2.2 ADAPTIVE CAPACITY

Adaptive capacity is defined in the IPCC Third Assessment Report (TAR) as "the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take

advantage of opportunities, or to cope with the consequences" (IPCC, 2001, p. 6). A slightly different take is presented in the IPCC Fourth Assessment Report (AR4) "the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behaviour and in resources and technologies"(Adger et al., 2007, p. 727).

2.3 SENSITIVITY

The IPCC TAR defines sensitivity as "the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli" (IPCC, 2001, p. 6).

2.4 CRITICALITY

Criticality is a relative concept related to how essential a component, system, or function is to the needs of society (Cabinet Office, 2012; Fisher and Norman, 2010; GAO, 2007; Luiijf et al., 2003). Infrastructure criticality has been defined as dependent on both the "level of contribution ... to society in maintaining a minimum level of ... law and order, public safety, economy, public health and environment" and the "impact level to citizens or to the government from ... loss or disruption" (Theoharidou et al., 2009, p. 40).

2.5 VULNERABILITY

A succinct definition of vulnerability as related to climate change is provided by the IPCC, where it is defined as "the propensity or predisposition to be adversely affected" (IPCC, 2012, p. 5). Adger defined vulnerability as "the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt"(2006, p. 268). The European Climate Adaptation Platform (CLIMATE-ADAPT) defines vulnerability as "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity"(EC and EEA, 2014).

2.6 ADAPTATION

Adaptation depends on adaptive capacity (Smit et al., 2001), and represents an "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation" (EC and EEA, 2014). The IPCC differentiates between adaptations in different systems: "In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate" (IPCC, 2012, p. 5).

2.7 RESILIENCE

Milman and Short refer to Folke (2006) when defining resilience as a system's ability to "maintain (or improve) upon its current state over time" and "adapt to stresses and changes and to transform into more desirable states" (2008, pp. 758, 759). In this context, resilience represents a system characteristic in the form of absorptive and adaptive capacity, a function of system stresses and accommodative responses. A more current and specific definition by the IPCC considers resilience to be "the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions" (IPCC, 2012, p. 5). Extremely similar, but tailored to communities,

the UNISDR and ICLEI definition is "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of the hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (UNISDR). Resilience focuses investment on increasing a city area's overall ability to support a vibrant, healthy society and economy under a wide range of circumstances (ICLEI)" (UNISDR, 2012, p. 85).

3 FRAMING RESILIENCE

3.1 FEEDBACKS AND RELATIONSHIPS

Until recently, the system characteristics related to climate change existed as purely theoretical concepts with which stakeholders might better understand the issues. Attempts to further define and specifically relate the different system characteristics to climate change impacts have resulted in conceptual frameworks that attempt to elucidate connectivity and feedbacks. Füssel and Klein (2006), presented one of the initial conceptual frameworks for climate change vulnerability research, documenting the development of terminology related to vulnerability as well as the evolution of approaches to vulnerability assessment. The framework itself provides a visual linkage map between many of the terms and concepts within the climate change discourse. The framework has been utilized and expanded by other research groups (e.g. EEA, 2012; ESPON Climate, 2011; Lung et al., 2011). and presents a compelling image to describe the system in ways that help lead to quantifiable definitions and explanatory equations. (Figure 1).

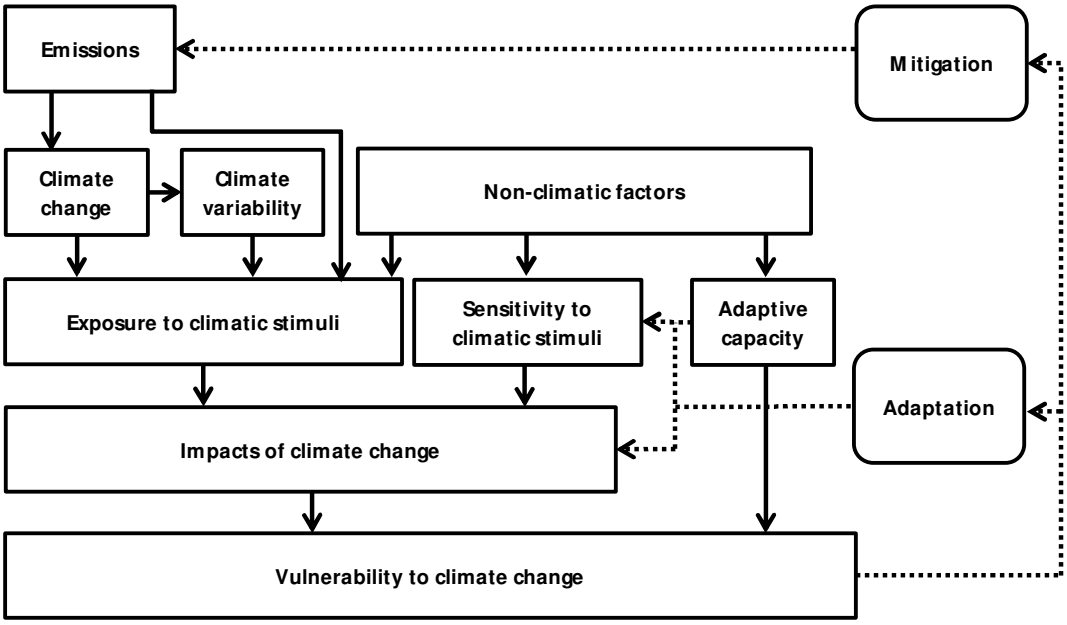

Fig. 1 vulnerability assessment framework (ESPON Climate, 2011); adapted from (Füssel and Klein, 2006)

Much of the current research on climate change impacts, adaptation, and vulnerability (IAV) follows the conceptual framework above, and is rapidly progressing in specificity as well as quality. There remains a definite lack of quantitative indicator-based assessments specific to settlements, cities, buildings, and infrastructure. While many studies reference cities or infrastructure, they are often referring solely to the inhabitants, and not to the physical structures and networks themselves. The two aspects of settlements need to be considered simultaneously, and the complexity of interactions between humans and the built environment disentangled, in order to assess potential impacts from climate change. In order to conceptualize this interaction and confluence between socioeconomic processes, climatic factors, and risk

and impacts, the IPCC has presented an alternate conceptualization (Figure 2). Here exposure, vulnerability, and hazards are used to determine the risk of impacts from climate change.

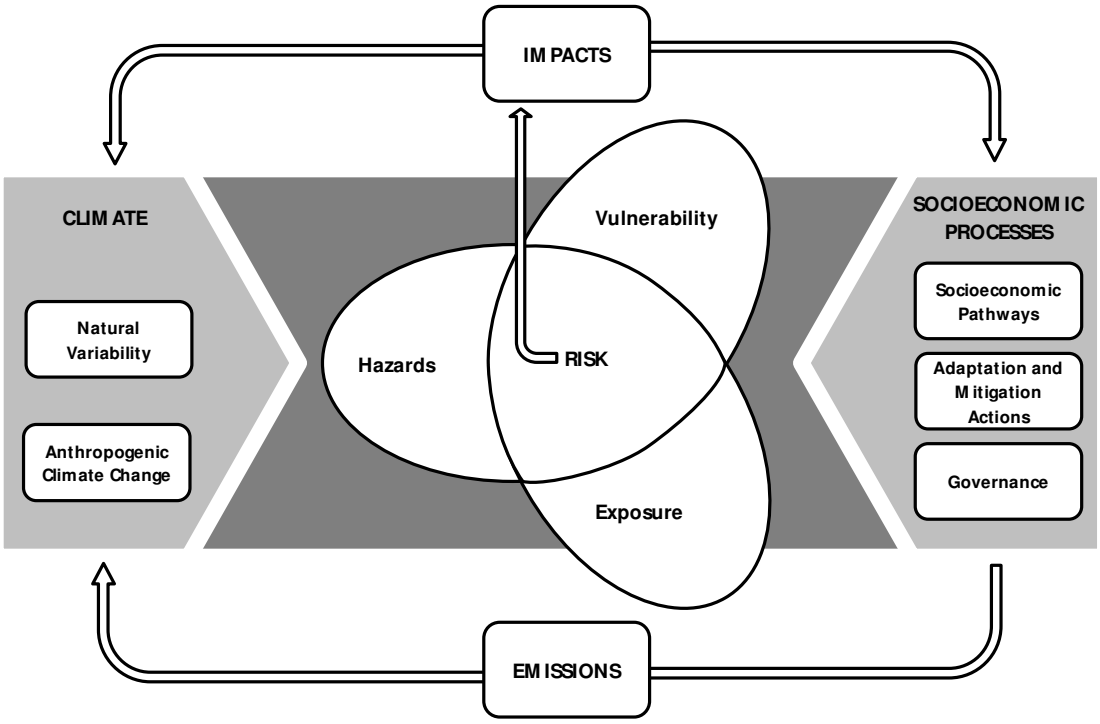

Fig. 2 risk assessment framework (IPCC, 2014)

3.2 VULNERABILITY AND RESILIENCE

As noted above, climate change vulnerability is related to the exposure and sensitivity of an object or system to risk, moderated by its capacity for adaptation (EC and EEA, 2014). Vulnerability is generally considered as a relative concept, used in reference or in comparison with another system (Wolf et al., 2013). Vulnerability can be reduced through adaptation to reduce either exposure or sensitivity, or both together. In physical systems such as architecture and infrastructure, an example of exposure reduction would be through relocation of components, while sensitivity can be reduced through hardening and protection of components and subsystems (DOE, 2010). The goal of vulnerability reduction in the context of architecture and infrastructure is to reduce the risk of damage to components and subsystems in order to manage risk.

Resilience in the built environment, on the other hand, refers to the maintenance of function in spite of damage. While components themselves may be resilient, the resilience of the system does not depend on this, only that the desired function persists or is able to resume with minimal time and resources after a disruption. A resilient system can be comprised of resilient components and subsystems, or alternately individual components can be protected, distributed, redundant, or even expected to fail. As long as these lower level components are well understood and managed spatially and functionally, the resilience at a higher scale can be maintained. The goal of the system is persistence of provision of desired functions, regardless of the specific methodology used to attain this.

4 PROMOTING RESILIENCE

Resilience is not assumed or promoted here to be the only, or the best, approach to minimizing impacts from climate change hazards and threats. What the concept of resilience does provide, however, is a middle ground: a safe haven between two competing paradigms. On the one side, efficiency has been promoted as the best way to achieve sustainability, though it often works in opposite manner, increasing consumption

through the rebound effect (Walker and Meyers, 2004; Walker and Salt, 2006). On the other side, defence and protection have been promoted in the past as ways to prevent potential threats from causing impacts (Garbin and Shortle, 2007). Efficiency and protection have their place, but both have been demonstrated to be fallible. The quest for efficiency can reduce options (i.e. removal of redundancies) and funnel resources into specific regimes, which are then prone to complete or sudden failure – the proverbial "all your eggs in one basket." Protection is never absolute, and efforts to provide protection can increase exponentially in response to linear threat increases (Garbin and Shortle, 2007). At a small enough scale, efficiency may provide cost and resource benefits, but when efficiency applied to components of a system or sector can results in critical susceptibilities where even isolated events can wreak havoc on provision of a necessary function.

As an example, district heat has been promoted as an efficient, environmentally friendly way to provide urban heat in a cold environment (Rosenthal, 2010; Tagliabue, 2013). In some cold communities district heat is relied upon as the sole method of heating residences. Reliance on this single point of provision can result in vulnerabilities in function provision; a single construction mistake in Oslo, Norway resulted in damage to the single protected (buried) pipe providing heat and hot water to downtown Oslo - a neighbourhood of 30000 inhabitants, resulting in a total loss of service for up to 3 days (Bakken et al., 2014; Sigurjonsdottir, 2014; Solberg, 2014). As this was an isolated incident, and electricity was still functional, vouchers were provided by the utility to refund the purchase of electric heaters (Hafslund, 2014). The result of this event is a loss of efficiency (redundant heating systems) but an increase in resilience (two separate systems providing the same functional capacity).

4.1 SCALES OF RESILIENCE

In keeping with the other terms in the climate change discourse, resilience is a common target for semantic debate. Much of the debate surrounding resilience centres on the different approaches to resilience by different fields. Engineering resilience is differentiated from social ecological resilience, as well as resilience in complex social ecological systems (SES), and systems of systems. Different fields employ slightly different understandings, with one essential difference being whether the system returns to its prior state (engineering resilience) or can move or transform to a different state (SES resilience), while maintaining provision of the desired function (Walker et al., 2004). It can be argued that these differing definitions consist simply of application of the same concept at different scales, and not a fundamental difference in understanding.

At smaller scales, engineering resilience may be the most relevant, whereby system components can reasonably be expected or hoped to return to their original state after a disturbance. As the scale increases, the resilience options may increase, if there are other methods available of providing the same service or function. At the city scale, resilience could presumably be assessed with a broad application to sectors, such as provision of clean water, shelter, and energy, regardless of the specific methodology of the provision.

While spatial scales may be the easiest to visualise and use as metaphors (Walker et al., 2004) derivation of the relationships both between resilience characteristics, and between characteristics and systemic resilience, is needed across multiple scales (i.e. spatial, temporal, and organizational) (UN-ESCAP, 2013).

4.2 MULTISCALE VULNERABILITY, RESILIENCE AND CRITICALITY

The relationship between vulnerability and resilience is often discussed and often confused – they are "different but complementary framings" (Turner II, 2010, p. 573), and are not subsets of each other, nor are they opposites – the absence of vulnerability does not equate with resilience (Manyena, 2006, p. 443). Vulnerability and resilience are related concepts, but vulnerability has "meaning only in relation to a specific hazard" while resilience is an intrinsic characteristic of complex systems (Manyena, 2006; Tyler and Moench,

2012, p. 317; Vugrin et al., 2010). Reduction in vulnerability and increase in resilience can be synergistic, however – both work to limit the extent of damage inflicted by a hazard. Reducing the vulnerability of system components can help prevent the resilience capacities of a system from being surpassed, and reduce the time and effort required for recovery. Vulnerability can be diminished by reducing potential impacts from a hazard, through location (reducing exposure) or protective design (reducing sensitivity).

Trees and forests provide an interesting and easily grasped outline of the interactions between vulnerability and resilience, showing how they are related and how they are not. In short, vulnerable systems need to exhibit resilience, and non-resilient systems need to limit their vulnerability.

The vascular system of a tree is comprised of a vast network of vessels and organs providing different functions. The leaves produce energy from sunlight through photosynthesis, and individually are relatively exposed and sensitive to injury. They are heavily networked and redundant however, allowing the system to tolerate a certain amount of peripheral damage while maintaining function at an acceptable level, and have a high capacity for recovery (healing); as a system they exhibit most if not all of the characteristics used to define resilience. Leaves are connected to stems and branches, which contain vessels for the transport of water to the leaves and the products of photosynthesis (photosynthate) from the leaves. As the scale increases from leaves and stems up to secondary and primary branches, both vulnerability and resilience decrease, while criticality increases. Failure of the smaller stems has lower consequences than failure of larger branches: they are less critical. The more critical larger branches have less redundancy and less capacity for recovery from damage yet they are less vulnerable: less exposed by being protected behind a thicker layer of bark, and less sensitive by being thicker and more fibrous (stronger). Branches terminate in the trunk, which provides structure to the tree, and provides a conduit for the vessels transporting water up from the roots, and photosynthate down from the leaves. While a tree has different systems providing critical functions, it is difficult to describe any individual element of a tree as "critical" to its survival. The trunk could be considered the single critical element, yet it exhibits reduced vulnerability: the important systems are less exposed by being protected behind the thickest bark layer, and less sensitive by being thicker and more fibrous (stronger). Though the trunk is a single element, the longitudinal vessels providing critical functions within the trunk remain networked and redundant.

The evolution of trees has led to interesting survival mechanisms, whereby it is clear that resilience expands beyond the systems of the tree, or its parts, or the tree itself. The loss of a single tree to a forest is similar in scale to the loss of a leaf or branch on a tree. It is a redundant element, and the forest can continue to thrive while tolerating a certain amount of damage or loss. Trees and forests have adapted mechanisms to limit (or embrace) the widespread effects of destructive events; a large fire may destroy the trees but in the process trigger the beginning of the seed cycle (Schwilk and Ackerly, 2001).

Unlike trees, which must rely on evolution over long time scales to exhibit adaptation, people have a capacity to immediately influence the vulnerability and resilience of the organ systems providing essential functions. Also unlike trees, the human body has high level organs, such as the heart, spinal cord, and brain, which are critical to function and survival. These organs lack redundancy and have little recovery capability; they are not particularly resilient, but they are protected by solid bone, reducing their exposure and sensitivity, and therefore vulnerability. People make decisions daily regarding the protection of critical resources based on real and perceived threats. The choice of protection level (decreasing vulnerability through sensitivity and exposure reduction) tends to increase with increasing criticality, and decreasing resilience. Motorcycle riders wear hard protective helmets – while police wear bulletproof vests. The choice of wearing a vest and helmet are in turn based on the criticality, vulnerability, and resilience of the underlying body systems, as well as the anticipated threat. Protecting the head and torso to reduce vulnerability are direct consequences of the high criticality, high vulnerability, and low resilience of these areas. Like a tree to a forest, the injury or death of a single person does not represent system failure or

collapse of a larger group. Up to a certain level of population loss, the group (e.g. community, society) can survive.

In all cases, a resilient system would be defined as one that can tolerate or absorb a certain amount of damage, and heal, recover, or transform. Beyond the resilience capacity of the system considered, the resilience scale moves up one level. The scale of the assessment determines the assessment of resilience. Failure is scale based – the failure of a single component is not the same as system failure; different thresholds exist at different scales for what constitutes acceptable performance, and what constitutes a failure. Similar to vulnerability and resilience, critical systems can only be defined at a specific scale. The heart and brain are critical systems in the human body, but that one individual may not be critical to the survival of the group, or of the larger society.

Applying a hierarchical resilience framework to the built environment, architecture and infrastructure, it becomes apparent that vulnerable systems should either reduce their vulnerability (exposure and sensitivity), or increase their resilience. The resilience of a community is a function of the vulnerability and resilience of individual components (physical and social), as well as the fabric or network that connects them. Climate change adaptation strategies should involve the protection or relocation of vulnerable assets, and the addition of resilient characteristics (absorption, redundancy, and recovery capacities) for those systems that remain vulnerable.

4.3 CRITICALITY AND THE PERSISTENCE OF NEEDED FUNCTIONS

While many national programs have moved from a focus on critical infrastructure protection to critical infrastructure resilience, often with explanations of why resilience is now the preferred method, they have been less explicit when explaining the specificity of what is critical and what is not (AU, 2010; Cabinet Office, 2010; GAO, 2010; Graham, 2011). Critical infrastructure is defined, and the sectors that comprise it are listed, but little effort is made to tease out which specific elements are essential to providing the needed services.

The large scale resilience of a city is a function of its intentions and ability to provide essential services and satisfy the needs of its inhabitants. This does not imply that every sub sector or component providing necessary functions needs to exhibit resilient characteristics - it is the persistence of function that is important. An alternate approach to defining criticality within a city would be to focus on the functions that are essential for urban survival. A place to start is with the seminal work on human needs and motivation by Abraham Maslow.

Necessary functions can be elucidated using Maslow's hierarchy of needs – introduced as motives for human behaviour, which been updated and revised through the years (Kenrick et al., 2010; Maslow, 1970, 1958, 1943). The hierarchy of needs posits a human motivation system whereby each subsequent need is predicated on the attainment or fulfilment of more basic needs (Figure 3).

While the hierarchy of needs is regularly scrutinized over the specifics of some certain segment of the hierarchy, the overall pattern remains well accepted (Clarke et al., 2006; Hagerty, 1999; Kiel, 1999; Koltko-Rivera, 2006; Wahba and Bridwell, 1976; Wicker et al., 1993). In the case of the defining and prioritizing human needs, there is little argument that survival is the most basic human need. These basic needs, the "immediate physiological need" for homeostasis (dynamic balance with the environment, including elements such as hunger, thirst, and temperature regulation), as well as the need for safety (self-protection) from direct harm, form the foundation from which other motivations and needs can build upon (Kenrick et al., 2010; Maslow, 1958, 1943).

Based on this hierarchy of needs we can propose that the provision of food, water, (temperature regulated) shelter, and the immediate and longer term minimization of risk of injury and death are the most critical human needs.

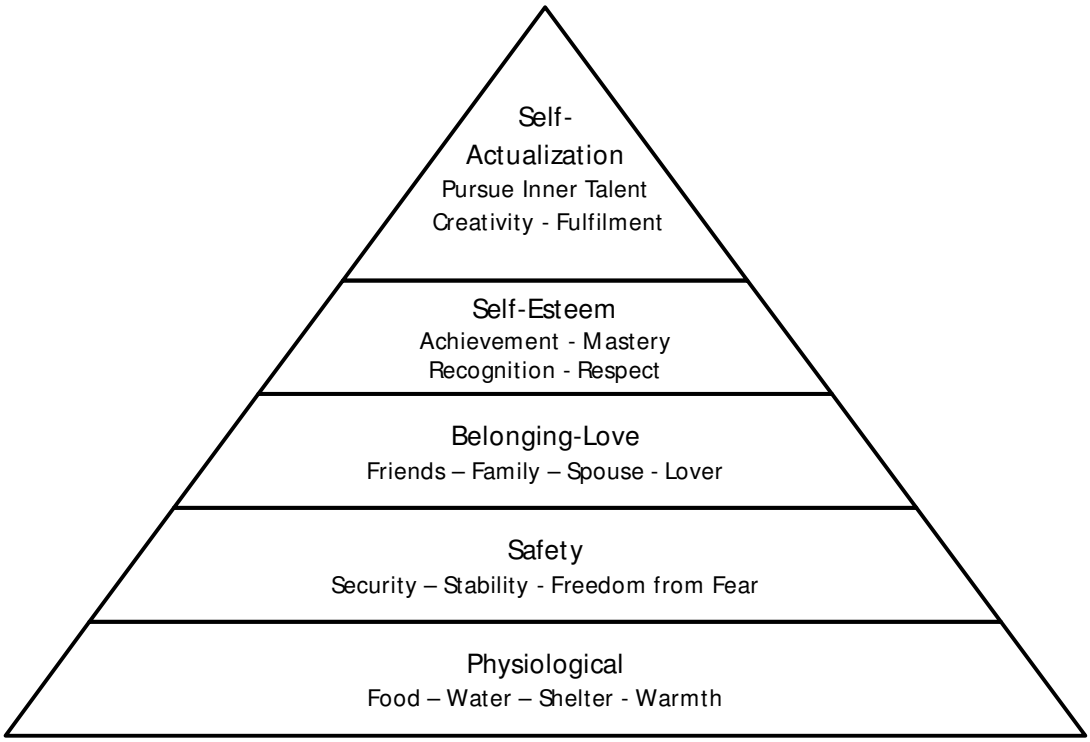

Fig. 3 Maslow's hierarchy of needs, adapted from (Maslow, 1970, 1943)

The hierarchical arrangement posits that these needs must be satisfied before moving up a level and confronting other needs and motivations.

Many of these critical needs are functions of the fabric of the urban city – they are dependent on, or consist of, services provided by architecture and infrastructure networks. In order to attempt to determine resilience at the city scale, the first task is to resolve which aspects of service provision could be considered critical to society. Beyond the definition and assessment of criticality, it is necessary to determine ultimate responsibility for these services – differentiating for example between personal, local, regional, and national responsibilities; as Maslow notes, there are various "paths to the same goal" (Maslow, 1943, p. 370). Admittedly, this differentiation is fuzzy, and subject to extreme cultural variability. An example of a potential needs hierarchy for services provided by architecture and infrastructure is shown in Figure 4.

5 CHARACTERISTICS FOR RESILIENT ARCHITECTURE AND INFRASTRUCTURE

5.1 TEMPORALITY

In addition to the varying potential scales of application, the three different temporal phases associated with resilience pose serious methodological challenges: Efforts necessary to anticipate, prevent, and prepare a system take place before a disruptive event; A system resists and absorbs during an event; Recovery occurs after a disruption.

These three phases (Figure 5) may correspond to different fields of expertise – vulnerability and risk management, crisis management, or adaptation – which are confronted with different challenges and develop specific methods accordingly.

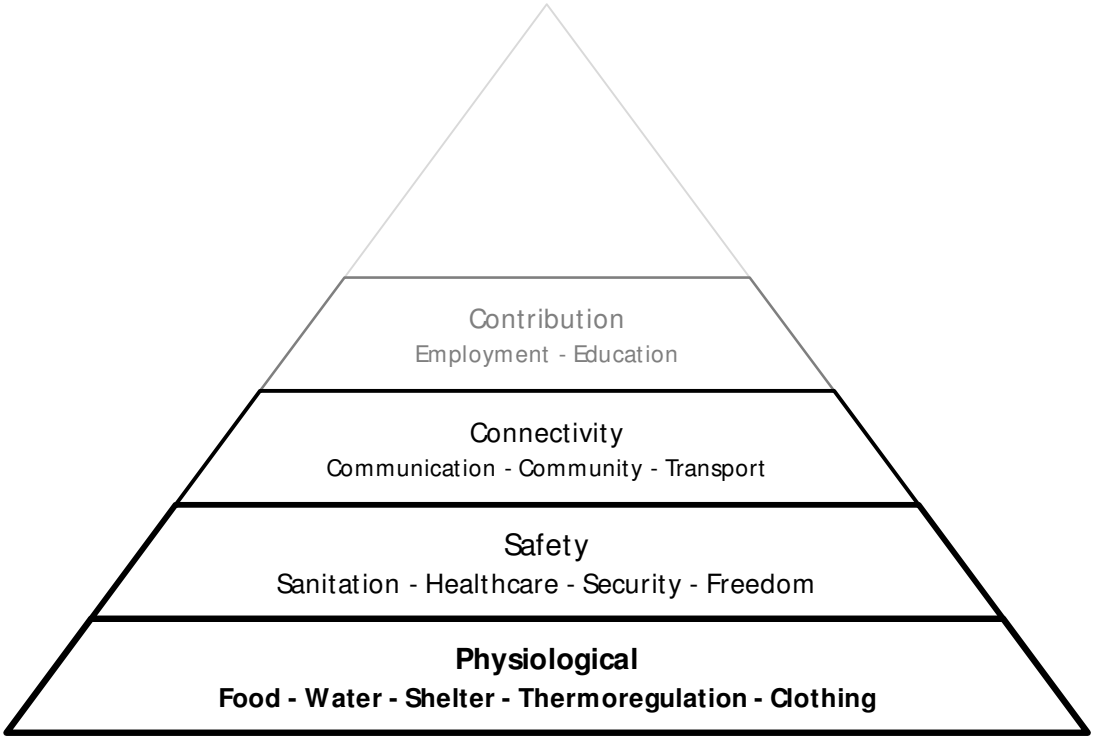

Fig. 4 hierarchy of service functions provided by architecture and infrastructure, based on (Maslow, 1970, 1943)

In the context of climate change, this cycle of phases related to events becomes more complicated. This resilience cycle operates within different temporal as well as spatial scales – climate change could be considered one huge event, where all three phases will be conflated and occur simultaneously. The effects of climate change will likely be realized in a recurring and successive manner with increasing intensity, so the temporal order retains its validity albeit in the form of miniature cycles that may occur within a larger phase.

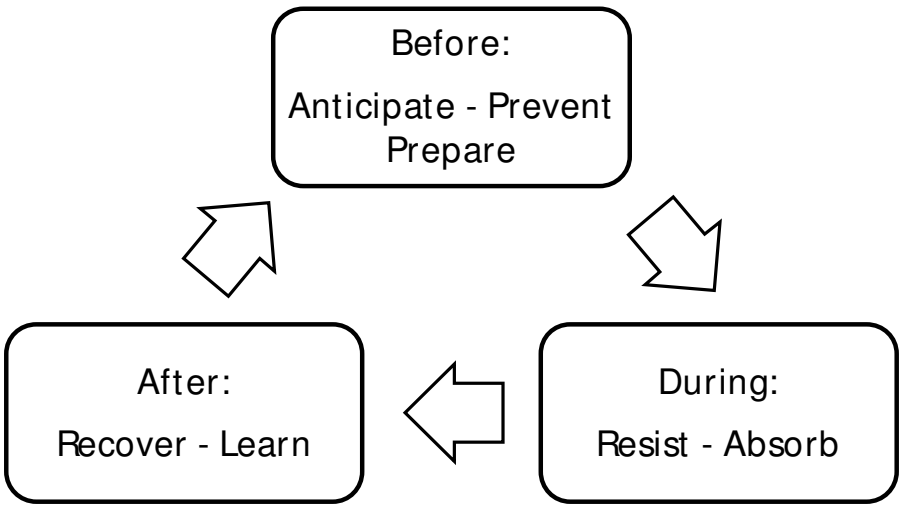

Fig. 5 temporal phases and corresponding activities related to resilience

5.2 PHYSICAL AND ORGANIZATIONAL RESILIENCE

The provision of critical services from architecture and infrastructure is imperative for people's quality of life. Architecture and infrastructure should be designed or adapted to reliably provide these services, resilient even in the face of potential hazards and threats. Resilient systems should be able to maintain function while maintaining or enhancing the spatial quality of the environment that surrounds people in their daily life. In the RAMSES project architecture encompasses design and management of urban fabric ranging from buildings to public spaces, landscape and urban form.Infrastructure describes built assets (physical) and all the institutions that are required to maintain the standards of living of a community (organizational). Infrastructure can be considered in terms of physical objects and networks or in terms of services. Physical assets are designed to provide services to their users and owners – in terms of resilience to climate change it should be recognized that the services provided are more important than the structures themselves.
A set of characteristics attributed to resilient systems was derived through literature review, and categorized according to their application to physical (Table 1) or organizational (Table 2) systems and networks.

PHYSICAL CHARACTERISTIC	**DESCRIPTIONS**
Connectivity, Feedbacks, Modularity	"How quickly and strongly the consequences of a change in one part of the system are felt and responded to in other parts of the system" (Walker and Salt, 2006) in (Schultz et al., 2012, p. 54). "The extent to which the components and processes that make up a system are dependent upon each other to maintain function" (Walker and Salt, 2006) in (Schultz et al., 2012, p. 53). "Interacting components composed of similar parts that can replace each other if one, or even many, fail" (Tyler and Moench, 2012, p. 313).
Dependence on Local Ecosystems	Local control over the essential "services provided by local and surrounding ecosystems" (the city's green and blue infrastructure - providing "flood control, temperature regulation, pollutant filtration and local food production)" ... "and taking steps to increase their health and stability" (da Silva et al., 2012, p. 136). "...presence of buffer stocks within systems that can compensate if flows are disrupted (e.g. local water or food supplies to buffer imports)" (Tyler and Moench, 2012, p. 313).
Diversity	The "different types of available resources that perform a particular function." Diversity in available resources for critical functions "provides a multitude of options for accomplishing those particular functions" (Longstaff et al., 2010b, p. 6). "...key assets and functions physically distributed so that they are not all affected by a given event at any one time (spatial diversity) and ... multiple ways of meeting a given need (functional diversity)" (Tyler and Moench, 2012, p. 315).
Performance	The "general level of capacity and quality at which an element or elements of a system performs an essential role" (HSSAI, 2009) cited in (Longstaff et al., 2010b, p. 6).
Rapidity, Responsiveness	The time required to restore system performance to a pre-disturbance level. "The capacity of a system to meet priorities and achieve goals in a timely manner to contain losses and avoid future disruption" (Bruneau et al., 2003, p. 738). "The ability to reorganise, to re-establish function and sense of order following a failure. Rapidity is a key part of responsiveness in order to contain losses and avoid further disruption" (da Silva et al., 2012, p. 135)

PHYSICAL CHARACTERISTIC	DESCRIPTIONS
Redundancy	Substitutable "elements, systems, or other units" ... "capable of satisfying functional requirements in the event of disruption, degradation, or loss of functionality" (Bruneau et al., 2003, p. 737; Schultz et al., 2012; Walker and Salt, 2006). "Superfluous or spare capacity to accommodate increasing demand or extreme pressures" (da Silva et al., 2012, p. 134). "Spare capacity for contingency situations, to accommodate extreme or surge pressures or demand" (Tyler and Moench, 2012, p. 313). A "quantifiable measure, or count, of a single resource type that performs a specific function. Redundant resources provide a failsafe, or back-up, when any individual unit fails. Redundancy is also a form of operational slack, or buffering from external shocks" (Longstaff et al., 2010b, p. 6).
Robustness	The "ability of elements, systems, and other units of analysis to withstand a given level of stress or demand without suffering degradation or loss of function" (Bruneau et al., 2003, p. 737). Robustness "depends on the ability of individuals, groups, or technologies to tolerate a broad range of conditions" ... determined as function of "performance, redundancy, and diversity" (Longstaff et al., 2010b, pp. 6, 21).
Safe Failure	The "ability to absorb shocks and the cumulative effects of slow-onset challenges in ways that avoid catastrophic failure if thresholds are exceeded. When a part of the system fails, it does so progressively rather than suddenly, with minimal impact to other systems. Failure itself is accepted" (da Silva et al., 2012, p. 135). "Ability to absorb sudden shocks (including those that exceed design thresholds) or the cumulative effects of slow-onset stress in ways that avoid catastrophic failure." Linkages designed such that "failures in one structure or linkage are unlikely to result in cascading impacts across other systems" (Tyler and Moench, 2012, p. 313).

Tab. 1 core dimensions of resilient physical systems and networks

ORGANIZATIONAL CHARACTERISTIC	DESCRIPTIONS
Adaptability, Flexibility	"Capacity to change as the surrounding environment changes while still maintaining functionality" (Walker and Salt, 2006) in (Schultz et al., 2012, p. 53). "The ability to change, evolve and adopt alternative strategies (either in the short or longer term) in response to changing conditions" (da Silva et al., 2012, p. 134). Adaptive capacity is represented as a function of "institutional memory, innovative learning, and connectedness" (Longstaff et al., 2010b, p. 7).
Connectivity, Feedbacks, Modularity	"Interpersonal and group connectedness is critical to the diffusion of institutional memory and innovative learning throughout the community" (Longstaff et al., 2010b, p. 8). The "ability to internalize past experiences, avoid repeated failures, and innovate to improve performance" (Tyler and Moench, 2012, p. 315).
Diversity	"Variety in the number of species, people, and institutions that exist in a social-ecological system" (Walker and Salt, 2006) in (Schultz et al., 2012, p. 53).

ORGANIZATIONAL CHARACTERISTIC	DESCRIPTIONS
Learning, Memory	Individual and institutional learning "from past experiences and failures" provides the ability to "use such experience to avoid repeating past mistakes and exercise caution in future decisions" (da Silva et al., 2012, p. 135). Accumulation of "shared experience and local knowledge of a group of people" resulting in institutional memory (Longstaff et al., 2010b, p. 7) Ability to use" information and experience to create novel adaptations to environmental changes or to avoid repeating old mistakes" (Longstaff et al., 2010b, p. 7).
Performance	The "general level of capacity and quality at which an element or elements of a system performs an essential role" (HSSAI, 2009) cited in (Longstaff et al., 2010b, p. 6).
Rapidity, Responsiveness	"The ability to reorganise, to re-establish function and sense of order following a failure. Rapidity is a key part of responsiveness" ... but should achieve a balance so as not to compromise the ability to learn (da Silva et al., 2012, p. 135) "Capacity to organize and re-organize in an opportune fashion;" ability to establish function, structure, and basic order in a timely manner both in advance of and immediately following a disruptive event or organizational failure (Tyler and Moench, 2012, p. 315).
Redundancy	Substitutable "elements, systems, or other units" ... "capable of satisfying functional requirements in the event of disruption, degradation, or loss of functionality" (Bruneau et al., 2003, p. 737; Schultz et al., 2012; Walker and Salt, 2006).
Resourcefulness	"The capacity to identify problems, establish priorities, and mobilize resources when conditions exist that threaten to disrupt some element, system, or other unit of analysis" including "the ability to apply material (i.e., money, physical, technological, and informational) and human resources to meet established priorities and achieve goals" (Bruneau et al., 2003, pp. 737–8). "The capacity to visualise and act, to identify problems, to establish priorities and mobilise resources when conditions exist that threaten to disrupt an element of the system. This capacity is related to the ability to mobilise assets (financial, physical, social, environmental, technology and information) and human resources to meet established priorities and achieve goals" (da Silva et al., 2012, p. 135). "Capacity to mobilize assets and resources for action. It also includes the ability to access financial and other resources, including those of other agents and systems through collaboration" (Tyler and Moench, 2012, p. 315).

Tab. 2 core dimensions of resilient organizational systems and networks

5.3 CHARACTERISTICS AND DIMENSIONS OF RESILIENCE

Highlights from the various physical and organizational dimensions and understandings of resilience attainment and assessment were presented and discussed during two workshops:

- A RAMSES stakeholder workshop with city representatives in Brussels 11 October 2013 organised by ICLEI-Local Governments for Sustainability
- A researchers' workshop with climate change mitigation and adaptation experts in Helsinki 23 October 2013 organised within the framework of COST (European Cooperation in Science and Technology) Action TU0902 Integrated Assessment of Cities

During these workshops three aspects were emphasised: core dimensions of resilient systems, identification of resilience characteristics for architecture and infrastructure, and approaches in which indicators can be identified and applied to recognise opportunities for intervention.

One of the activities in the workshop focused on identifying and assessing the implications and understanding of resilience characteristics. In this activity workshop participants were first asked to list core dimensions of resilience according to their own experience and knowledge, after which this input was matched with resilience characteristics derived from literature reviews. This set consisted of characteristics gleaned from the literature, separated from context and scale and presented without value in expert and stakeholder workshops. The purpose of this exercise was to tease out the current understanding of these terms - especially with respect to their relationship with resilience. The characteristics are used to inform the development of an operational understanding of resilience, while not necessarily maintaining (or narrowing debate into) existing patterns. Due to the variety of approaches of considering resilience in the literature, the list of characteristics includes both variables related to mechanisms of achieving, promoting, or enhancing resilience, as well as variables related to ex-post evaluation.

Table 3 summarises the main characteristics of resilient systems identified in literature and by RAMSES workshop participants (the latter's additional contribution *in italic*).

CHARACTERISTIC	**DESCRIPTIONS**
Adaptability, flexibility	Capacity or ability to: • change while maintaining *or improving* functionality • evolve • adopt alternative strategies *quickly* • respond to changing conditions *in time* • *design open and flexible structures (in general)*
Connectivity, feedbacks, safe-failure	Functional interdependence of system components and processes (effect of change in one part of the system on other parts of the system). Capacity or ability to: • absorb shocks • absorb cumulative effects of slow-onset challenges • avoid catastrophic failure if thresholds are exceeded • fail progressively rather than suddenly • fail without cascading impacts (domino effect) • *analyse and implement across spatial scales (city to site)* • *analyse as human-technology coupled system* • *identify lock-in effects and potential conflicts with mitigation* • *identify synergies with other city policies, added value assessment* • *balance clear distribution of responsibility with concerted action*
Dependence on local ecosystems	Local control over services provided by local and surrounding ecosystems. Maintaining health and stability of green and blue infrastructure, providing: • flood control • temperature regulation • pollutant filtration • local food production etc. • *bioclimatic design and management (adjusted to local conditions)*
Diversity	Spatial diversity - Key assets and functions physically distributed to not all be affected by a given event at any time Functional diversity - Multiple ways of meeting a given need • *balance diversity with potential cascading effects*

CHARACTERISTIC	DESCRIPTIONS
Learning, memory, *foresight*	Individual and institutional. Capacity or ability to: • learn from past experiences and failures • use information and experience to create novel adaptations • avoid repeating past mistakes • accumulate, store, and share experience • *build on long-term cultural value and history of the city* • *integrate resilience in long-term development scenarios*
Performance	How well does the system perform in its role? • Functional capacity • System quality • *in an appropriate and efficient way* • *self-sustaining, reducing external dependencies* • *compared to others – "I want a bigger dike than my neighbours"*
Rapidity, responsiveness	Following a disruptive event, the capacity or ability to: • contain losses, including mortality and illness • reorganise • maintain and re-establish function • reinstate structure • restore basic order • avoid future disruption
Redundancy, modularity	The capacity or ability to: • substitute systems, or elements of systems • buffer from external shocks or demand changes • replace components with modular parts • *balance redundancy with potential cascading effects*
Resourcefulness	The capacity, ability, *resources and infrastructures* to: • identify (and anticipate) problems • establish priorities • mobilise resources • visualise, plan, collaborate and act • *re-evaluate* • *integrate resilience in governance and working processes* • *involve and co-create with citizens (e.g., crowd-sourcing and funding)*
Robustness	The capacity or ability to: • withstand a given level of stress or demand • without degradation or loss of function • *capacities that ensure sufficient margins*
Co-benefits	• *Added value assessment of resilience* • *No/low regret measures*

Tab. 3 core dimensions of resilient systems, from RAMSES workshop participants and (Adger et al., 2005; Briguglio et al., 2008; Bruneau et al., 2003; Chang and Shinozuka, 2004; Chuvarayan et al., 2006; da Silva et al., 2012; Davis, 2005; Fiksel, 2003; Galderisi et al., 2010; Godschalk, 2003; ICSU, 2002; Longstaff et al., 2010a; Maguire and Hagan, 2007; McDaniels et al., 2008; Reghezza-Zitt et al., 2012; Schultz et al., 2012; Tierney and Bruneau, 2007; Tyler and Moench, 2012; UN-ESCAP, 2008; Van Der Veen and Logtmeijer, 2005; Wilson, 2012)

The importance of thresholds was emphasised by the workshop participants, in particular the difference between life and death - which measures are needed to prevent injury and loss of life. Linking resilience to co-benefits, no- and low-regret measures, was mentioned often and stressed as a core manner in which to operationalize visions of resilience in cities' daily routines. At the request of the participants an additional row was added to the table to indicate the importance of this dimension.

5.4 DEVELOPING RESILIENCE INDICATORS

The development of indicators for resilience in architecture and infrastructure is a difficult task, as they must address the typical challenges of assessment (e.g. feasible, cost-effective, and informative) while simultaneously addressing and capturing the very complex nature of resilience. In practice, different indicators have been proposed to assess proxy properties of resilience. Any indicator framework developed for assessment of resilience must not only address its multi-scale nature, but must acknowledge the difference between measurement of ex-post resilience to a realized event, and system characteristics perceived to contribute to resilience:

- Persistence, resistance, robustness could be assessed with outcome-based indicators which measure the effectiveness of action and policy
- Adaptability, responsiveness, ability to recover could be assessed with process-based indicators which monitor progress in implementation.

The theoretical underpinnings and specific definition of resilience has been approached by many different disciplines, stakeholders and schools of thought. This extreme diversity is reflected in the nature and focus of understandings of resilience. While there may be no universal, standardized definition or assessment methodology for resilience in the built environment, research in the field is accelerating, and seems to be converging around a few key themes. Three related capabilities are considered important (or necessary) for increasing resilience in systems and networks:

1. The provision of absorptive capacity so that the system or network can withstand disruptions;
2. Adaptive capacity so that service functions can be delivered via alternate paths;
3. Restorative capacity so that recovery from a disruptive event can be accomplished quickly and with minimum effort (Turnquist and Vugrin, 2013).

As such, resilience can be facilitated through redundant, distributed components, and design for safe failure, whereby the system is designed so that failure of a component can be absorbed by a network and does not propagate (cascading or escalating through the system). This requires localised, knowledge-based and integrated cross-scale indicators of resilience for design and management of urban architecture and infrastructure.

6 CONCLUSIONS

Resilience in architecture and infrastructure networks refers to the maintenance of function in spite of damage. Individual components themselves may be resilient, but the resilience of the system does not depend on this, only that the desired function persists or is able to resume with minimal time and resources after a disruption. A resilient system can be comprised of resilient components and subsystems, or alternately individual components can be protected, distributed, redundant, or even expected to fail. As long as these lower level components are well understood and managed spatially and functionally, the resilience at a higher scale can be maintained. The goal of the system is persistence of provision of desired functions, regardless of the specific methodology used to attain this.

In principle, incorporating resilience principles and metrics into standards and codes could provide a monitoring framework for improvement of practices, and a consistent approach across sectors and countries. Review of research literature, codes and standards, design guidelines and assessment schemes and corresponding testing of the review results in stakeholder and expert workshops however show that few operational indicators exist. Instead, best practice guidelines are increasingly perceived as efficient tools to encourage and promote resilience and deliver a level of reassurance not otherwise available through specific indicators.

A number of publications provide design recommendations for a climate change adapted built environment, including a wide range of recommendations for "resilient" architecture and infrastructure adaptation to

climate change impacts, such as adjustment in grey and green infrastructures (e.g. BRTF, 2013a, 2013b; BSA, 2013; DEFRA, 2012; KK, 2011). Grey infrastructures can be defined as "construction measures using engineering services", while green infrastructures are "vegetated areas and elements such as parks, gardens, wetlands, natural areas, green roofs and walls, trees etc. contributing to the increase of ecosystems resilience and delivery of ecosystem services" (EEA, 2012a, p. 7).

These design measures show how morphological factors and socio-economic activity can alter exposure and impact at local scale in cities, and how appropriate architecture and infrastructure design can mitigate these effects. Damage risks and costs can likely be considerably reduced when designing the built environment with inherent flexibility for adaptation to climate change, prioritising passive and local solutions, and providing redundancy of solutions (diverse supply options). In addition, low- and no-regret options could provide a range of co-benefits for climate change mitigation/adaptation as well as quality of life; for example, green areas and water bodies could provide storm water management, delay the urban heat island effect, and create local leisure facilities for the urban population. Costs could further be reduced when adaptation measures are timed according to upcoming windows of opportunity such as building retrofits, urban renewal, densification or development (EEA, 2012a).

Resilience exists as an inherent characteristic of a system, yet one that cannot be fully exposed ex-ante; Resilience is only observable after an event. It may however be possible to learn from past examples of resilience which system characteristics help it exhibit resilience in the face of adversity - developing a database of events and responses in order to derive which characteristics are most associated with realized resilience. These characteristics can be cultivated in new developments and existing communities. Indicators based on these characteristics and determining factors are useful for phenomena that have yet to be observed, or are not directly measurable, but for which a conceptual understanding is available. The problem with applying this indirect approach to resilience assessment is determining which characteristics of systems influence or determine their capacity for resilience, and clarifying and simplifying these complex concepts into indicators. Resilience may be directly measurable as successful restoration of functionality after a disruptive event, but indicator development requires working backward from ex-post assessment to ex-ante indicators of system characteristics.

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REFERENCES

Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16(3), 268–281.

Adger, W. N., Agrawala, S., Mirza, M. M. Q., Conde, C., O'Brien, K., Pulhin, J., … Takahashi, K. (2007). 17. Assessment of adaptation practices, options, constraints and capacity. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.), Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (pp. 717–743). Cambridge, UK: Cambridge University Press; Published for the Intergovernmental Panel on Climate Change (IPCC).

Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockström, J. (2005). Social-Ecological Resilience to Coastal Disasters. Science, 309(5737), 1036–1039.

Allenby, B., Murphy, C. F., Allen, D., & Davidson, C. (2009). Sustainable engineering education in the United States. Sustainability Science, 4(1), 7–15.

AU. (2010). Critical Infrastructure Resilience Strategy. Canberra, Australia: Australian Goverment (AU).

Bakken, J. D., Eggesvik, O., & Kirkebøen, S. E. (2014, February 13). Ny lekkasje i fjernvarmenettet. Osloby. Retrieved from http://www.osloby.no/nyheter/Ny-lekkasje-i-fjernvarmenettet-7468905.html

Briguglio, L., Cordina, G., Farrugia, N., & Vella, S. (2008). Economic Vulnerability and Resilience: Concepts and Measurements (Research Paper No. 2008/55). Helsinki, Finland: The United Nations University World Institute for Development Economics Research (UNU-WIDER).

BRTF. (2013a). Building Resiliency Task Force Report - Summary (Summary Report). New York, NY: Building Resiliency Task Force (BRTF), Urban Green Council, New York Chapter of the U.S. Green Building Council (USGBC).

BRTF. (2013b). Building Resiliency Task Force Report (Full Proposals). New York, NY: Building Resiliency Task Force (BRTF), Urban Green Council, New York Chapter of the U.S. Green Building Council (USGBC).

Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., … von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*, 19(4), 733–752.

BSA. (2013). Building Resilience in Boston: 'Best Practices' for Climate Change Adaptation and Resilience for Existing Buildings. Boston, MA: Prepared by Linnean Solutions, The Built Environment Coalition, and The Resilient Design Institute (RDI) for Boston Society of Architects (BSA), the Boston Green Ribbon Commission, and the City of Boston.

Cabinet Office. (2010). Sector Resilience Plan for Critical Infrastructure 2010. London, UK: Civil Contingencies Secretariat, UK Cabinet Office.

Cabinet Office. (2012). A Summary of the 2012 Sector Resilience Plans. London, UK: Civil Contingencies Secretariat, UK Cabinet Office.

Chang, S. E., & Shinozuka, M. (2004). Measuring Improvements in the Disaster Resilience of Communities. *Earthquake Spectra*, 20(3), 739–755.

Chuvarayan, A., Peterson, C., & Martel, I. (2006). A Strategic Approach for Sustainability and Resilience Planning within Municipalities (Master of Strategic Leadership Towards Sustainability). Blekinge Institute of Technology, Karlskrona, Sweden.

Clarke, M., Islam, S. M. N., & Paech, S. (2006). Measuring Australia's well-being using hierarchical needs. *The Journal of Socio-Economics*, 35(6), 933–945.

Da Silva, J., Kernaghan, S., & Luque, A. (2012). A systems approach to meeting the challenges of urban climate change. International *Journal of Urban Sustainable Development*, 4(2), 125–145.

Davis, I. (2005). Observations on Building and Maintaining Resilient Buildings and Human Settlements to withstand Disaster Impact. In Proceedings International Conference, 'Built environment issues in small island states and territories'. Kingston, Jamaica.

Davis, S. J., Caldeira, K., & Matthews, H. D. (2010). Future CO2 Emissions and Climate Change from Existing Energy Infrastructure. *Science*, 329(5997), 1330–1333.

DEFRA. (2012). Adapting to Climate Change - Future Worlds Images. London, UK: UK Department for Environment, Food & Rural Affairs (DEFRA).

DOE. (2010). Hardening and Resiliency: U.S. Energy Industry Response to Recent Hurricane Seasons (Final Report). Washington, DC: U.S. Department of Energy (DOE) Office of Electricity Delivery and Energy Reliability (OE) Infrastructure Security and Energy Restoration (ISER).

EC, & EEA. (2014). Climate Adapt - Glossary. The European Climate Adaptation Platform (CLIMATE-ADAPT): a partnership between the European Commission (EC) Directorate-General (DG) for Climate Action (CLIMA), DG Joint Research Centre (JRC) and other DGs, and the European Environment Agency (EEA).

EEA. (2012). Climate change, impacts and vulnerability in Europe 2012 - An indicator-based report (EEA Report No.

12/2012). Copenhagen, DK: European Environment Agency (EEA).

ESPON Climate. (2011). ESPON Climate - Climate Change and Territorial Effects on Regions and Local Economies. Scientific Report (Final Report No. Version 31/5/2011). Luxembourg: ESPON 2013 Programme: European observation network on territorial development and cohesion.

Fiksel, J. (2003). Designing resilient, sustainable systems. Environmental Science & Technology, 37(23), 5330–5339.

Fisher, R. E., & Norman, M. (2010). Developing measurement indices to enhance protection and resilience of critical infrastructure and key resources. *Journal of Business Continuity & Emergency Planning*, 4(3), 191–206.

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*, 16(3), 253–267.

Füssel, H.-M., & Klein, R. J. T. (2006). Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. *Climatic Change*, 75(3), 301–329.

Galderisi, A., & Ferrara, F. F. (2012). Enhancing urban resilience in face of climate change: a methodological approach. *TeMA Journal of Land Use Mobility and Environment*, 5(2), 69–88.

Galderisi, A., Ferrara, F. F., & Ceudech, A. (2010). Resilience and/or Vulnerability? Relationships and Roles in Risk Mitigation Strategies. In P. Ache & M. Ilmonen (Eds.), Space is Luxury. Selected Proceedings of the 24th AESOP Annual Conference (pp. 388–405). Espoo, FI: Aalto University School of Science and Technology Centre for Urban and Regional Studies.

GAO. (2007). Critical Infrastructure: Challenges Remain in Protecting Key Sectors (Testimony Before the Subcommittee on Homeland Security, Committee on Appropriations, House of Representatives No. GAO-07-626T). Washington, DC: United States Government Accountability Office (GAO).

GAO. (2010). Critical Infrastructure Protection: DHS Efforts to Assess and Promote Resiliency Are Evolving but Program Management Could Be Strengthened (Report to Congressional Addressees No. GAO-10-772). Washington, DC: United States Government Accountability Office (GAO).

Garbin, D. A., & Shortle, J. F. (2007). Measuring Resilience in Network-Based Infrastructures. In Critical Thinking: Moving from Infrastructure Protection to Infrastructure Resilience (pp. 73–85). Fairfax, VA: George Mason University (GMU) School of Law Critical Infrastructure Protection (CIP) Program.

Godschalk, D. (2003). Urban Hazard Mitigation: Creating Resilient Cities. *Natural Hazards Review*, 4(3), 136–143. doi:10.1061/(ASCE)1527-6988(2003)4:3(136)

Graham, A. (2011). Canada's Critical Infrastructure: When is Safe Enough Safe Enough? (No. 2). Ottawa, Ontario, Canada: The Macdonald-Laurier Insitute (MLI) for Public Policy.

Hafslund. (2014). Kundeinformasjon i tilknytning til graveskade i Akersgata torsdag 12. februar 2014. Hafslund Varme AS.

Hagerty, M. R. (1999). Testing Maslow's Hierarchy of Needs: National Quality-of-Life Across Time. *Social Indicators Research*, 46(3), 249–271.

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, 4(1), 1–23.

HSSAI. (2009). Concept Development: An Operational Framework for Resilience (No. RP09-01.03.02.12-1). Arlington, VA: Homeland Security Studies and Analysis Institute (HSSAI) Prepared for Department of Homeland Security (DHS) Directorate of Science and Technology.

ICSU. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. Scientific Background Paper commissioned by the Environmental Advisory Council of the Swedish Government in preparation for WSSD (Scientific Background Paper No. 3) (p. 37). Paris, France: International Council for Scientific Unions (ICSU).

IEA. (2012). World Energy Outlook 2012. Paris, France: Organisation for Economic Co-operation and Development/International Energy Agency (OECD/IEA).

IPCC. (2001). Climate Change 2001: Impacts, Adaptation and Vulnerability. Summary for Policymakers. In J. J. McCarthy, O. F. Canziani, N. A. Leary, D. J. Dokken, & K. S. White (Eds.), Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press; Published for the Intergovernmental Panel on Climate Change (IPCC).

IPCC. (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) (A

Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change). Cambridge, UK and New York, NY, USA: Cambridge University Press; Published for the Intergovernmental Panel on Climate Change (IPCC).

IPCC. (2013). Climate Change 2013: The Physical Science Basis (Summary for Policymakers), Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, NY, USA: Cambridge University Press; Published for the Intergovernmental Panel on Climate Change (IPCC).

IPCC. (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Working Group II Contribution to the IPCC 5th Assessment Report (Summary for Policymakers). Intergovernmental Panel on Climate Change (IPCC), Cambridge, UK.

Kenrick, D. T., Griskevicius, V., Neuberg, S. L., & Schaller, M. (2010). Renovating the Pyramid of Needs Contemporary Extensions Built Upon Ancient Foundations. *Perspectives on Psychological Science*, 5(3), 292–314.

Kiel, J. M. (1999). Reshaping Maslow's hierarchy of needs to reflect today's educational and managerial philosophies. *Journal of Instructional Psychology*, 26(3), 167.

KK. (2011). Copenhagen Climate Adaptation Plan. Copenhagen, DK: Københavns Kommune (KK) Municipality of Copenhagen.

Koltko-Rivera, M. E. (2006). Rediscovering the later version of Maslow's hierarchy of needs: Self-transcendence and opportunities for theory, research, and unification. *Review of General Psychology*, 10(4), 302–317.

Longstaff, P. H., Armstrong, N. J., & Perrin, K. (2010). Building Resilient Communities: Tools for Assessment (White Paper). Syracuse, NY: Institute for National Security and Counterterrorism (INSCT).

Longstaff, P. H., Armstrong, N. J., Perrin, K., Parker, W. M., & Hidek, M. (2010). Building Resilient Communities A Preliminary Framework for Assessment. *Homeland Security Affairs*, VI(3).

Luiijf, E., Burger, H., & Klaver, M. (2003). Critical Infrastructure Protection in The Netherlands: A Quick-Scan. In EICAR Conference Best Paper Proceedings (Vol. 19). Copenhagen, DK: EICAR.

Lung, T., Lavalle, C., Hiederer, R., & Bouwer, L. M. (2011). Report on potential impacts of climatic change on regional development and infrastructure (Deliverable No. D6.3). Amsterdam, NL: 7th Framework Programme RESPONSES project. European responses to climate change: deep emissions reductions and mainstreaming of mitigation and adaptation.

Maguire, B., & Hagan, P. (2007). Disasters and communities: understanding social resilience. *The Australian Journal of Emergency Management*, 22(2), 16–20.

Manyena, S. B. (2006). The concept of resilience revisited. *Disasters*, 30(4), 434–450.

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review*, 50(4), 370–396.

Maslow, A. H. (1958). A Dynamic Theory of Human Motivation. In C. L. Stacey & M. DeMartino (Eds.), Understanding human motivation (pp. 26–47). Cleveland, OH, US: Howard Allen Publishers.

Maslow, A. H. (1970). Motivation and Personality (2nd ed.). New York, NY: Harper.

McDaniels, T., Chang, S., Cole, D., Mikawoz, J., & Longstaff, H. (2008). Fostering resilience to extreme events within infrastructure systems: Characterizing decision contexts for mitigation and adaptation. *Global Environmental Change*, 18(2), 310–318.

Milman, A., & Short, A. (2008). Incorporating resilience into sustainability indicators: An example for the urban water sector. *Global Environmental Change*, 18(4), 758–767.

Reghezza-Zitt, M., Rufat, S., Djament-Tran, G., Le Blanc, A., & Lhomme, S. (2012). What Resilience Is Not: Uses and Abuses. Cybergeo: European Journal of Geography, Environment, Nature, Landscape(Article 621).

Rosenthal, E. (2010, April 12). Europe Finds Clean Energy in Trash, but U.S. Lags. The New York Times.

Schultz, M. T., McKay, S. K., & Hales, L. Z. (2012). The Quantification and Evolution of Resilience in Integrated Coastal Systems (No. ERDC TR-12-7). Washington, DC: U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC).

Schwilk, D. W., Ackerly, D. D., (2001). Flammability and serotiny as strategies: correlated evolution in pines. *Oikos,* 94(2), 326–336.

Sigurjonsdottir, S. (2014, February 13). Fortsatt over 500 husstander uten fjernvarme. Osloby.

Smit, B., Pilifosova, O., Burton, I., Challenger, B., Huq, S., Klein, R. J. T., & Yohe, G. W. (2001). 18. Adaptation to climate change in the context of sustainable development and equity. In J. J. McCarthy, O. F. Canziani, N. A. Leary, D. J. Dokken, & K. S. White (Eds.), Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of W orking Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press; Published for the Intergovernmental Panel on Climate Change (IPCC).

Solberg, S. M. (2014, February 14). Hele Oslo sentrum uten fjernvarme NA24.

Tagliabue, J. (2013, April 29). Oslo Copes With Shortage of Garbage It Turns Into Energy. The New York Times.

Theoharidou, M., Kotzanikolaou, P., & Gritzalis, D. (2009). Risk-Based Criticality Analysis. In C. Palmer & S. Shenoi (Eds.), Critical Infrastructure Protection III (pp. 35–49). Springer Berlin Heidelberg.

Tierney, K., & Bruneau, M. (2007). Conceptualizing and Measuring Resilience: A Key to Disaster Loss Reduction. TR News, 250(May/June), 14–17.

Turner II, B. L. (2010). Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science? *Global Environmental Change*, 20(4), 570–576.

Turnquist, M., & Vugrin, E. (2013). Design for resilience in infrastructure distribution networks. *Environment Systems & Decisions*, 33(1), 104–120.

Tyler, S., & Moench, M. (2012). A framework for urban climate resilience. *Climate and Development*, 4(4), 311–326.

UNEP. (2009). Buildings and Climate Change: Summary for Decision-Makers. Paris, France: United Nations Environment Programme (UNEP) Sustainable Buildings and Construction Initiative (SBCI).

UN-ESCAP. (2008). Sustainability, resilience and resource efficiency: Considerations for developing an analytical framework and questions for further development (Unedited Discussion Paper). United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP) Environment and Development Division (EDD

UN-ESCAP. (2013). Building Resilience to Natural Disasters and Major Economic Crises (No. ST/ESCAP/2655). Bangkok, Thailand: United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP

UNISDR. (2012). How To Make Cities More Resilient - A Handbook For Local Government Leaders. Geneva, Switzerland: United Nations Office for Disaster Risk Reduction (UNISDR).

Van Der Veen, A., & Logtmeijer, C. (2005). Economic Hotspots: Visualizing Vulnerability to Flooding. Natural Hazards, 36(1-2), 65–80.

Vugrin, E. D., Warren, D. E., Ehlen, M. A., & Camphouse, R. C. (2010). A Framework for Assessing the Resilience of Infrastructure and Economic Systems. In K. Gopalakrishnan & S. Peeta (Eds.), Sustainable and Resilient Critical Infrastructure Systems (pp. 77–116). Springer Berlin Heidelberg.

Wahba, M. A., & Bridwell, L. G. (1976). Maslow reconsidered: A review of research on the need hierarchy theory. *Organizational Behavior and Human Performance*, 15(2), 212–240.

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society*, 9(2), 5.

Walker, B., & Meyers, J. A. (2004). Thresholds in ecological and social-ecological systems: a developing database. *Ecology and Society*, 9(2).

Walker, B., & Salt, D. (2006). Resilience thinking: sustaining ecosystems and people in a changing world. Washington, DC: Island Press.

WCED. (1987). Report of the World Commission on Environment and Development: 'Our Common Future'. Oxford, UK: United Nations World Commission on Environment and Development.

Wicker, F. W., Brown, G., Wiehe, J. A., Hagen, A. S., & Reed, J. L. (1993). On Reconsidering Maslow: An Examination of the Deprivation/Domination Proposition. *Journal of Research in Personality*, 27(2), 118–133.

Wilson, A. (2012). Resilient Design: Smarter Building for a Turbulent Future. *Environmental Building News*, 21(3), 1–15.

Wolf, S., Hinkel, J., Hallier, M., Bisaro, A., Lincke, D., Ionescu, C., & Klein, R. J. T. (2013). Clarifying vulnerability definitions and assessments using formalisation. *International Journal of Climate Change Strategies and Management*, 5(1), 54–70.

IMAGE SOURCES

Title image: Mining scars; Montaña La Sahorra, Tenerife, Spain. Photo: J. Kallaos

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NEW TECHNOLOGIES FOR SUSTAINABLE ENERGY

IN THE SMART CITY: THE WET THEORY

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ABSTRACT

The paper tries to develop a new approach to the sustainable planning for the smart city based on the assumption that the relationship between new technologies and urban system could be developed in a new way considering the WET theory. The WET theory starts from the main components for the establishment and the survival of the human settlements: Water, Energy and Technologies (WET). By considering this approach, technology could be envisaged as a switch element for the bifurcation that could be generated inside the process of management of the modern urban systems. On the one hand, technology can improve the use of renewable energies and it can promote a different way of using energy inside the city. On the other hand, technology can produce a huge structural work that can drive the urban system towards a worst dimension, by causing permanent change inside the territory as a whole, particularly at large scale. Starting from these considerations, the paper proposes a focus on the two mentioned possibilities, by considering the best dimension, represented by the DESERTEC project and the worst one prefigured by the South to North Water Diversion Project (SNWDP) that is going to start in China.

KEYWORDS:
Smart City, Urban Entropy, New Technologies, WET Theory.

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智能城市（SMART CITY）中的可持续能源新技术

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摘要

本文旨在为智能城市的可持续发展规划开发一种新方法，其基础是设想通过 WET 理论以一种新的方式在新技术和城市体系之间建立关系。

WET 理论源于人类居住区的建立和生存所必需的主要因素：水、能源和技术（WET）。通过考虑采用此方法，将技术视为能够打通现代城市体系管理进程中关键节点的转换因素。而且，技术还可以提高对可再生能源的利用，并在城市能源利用领域中开拓出一条与众不同的道路。但在另一方面，技术可带来大量的建筑施工，这会使城市体系朝向不利的一面发展，总之会在区域内造成大规模的永久性改变。

从这些考虑因素入手，本文将就上述两种可能进行着重阐述，以 DESERTEC 项目代表有利的一面，以在中国即将开始的南水北调工程（SNWDP）代表不利的一面。

关键词

智能城市；城市熵；新技术； WET 理论

1 TECHNOLOGY AND CITY

Technology represents a basic element in the process of building up the urban artefact. When man has felt the need to adapt the natural environment in order to establish human activities, he has used technology to do it. From sharp stone or primitive axe towards digital excavators or remote controlled crane.

The term technology is connected with the term technique. Nevertheless, with technological revolution we have been driven to consider technology, which identified the process and the study to transform materials into goods, with the product itself. Today the term "technology" is used to refer to ICT tools available. In a certain way it's so possible to identify technology with technique. Furthermore, it is possible to say that the term technique means all the actions, choices and behaviors that transform an object into a tool.

"Without technique the man would not exist and would not existed ever" (Ortega y Gasset 1933). It is important to preserve anyway the meaning of process, also mental, which is inside the word: "mechanic", definitely confirmed with word: "machine". The term: "mechanè" is already present inside the Omero's writings with the meaning of: gear, mechanism, but not only in a physical way, it can mean: reasoning cunning, trick as well. "The machine has been designed to get a certain result, born in order to get this goal and represents the materialization of a strategy useful to get a specific purpose" (Boncinelli 2006).

Starting from those assumptions it is very interesting to consider the city as a human artifact created just thanks to the technique/technology. If we consider the evolution of the technique related to the process of progressive transformation of the natural environment, made by man in order to survive to different natural threats, we will observe a curve growing from the proto-techniques toward the mature phase of technology (figure 1).

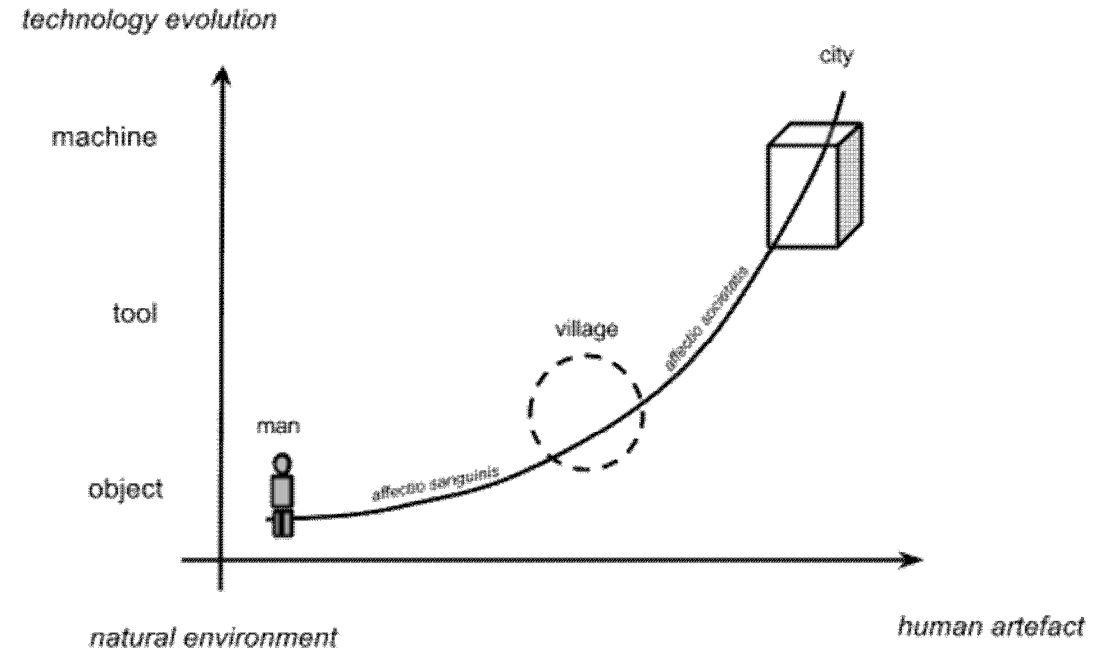

Fig. 1 The curve of the adapted space related to the evolution of technology and the development of the human settlement

City and technology have very close relationship since the first human action made to resist to natural events or produce a human settlement because of the changes and the evolution between the *affectio sanguinis* and the *affectio societatis*. Technology has to be considered like a fundamental factor inside the evolution process of the human beings. Thanks to technology, man can extend its senses in order to have a best perception of the environment. Thanks to technology, man can develop his capabilities to understand natural events, to carry on sciences development and to build a common space for more people.

Technology has to be intended as a basic factor of the human evolution. Today, technology has a new acceleration, which can separate it from the human evolution process. In the industrial revolution the machine was employed to support men in the production activities. In that period there was a total change in human settlements but technology was still inside the process. With the digital revolution, technology has gone beyond the human capability of using it, by producing a huge transformation in the human capabilities of relationship. If men don't understand that technology has to be adopted and not added up in the evolution process, there will be a wrong use of innovation and a distorted dimension of mankind.
The smart city has to consider the adoption of the ICT inside its process of development and not the addition of the technological equipment (like sensors) to the physical system of the city.
According to this approach, technology is one of the fundamental factor for the smart city as the WET theory tries to describe.

2 URBAN ENTROPY INSIDE THE SMART CITY

Considering the system approach to the interpretation of the city (Regulsky 1983) it is possible to say that the evolution of the urban system is closely connected with the evolution of its subsystems and mainly with the socio-anthropic ones (Gibson 1993). One of the problem that can cause a wrong development of the system is entropy. The urban entropy is intended like a negative condition of the system, which tends to move out itself from the management process, following distorted trends of development. The urban entropy is related to several factors: urban pollution, energy waste, the excessive production of waste, the increment of the conditions of vulnerability of sub-systems, the high social conflict, a high crime rate, etc.. These conditions may produce adverse effects and different kinds of discrepancies within the urban system, related to the improper use of available resources.
It is possible to say that a city is much more sustainable when the physical system and the functional one evolve with a compatible speed. In other words, the system has a dimension of urban sustainability when it saves the permanence of the functions in the historic sites of the city. The more the urban functions are moved away from the traditional sites of location, the less the urban sustainability improves.
The functional system represents the subsystem of great importance, but this should be considered in relation to the other subsystems: the physical (spaces and areas where the functions take place), the economic (represented by the processes that support the functioning of the city) and the social (composed by the individuals who populate the city and their interactions) (Papa 1992).
Considering this approach, it is possible to define policies for the governance of urban and territorial transformations by starting from the need to make the evolution of the system be compatible and sustainable. However, it should be immediately noted that, interpreting the city as a system within larger metasystems (including the Earth), and being the planet a closed system, the amount of entropy inevitably generated by the processes of transformation of energy (considering the second law of thermodynamics) is steadily increasing (Pulselli e Tiezzi 2008).
The cities, being energy-consuming systems (Fistola 2010), are the places where policies to reduce entropy should be implemented through appropriate actions of urban planning. Delving into the matter, it is possible to say that the first actions of a new territorial government are due to the entropic mitigation. The more we can control the urban entropy (which the system generates for its survival and evolution), the greater we can contain urban development into the expected range of trajectories within which the potentially positive states (i.e. sustainable and compatible with the available resources) are located. Reconsidering the graph showing the trend of urban evolution (figure 2), it is possible to identify the entropic areas, represented by the portions of space outside the expected range of the paths. When the system crosses into these areas, it means that the levels of entropy are dramatically high and an over-use of resources to bring back the system within the range of the expected trends is needed.

The entropic areas can be further subdivided according to the increasing entropy. The areas can be distinguished in two different kinds. The first one refers to reversible entropy areas, for which it is possible to recover the system tracing it back to the range of urban sustainability (by using a considerable amount of social, environmental and economic resources). The second one refers to unrecoverable entropy areas where the system goes to the "heat death" and the city suffers the structural collapse and the disintegration of the relationship among elements (Fistola 2012).

In order to give some examples of the above said assumptions, it can be supposed that inside the recoverable entropy area it is possible to place those cities in which entropy has been mainly produced by a "dominant" cause such as urban pollution, strong social conflicts, widespread urban hazard for natural causes, hydrogeological instability, and so on. The extra resources to be used for the "reconversion" of the system within the range of sustainability can be of energy, social financial nature and so on.

In a very marginal position and borderline in respect to the unrecoverable entropy area there are the urban contexts where, in the different subsystems, some entropic generations/productions take place, which act in synergy and entail the use of exceptional resources for reconversion through specific interventions. It is the case of the promulgation of special laws for those cities affected by a heavy structural crisis. Finally it will be said that the cities affected by the "heat death" are those exposed to a constant and very high entropic pressure or those hit by disasters that require evacuation. Indeed the case of Chernobyl is a striking example.

Starting from this idea, it is possible to say that the reversible entropic areas characterize the processes of "growth", while the range of sustainability includes the processes of "evolution" of the city. As for the concept of sustainable development, it must be recognized the impossibility of defining a condition of perfect sustainability (because any development process produces entropy), also within the range of expected trends the city produces entropy since it use resources (energy) for its evolution.

3 THE WET THEORY: A NEW GENERATIVE ENVIRONMENT FOR THE CITY

Thus entropy, considered as urban energy dissipation (derived from the available resources), is the element to mitigate in the will of orienting the urban system towards sustainability. As above-assumed, technology can play a vital role in this regard.

To consider the relationship between technology and energy within the city it is possible to refer to the "WET Theory". The WET theory can provide a useful scientific reference for managing territorial transformations since it reconsiders the essential resources for the urban evolution which, as for the primordial wet environments of our planet, allow the growth of vital systems. Water and energy represent the necessary conditions for the survival of the socio-anthropogenic and functional subsystems respectively and therefore able to ensure the subsistence of the urban system.

Technology ensures the progress and the advancement of the urban system by representing the key factor in the evolution. It is known from the theory of entropy applied to social systems (Rifkin 1992) and from other studies on the environmental impacts (produced by the anthropic presence) that technology acts as a transformer of energy and therefore as an entropy generator.

In particular, the equation "IPAT", (Chertow 2001) describes how the Impact can be correlated to factors such as Population Affluence and Technology.

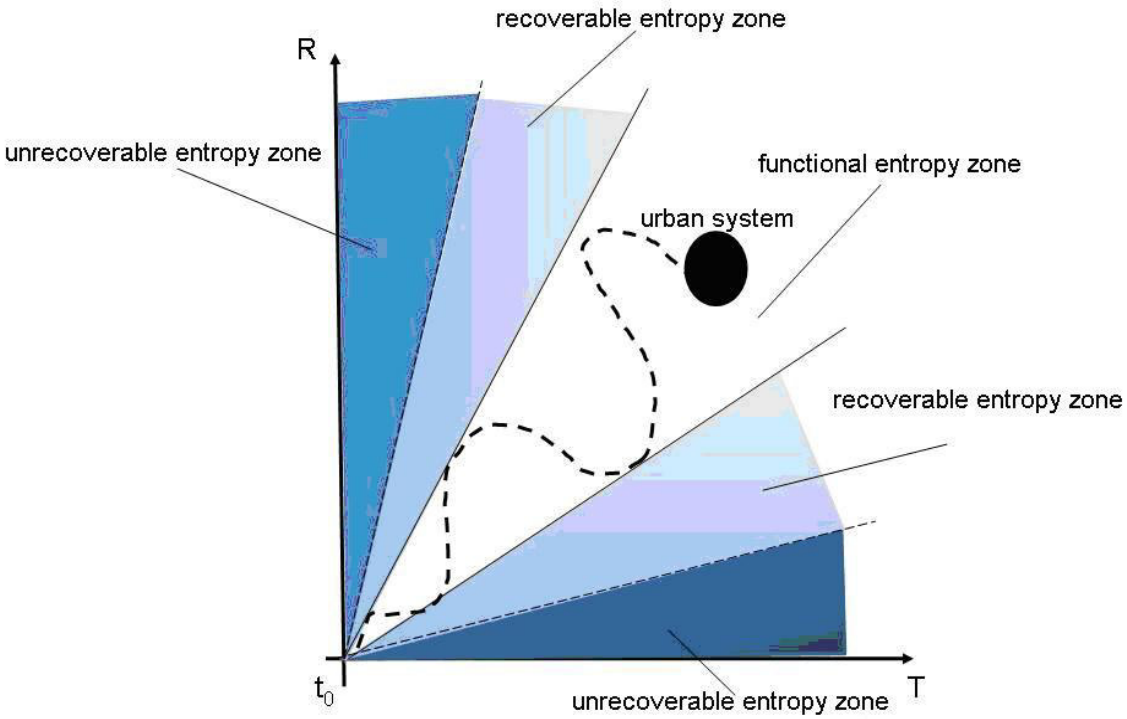

Fig. 2 The evolution trend of the urban system and the different entropy zones

Even from this equation, it can be assumed that the environmental impacts, which here can be considered like the systemic expression of entropy, are directly associated with the development of the elements of the urban subsystem (Commoner 1972).

Among the terms of the equation, technology seems to offer possibility to make an immediate and effective action to reduce impacts (Sachs 2008). It is clear that, the technology component seems to be the regulatory element on which it is possible to act immediately.

A first example can be provided by the processes of virtualization (Fistola and La Rocca 2001) which can be activated through the new technologies that effectively reduce the intensity of use of urban functions and also its land consumption.

This reflection could possibly lead to reconsider the "anti-technological" approaches in the field of urban science that for a long time have led to move away from the possibility of understanding and interpreting the processes of urban change, and have produced the consequent impossibility of defining new policies, in order to manage the evolution of the urban system.

Cities are the places of human survival, spaces for a new society and factories of knowledge, technology now pervades every relational, productive and economic process.

The smart city seems to be the closest urban scenario to which it is necessary to define the methods, the procedures and the policies for the government of the evolution of the urban system (Fistola 2013).

The use of the system logic in the paradigmatic definition of smart city allows to extend the idea of “smartness” by including also the metropolitan area and the landscape components.

In other words, maybe it is possible to consider also the “smart landscape”, which can refer to the setting up of the identity components of the extra-urban dimension capable of stopping territorial entropy and to drive the governance of transformations towards harmonic and balanced contexts, whose development could be always checked and compatible with the available resources of the system evolution.

The task of the new urban planning consists in proposing and implementing these processes by considering new approaches and new theories oriented to increase the social capital in the city and inspired by the sustainability and compatibility of the urban evolution.

The use of new technologies for building a complex territorial knowledge have to support the decision-makers in their choices.
Accordingly, for example, the GIS become the innovating environments of territorial knowledge development (Fistola 2009) and, combined with the remote sensing techniques, can help in building information complex scenarios for an effective support to transformation.
However, it should be considered that the use of technology could have a dual development in relation to the entropy production.
When technology is adopted to drive evolutionary urban processes (and it is used by considering the general principles of sustainability), it produces positive effects and it greatly reduces urban entropy. On the other hand, when technology is mainly used in relation to the need to foster and promote the process of economic growth of a specific region, it may trigger a significant number of negative externalities that can spread on contiguous territories and ecosystems. This possibility can be seen as a bifurcation that is generated on the curve that describes the evolution of sustainable urban system and it can usefully represent the proper, or improper, use of the technology (Figures 3).

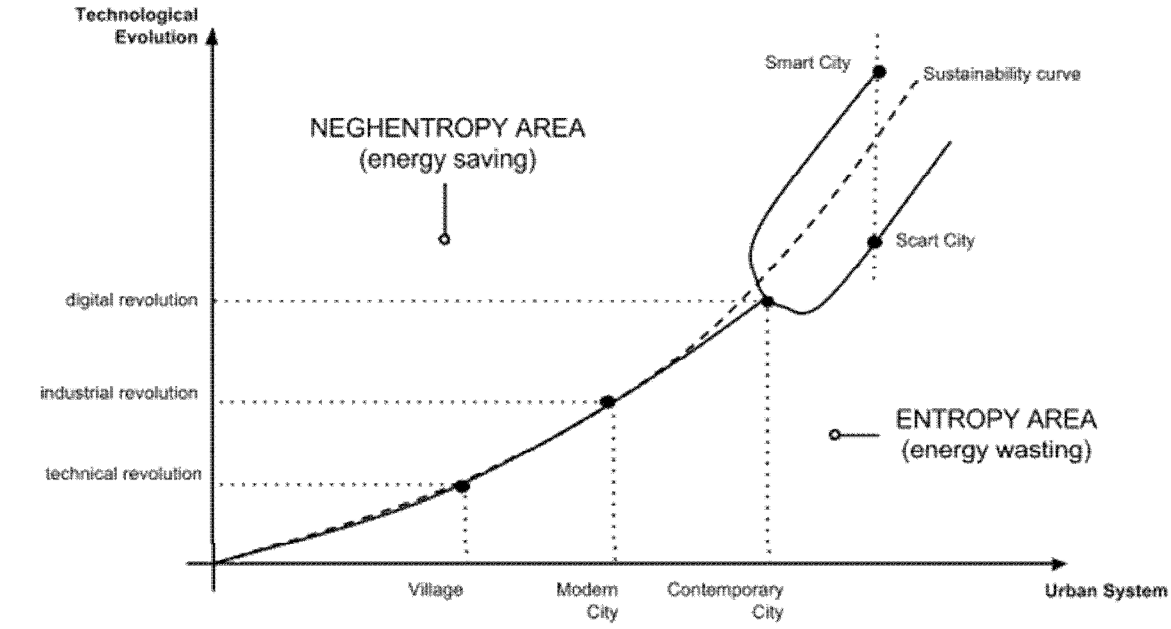

Fig. 3 The curve of sustainable evolution of the urban system and the bifurcation in the possible use of technology inside the city.

The proper use, described by the high branch of the bifurcation, allows a significant advancement of the city towards the sustainability dimension, increases the urban smartness (Fistola, 2013) and generates a reduction of entropy. The lower branch, instead, which is located below the curve of urban sustainability, leads the city towards a condition of entropic spread and continuous wasting of energy resources.
Then the two branches of the bifurcation can describe two potential conditions that the urban system can take according to the correct or incorrect use of technology: the smart city or the scart city.
The two mega-projects, described in the following, can represent this bifurcation, showing how the use of technology can drive an urban (territorial) system towards two opposite conditions.

4 THE ENTROPIC WAY: THE SOUTH TO NORTH WATER DIVERSION PROJECT IN CHINA

In China, since about a quarter of century, researchers and scientists, people and politicians have been discussing about the South to North Water Diversion Project (SNWDP), which is considered the greatest work of engineering infrastructure in the world, if it will be completed.

There are different opinions between those who believe that the project is essential to solve the water requirements of the northern countries and those who believe that the environmental and economic impacts will be higher than the benefits.

The project bases on the idea of diverging four principal rivers from south to north to supply the need for water in the northern developed regions. The northern part of China is historically characterized by water scarcity compared to the southern regions, also because it has been a center of population growth, industrial development and intensive agriculture for a long time. The idea was conceived by the former Chinese leader Mao Zedong in 1952. After fifty years of discussions and conflicts, it was approved by the Country's Cabinet, in December 2002.

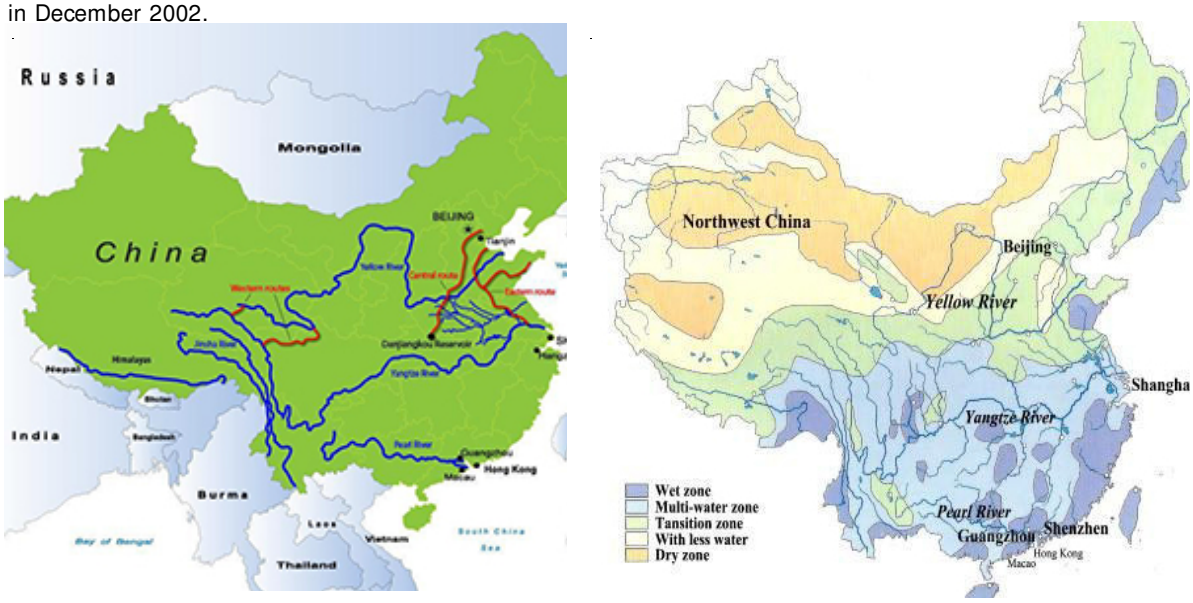

Fig. 4 Map of the South to North Water Diversion Project (left) and distribution of wet and dry zones in China (right))

The mega project has an estimate total cost of 62 billion of US dollars. In the government's opinion, the project is essential to guarantee the economic developing of the northern and western regions in the fastest way even though this vision is very controversial.

The project consists of three water-transferring routes -the Eastern Route, the Central Route and the West Route-, which will connect four rivers basins: the Yangtze River in the central China to the Hai, the Yellow and Huai Rivers in the north area. The eastern and central routes will be channeled under the Yellow River, while the western route entails pumping water over a part of the Himalayan mountain range.

The Eastern Route has started to be built since December 2002 and is expected to be finished in 2030. This route diverts water from the Yangtze River and is an upgrade of the ancient course of the Beijig-Hangzhou Grand Canal that was built to transport grain and other commodities to Beijing through the Jangsu, Anhui and Shandong provinces.

This part of the project is in an advanced state and through a tunnel under the Yellow River the water will reach Tianjin. The finished diversion will involve a complex system of pumping stations (23 total stations with a power capacity of 454 megawatts) to take about 1 billion m^3/year.

The Middle Route started in 2003 and was expected to be finished in 2010 but still now it is under construction. The northern stretch was finished in 2008 and its cost was about two billions of US dollars.

It doesn't takes water from rivers but from reservoirs in Hebei province, where farms and industries had to cut their consumes to let the water be diverted to Beijing and Tianjin.

One of the main problem occurred in the construction of this route has been the displacement of people living near the Danjiangkou Reservoir and along the canal. This created a lot of social conflicts and discontent both in people and scientists wondering about the real utility of the project, especially considering

the state of water pollution. It is very likely that the project will have no benefit at all, because it will not diverge any potable water.

The third route, called the Big Western Line, started in 2010. It has been scheduled to bring water from the major tributaries of the Yangtze (Tongtian, Yalong and Dadu rivers) to the northwest Chinese region.

For the water transfer project it is expected to build some pumping stations for lifting water, while some long tunnels will drive the water course through Bayankala Mountain. The whole project is expected to be completed in 2050 and it is clear by now that the initial cost has been underestimated.

Fig.5 Tunnel under the Yellow River

At present, this project raises many concerns. First of all the high levels of pollution in China affect also the quality of water and the opportunity to bring potable water through these three routes is very improbable. At that time it would have had to take 426 sewage treatment plants to bring water to Beijing.

The second issue regards the incapacity of the Chinese government to make appropriate decisions to solve the problem concerning the policy for coping for supplying water as well as for encouraging conservation and rationalized use of the resource. In this sense, the SNWDP seems to be the mean for Chinese government to rely on technologies to avoid making decisions.

5 THE SUSTAINABLE WAY: THE DESERTEC PROJECT, A NETWORK OF RENEWABLE ENERGY

DESERTEC seems to be the largest project to use renewable energies, even though it is quite far from getting large approval and consensus. Nevertheless, it can represent a positive example of using technologies potentiality in order to reduce impacts on the inevitable territorial transformation.

The project is based on the idea of taking renewable energies from countries where they are more available and abundant. This could be possible by means of a super smart grid using the high voltage direct current (HVDC) as method of transmission.

The DESERTEC concept considers to use all kinds of renewable sources of energy (wind, sun, water) leaving a central role to energy produced by sun in the desert regions of the world.

The Desertec Foundation official web site shows the principles for the individuation of the main sources inside the smart grid on which the project is based:

- Solar-Thermal Power (CSP) in desert regions;
- Wind power in coastal areas;
- Hydro power in mountainous regions;
- Photovoltaics in sunny areas;
- Biomass and Geothermal power where geographic conditions are favorable.

The Trans–Mediterranean Renewable Energy Cooperation (TREC), an international network of politicians, academics and economists that gave rise to the Desertec Foundation (DF), developed this concept in 2003. The Foundation's target regards the implementation of the project in the EUMENA (Europe, Middle East and North Africa) region.

In 2008, the first version of the Mediterranean Solar Plan of the Union for the Mediterranean (UfM), aimed at developing the renewable energy projects, was presented. The Foundation's studies, in fact, demonstrated that it could be possible to satisfy both the whole energy demand by the MENA (Middle East and North Africa) region and a part of the European demand by using a little part of the desert sun. The energy produced would be enough to feed the desalination plant for the potable water in the MENA region too.

The research developed during the recent years states that the MENA region could satisfy its own energy requirement and it could export the surplus considerably reducing CO_2 emissions by 80%. It has been also calculated that the savings for Europe would amount at about € 30 megawatts/h (Desert Power 2050).

But the real challenge of DESERTEC consists in realizing a global network of renewable energy connecting those countries where this energy is more easily produced. This means, first of all, to work on political convergence of all the involved countries because the net will overshoot borders.

It is a very hard target to get, if we consider the economic interests at stake. Probably related to these uncertainties, in 2009, the no profit Desertec Foundation started an industrial initiative -called Dii GmbH- aimed at implementing the project by assuring technological, political and economic conditions to its realization. The Desertec Principles, Criteria and Indicators (PCIs) were worked out in 2012. They are based on the idea of cooperation between regions and nation-states and affirm the necessity of a transition from fuel energy to green energy.

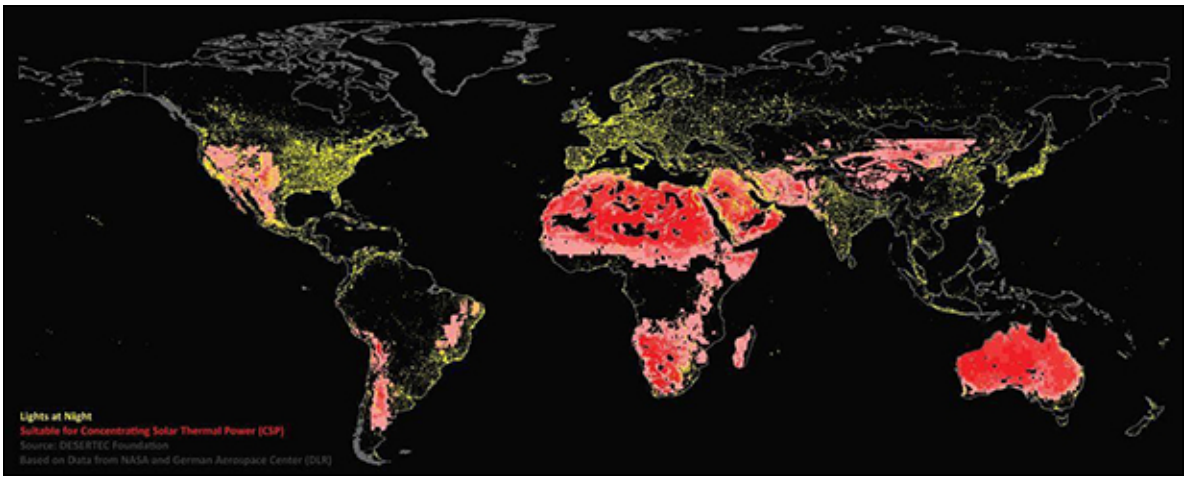

Fig. 6 Localization of deserted areas (red) and energy demand concentration (yellow)

The document points out five main principles for achieving the final goal of sustainability (environmental, economic, social):

1. Electricity from renewable resources,
2. Reliability of electricity supply,
3. Water use,
4. Socio-economic impact / Local benefits,
5. Environmental responsibility and conservation of natural resources and biodiversity.

Each principle is articulated into criteria and indicators to achieve sustainable levels.

The Desertec criteria are a work in progress that will be developed and transformed also according to the contribution of the actors involved. The Desertec-Dialogue, in fact, is the project promoted by the German Ministry of Foreign Affairs and is based on the definition of the criteria that are to be shared and accepted by local and external stakeholders involved in the realization of the energy plants.

The main objective consists in combining the legitimate interests of investors and companies with the important demand for a reasonable regional development. Following the vision of the Foundation, which is based on the collaboration between Europe and MENA regions, this dialogue project is also aimed to satisfy the demand for employment by creating new opportunities of working. It started in Morocco and Tunisia in autumn 2013.

The objective to create consensus both at local and at large scale is pursued by a network of regional skilled coordinators who are placed in each state. Their role consists in individuating the adequate conditions to spread out the DESERTEC vision also by involving local actors (no profit organizations, academics, private societies, etc.).

The implementation of the DESERTEC project is based also on scientific cooperation: in 2010, in fact, a University Network as a cultural platform to develop studies and research in energetic field was founded.

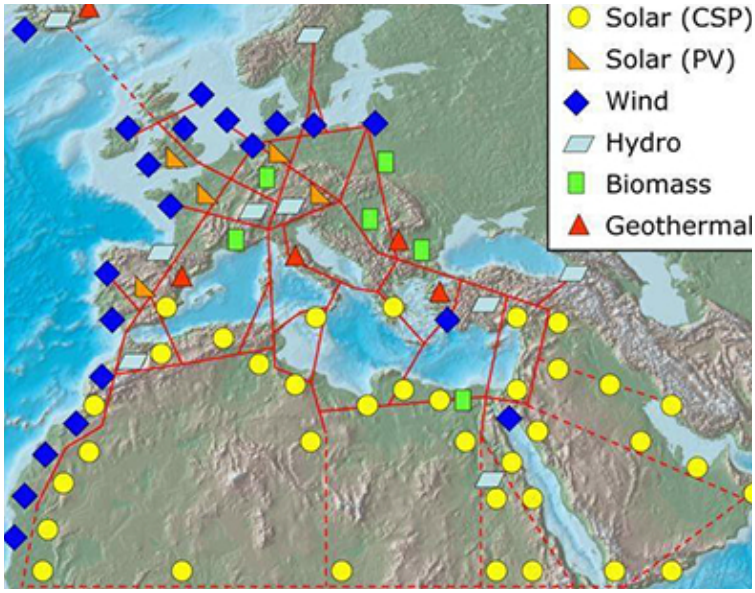

Fig. 7 The DESERTEC mega grid

The network consists of 18 universities from North Africa, the Middle East and from Europe engaged in promoting the knowledge transfer. Among its targets, the Universities Network also contributes to the education of skilled experts able to improve the production and the installation of alternative and renewable energy systems.

Some experimental projects have been started to test the DESERTEC theory on sustainability and clean energies. The first project has been the TuNur project. Begun in 2011, it was aimed at developing the first utility-scale solar export project between Tunisia and Europe. The project is worked out by a South-North partnership between a group of Tunisian investors (50%) and UK-based Nur Energie (50%). It is expected to induce about 20.000 new jobs and it will use dry-cooling systems to reduce water by 90%. And that will bring energy to Italy by 2016.

In Algeria, an ambitious national program was launched to promote energy efficiency. The program is targeted to install 12,000 MW of power and to generate capacity from renewables until 2030 to supply 40% of the domestic electricity demand and to allocate an additional 10,000 MW for export (Dii-Eumena, 2011).

In Morocco, an agreement has been signed between Dii and the Moroccan Agency for Solar Energy (MASEN)

to investigate the possibility to integrate African and European market in producing sustainable energies. The energy that will be produced will feed both the Moroccan and the Spanish network by 2016.
In 2011, the Desertec signed a Memorandum of Understanding (MoU) with Medgrid, the other meta-project launched in 2009 by the French government under the Mediterranean Solar Plan (MSP). This agreement showed an integrate vision, which is to connect the two projects by five interconnection and to create a single market of renewable energies. At present, the Desertec project has stopped and its possibility of realization are in discussion. As in the case of the SNWDP, it raises some concerns especially about its costs and its capacities of integrating different political interests.

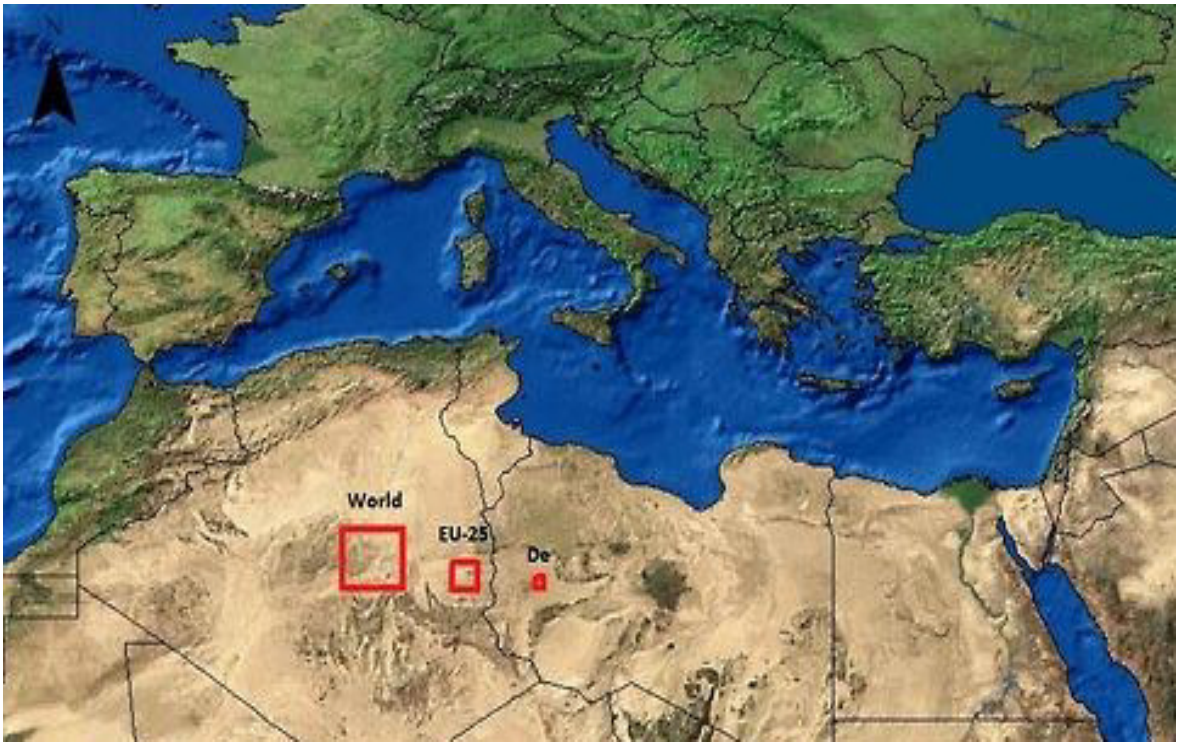

Fig. 8 The DESERTEC concept is based on the realization that a little part of the Sahara desert area could feed energy for Europe and the rest of the world

The project has also been considered as a new colonialism for being too much concentrate on the export of energy from the producing countries. It is surely a top-down process of change that probably will need a long time to be realized, but it well represents the case of adopting technology to drive evolutionary urban processes towards sustainability consumption of resources.
Although its limits, also due to the presence of important exponents of the world finance, the DESERTEC could represent an attempt to drive the inevitable change that we have to impose on our current lifestyle in terms of consumption of resources (La Rocca 2011). On the contrary, the SNWDP project represents an example of using technologies to realize mega-projects that could create deep differences of development within the same country. The negative effects that can affect the natural ecosystems and the contiguous regions will generate entropy and energy wasting. In this sense, it is possible to state that urban smartness, at the urban scale as well as at large scale, strongly depends on the use of technology.

6 CONCLUSION

The focus on the urban smartness (Fistola 2013) and the study about the relationship between urban smartness and the proper use of energy inside the city have mainly to deal with the concept of urban entropy. This new way to analyze the trend of the city seems to allow an alternative way to envisage the right or the wrong way to use technology for the evolution of the urban system.

Surely, technology speeds up the development process and permit the realization of mega-projects, but its use (proper or improper) can strongly affect the urban and territorial development in terms of livability and subsistence. As the paper tries to state, it is important to underline that in a condition of poor resources it is no possible to take the wrong way (of the bifurcation), because this way produces a very high increase in entropy and drives towards the heat death of the urban system.

The two examples considered show how everything seems to be achived by using technologies. The case of the Chinese project seems to lack a global vision regarding the effects that the mega-project could have on the economic and social development of the southern regions. The project target is so much concentrated on the necessity of assuring water to the capital region that it does not take in any account the negative effects this change could generate.

On the other hand, the DESERTEC shows how it is possible to optimize the use of the resources to get energy and how technology can be used also to soothe political conflicts among different countries involved. This could have a positive effect on the production of entropy inside the evolution process of territory.

The WET theory, which is at the first stage of its development, could be useful to point out, from a different point of view, the relationships between water, energy, technology and the urban system considering the technology as a key factor for the sustainable evolution of the city.

NOTES

Although the paper grounds on a common research work, paragraphs 1, 2, 3 has been written by R. Fistola and paragraphs 4, 5 by R.A. La Rocca. Conclusions are the result of joint reflection.

REFERENCES

Boncinelli E. (2006), L'anima della tecnica, Rizzoli, Milano.

Chertow M.R. (2001), "The IPAT equation and its variants", in Journal of Industrial Ecology, 4 (4):13-29.

Commoner B. (1972), The closing circle, Alfred A. Knopf - Garzanti Editore.

DESERTEC Foundation, Principles, Criteria and Indicators for the Evaluation of Renewable Energy Power Plants - Version 1.0, www.desertec.org

Fistola R. (2013), "Smart City, riflessioni sull'intelligenza urbana", in TeMA Journal of Land Use Mobility and Environment, 1/13 (www.tema.unina.it).

Fistola R. (2012), "Urban entropy vs sustainability: a new town planning perspective", in Pacetti M., Passerini G., Brebbia C. & Latini G., The Sustainable City VII. Urban regeneration and sustainability, WIT Transactions on Ecology and the Environment, Series Volume 155, WIT Press.

Fistola R. (2010), Ecourbanistica: toward a new sustainable town planning, in Brebbia C., Hernandez S., Tiezzi E., (eds.), The Sustainable City VI. Urban regeneration and sustainability, WIT Transactions on Ecology and the Environment, Series Volume: 129, WIT Press.

Fistola R. (2001), M.E-tropolis- funzioni innovazioni trasformazioni della città, Giannini, Napoli.

Fistola R., La Rocca R. A. (2013), "Smart City Planning: a systemic aproach", in proceedings of: The 6th Knowledge City World Summit, Istanbul, September 2013.

Fistola, R., La Rocca R.A. (2001), "The virtualization of urban functions", in: NETCOM n.15: "Geocyberspace: building territories in geographical space on the 21st century", settembre 2001.

Fistola R. (1992), La città come sistema, (Volume II, Chapter 2). Per il XXI secolo una enciclopedia. Città cablata e nuova architettura, eds. C. Beguinot and U. Cardarelli, Università degli Studi di Napoli "Federico II" (Di.Pi.S.T.), Consiglio Nazionale delle Ricerche (I.Pi.Ge.T.), Napoli, 1992.

Gibson J. E. (1997), Designing the new city: a systemic approach, John Wiley, London and New York.

Moore S., 2013, China's Massive Water Problem, New York Times, march 2013.

Ortega y Gasset J, (1933), "Man, as project", in Reading For Philosophical Inquiry: Article Series.

Papa R. (1992), La città funzionale, in C. Beguinot, U. Cardarelli (a cura di), 1992, Per il XXI secolo una enciclopedia. Città cablata e nuova architettura, Università degli Studi di Napoli "Federico II" (Di.Pi.S.T.), Consiglio Nazionale delle Ricerche (I.Pi.Ge.T.), Napoli, vol. II, cap. 2.

Pulselli R.M. e Tiezzi, E. (2008), Città fuori dal caos. La sostenibilità dei sistemi urbani, Donzelli Editore, Firenze 2008.

Regulsky J. (1983), La pianificazione della città un approccio sistemico, Officina Edizioni, Roma.

Rifkin J. (1972), Entropy: Into the Greenhouse World , Bentam, Rev Rei edition.

Sachs, J. D. (2008), Common Wealth Economics for a Crowded Planet, Penguin Press, New York, USA.

TREC Development Group, Trans-Mediterranean Renewable Energy Cooperation "TREC" for development, climate stabilisation and good neighbourhood, www-desertec.org

von Bertalanffy L. (1972), General System Theory, Penguin Books, Harmondsworth.

Zickfeld F., Wieland A. (2012) Desert Power, Dii GmbH, Munich.

http://www.desertec.org

http://www.internationalrivers.org/

http://www.tunur.tn/

www.dii-eumena.com

http://www.medgrid-psm.com/

IMAGES SOURCES

Image on first page: "Urban Entropy" by James Enos http://www.wearethefrontier.com; Fig. 1-2-3 are from the authors; fig. 4-5 are from http://www.internationalrivers.org; fig. 6-7 are from http://www.desertec.org.

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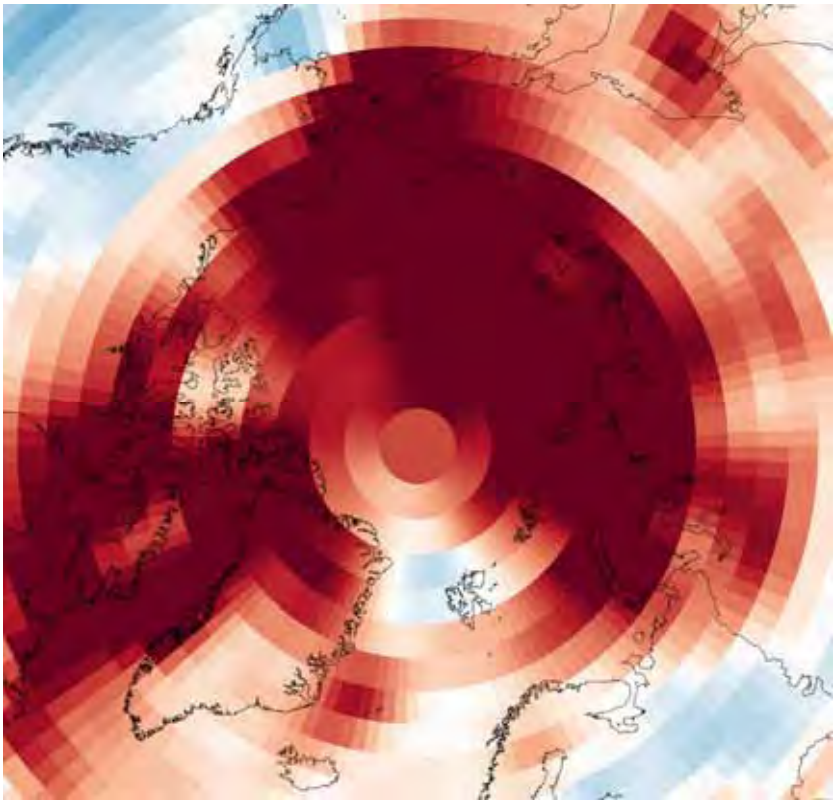

CLIMATE CHANGE ADAPTATION

CHALLENGES AND OPPORTUNITIES FOR SMART URBAN GROWTH

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ABSTRACT

Climate change is one of the main environmental issues challenging cities in the 21th century. At present, more than half of the world population lives in cities and the latter are responsible for 60% to 80% of global energy consumption and greenhouse gas (GHG) emissions, which are the main causes of the change in climate conditions. In the meantime, they are seriously threatened by the heterogeneous climate-related phenomena, very often exacerbated by the features of the cities themselves.
In the last decade, international and European efforts have been mainly focused on mitigation rather than on adaptation strategies. Europe is one of the world leaders in global mitigation policies, while the issue of adaptation has gained growing importance in the last years. As underlined by the EU Strategy on adaptation to climate change, even though climate change mitigation still remains a priority for the global community, large room has to be devoted to adaptation measures, in order to effectively face the unavoidable impacts and related economic, environmental and social costs of climate change (EC, 2013). Thus, measures for adaptation to climate change are receiving an increasing financial support and a growing number of European countries are implementing national and urban adaptation strategies to deal with the actual and potential climate change impacts.
According to the above considerations, this paper explores strengths and weaknesses of current adaptation strategies in European cities. First the main suggestions of the European Community to improve urban adaptation to climate change are examined; then, some recent Adaptation Plans are analyzed, in order to highlight challenges and opportunities arising from the adaptation processes at urban level and to explore the potential of Adaptation Plans to promote a smart growth in the European cities.

KEYWORDS:
Climate Change, Urban Adaptation, Smart Growth

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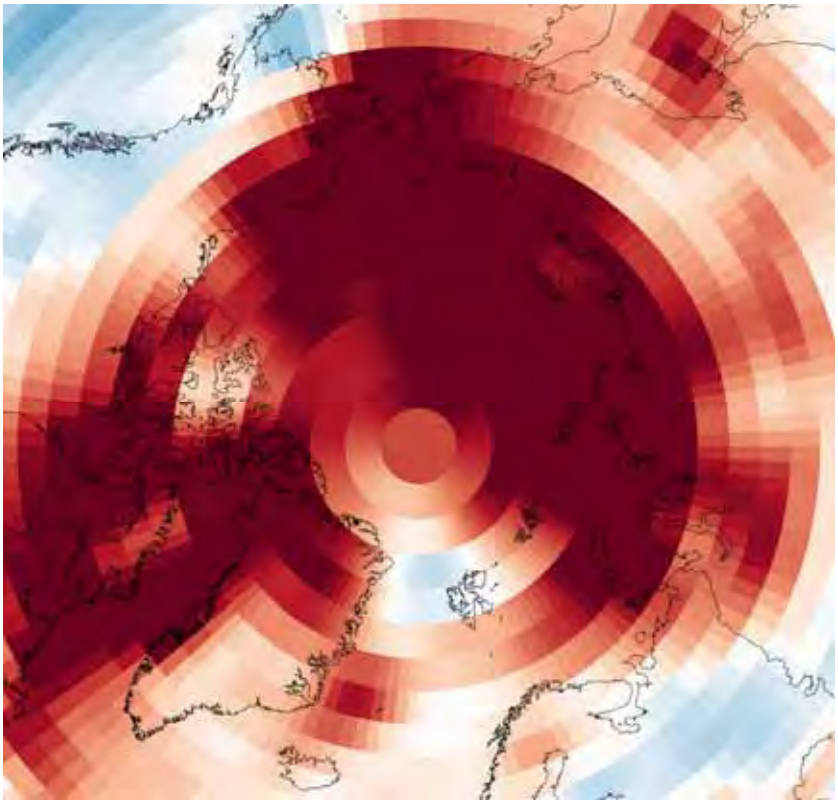

气候变化适应

智能城市增长的挑战和机遇

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摘要

气化变化是城市在二十一世纪所面临的主要环境问题之一。欧洲城市容纳了该地区人口的四分之三，并占用了总体能源消耗和温室气体（GHG）排放的60%至80%，这是造成气化条件变化的主要原因。与此同时，欧洲城市受到各类与气候相关的现象的严重威胁，而这些与气候相关的现象常常因这些城市的自身功能而更加恶化。

在过去十年中，国际和欧洲一直将工作重点放在缓解战略而非适应战略上。欧洲是倡导全球缓解政策的先导之一，而与此同时适应性问题的重要性在过去几年中也有所提升。尽管气化变化缓解战略仍然在全球范围内保持优先地位，但随着针对气候变化适应的欧盟战略得到强化，为有效应对气候变化所带来的不可避免的影响和相关的经济、环境及社会成本，必须为适应措施的应用提供更大空间（EC，2013）。因此，有关气候变化的适应措施正在得到越来越多财政上的支持，并且越来越多的欧洲国家正逐步实施国家和城市适应战略，来应对当前和潜在的气候变化影响。

依上述考虑因素，本文探讨了目前在欧洲城市中实施的适应战略的优势和劣势。首先要审查关于提高城市对气候变化适应能力的主要欧共体建议；然后分析一些最新的适应方案，其目的是突显出在城市层面的适应过程中所生产的挑战和机遇，并探讨适应方案对于在欧洲城市中促成智能增长的潜在能力。

关键词
气候变化；城市适应；智能增长

1 CITIES DEALING WITH CLIMATE CHANGE IMPACTS

Climate change and the growth of urban population are widely recognized as the major drivers of change in the 21st century.

Climate change, which represents one of the most challenging issues of our time, refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007). According to IPCC, it is largely due to greenhouse gas (GHG) emissions. Carbon dioxide (CO_2) is the most important anthropogenic GHG and recent data confirm that consumption of fossil fuels accounts for the majority of global anthropogenic GHG emissions (IPCC, 2011).

At present, more than half of the world population lives in cities and it will further increase by 2050. In Europe, the 73% of the population was living in urban areas in 2011 and the level of urbanization is expected to be at 82% by 2050 (UN, 2012) (fig. 1).

Hence, as the cities are responsible for 60% to 80% of global energy consumption and GHG emissions, it is clear that the two phenomena are largely interconnected and that the ways in which climate change and urban population trends will develop and interact "will be of great consequence to the well-being of human populations as the century proceeds" (Klein, Schipper, Dessai, 2003). According to the last report of the IPCC (2013), indeed, the "continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions".

Thus, cities play a key role in face of climate change and climate related phenomena. On the one hand, urban lifestyle and economy are largely responsible for global energy consumption and contribute for about the 70% to the GHG emissions (Birkmann et al. 2010; EU, 2011). On the other hand, cities are seriously threatened by the impacts of climate change, requiring serious and effective strategies addressed to reduce their exposure and vulnerability to climate-related phenomena and, consequently, to prevent the potential damage to urban population.

Up to now, major efforts have been addressed to promote mitigation strategies, aimed at reducing GHG emissions, while less attention has been devoted to adaptation strategies, aimed at improving cities' capability to deal with the impacts of climate change. In Europe, one of the world leaders in global mitigation policies, ambitious energy and climate change objectives have been established in 2007 by the EU 20-20-20 Strategy. In 2011, the 2050 Energy Roadmap set new long-term targets, addressed to achieve the 80-95% reduction of GHG emissions by 2050 (compared to 1990) (Egenhofer, Alessi, 2013).

The issue of adaptation is gaining importance only recently: the EU Strategy on adaptation to climate change, adopted in 2013, clearly underlines that "although climate change mitigation must remain a priority for the global community (…), we (…) have no choice but to take adaptation measures to deal with the unavoidable climate impacts and their economic, environmental and social costs" (EC, 2013). Thus, the measures for adaptation to climate change are receiving an increasing financial support and a growing number of European countries are implementing national and urban adaptation strategies to deal with actual and potential climate change impacts (Birkmann, 2011). The focus on adaptation stems from the growing and shared awareness that, despite the efforts to reduce GHG emissions, climate change is going to occur (Solomon et al., 2007) and its impacts will be particularly severe in urban areas (ICLEI, 2011), due to the concentration of people and assets.

In Europe, the changes in climate conditions are already affecting numerous countries and are going to spread on all European countries. Nevertheless, according to the results of the ESPON 2013 Programme, climate stimuli are heterogeneous in nature and typology and not uniformly distributed in the European regions.

Hence, in order to understand the impacts of climate change on European cities, both the heterogeneous distribution of climatic stimuli in the European regions and the role of urban features in modifying regional climate conditions have to be taken into account.

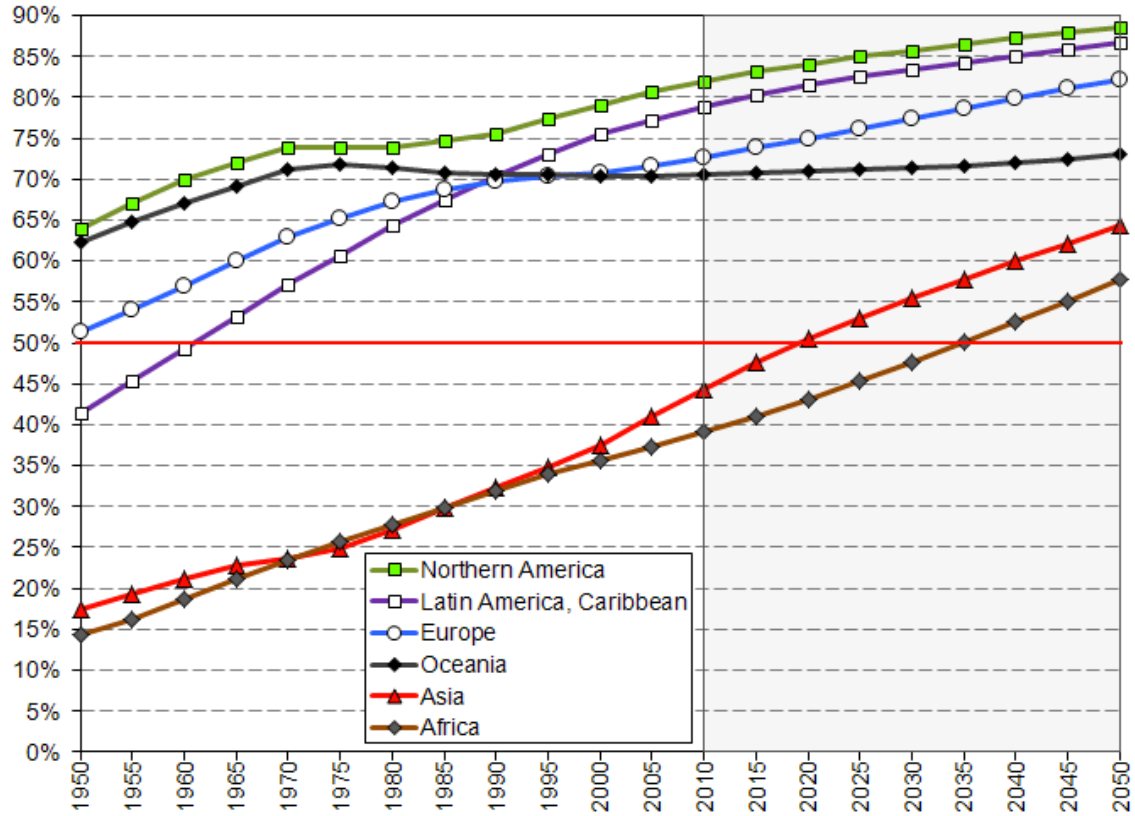

Fig. 2 Urban Population by major geographical areas (% on total population)

Numerous scholars have pointed out the key role of local factors in modifying climate change impacts on urban areas (McCarthy et al., 2010; Nguyen Xuan, 2011), even though up to now the features of urbanized areas have received little attention in climate model projections (IPCC, 2007).

Nevertheless, it is largely recognized that cities may experience different impacts in respect to surrounding regions, due to heterogeneous factors: for example, a high degree of surface sealing may impair rainwater drainage, reinforcing the urban heat island effect (Magee et al., 1999; Müller, 2012; Lehmann et al. 2012); the prevalence of built-up areas on natural spaces creates a peculiar microclimate in cities, which may affect air temperature, wind direction and precipitation patterns. Moreover, the growing concentration and the ageing of urban population may exacerbate exposure and vulnerability of cities to climate-related phenomena. Finally, since cities are strongly dependent on their hinterland, namely for food and water supply, they are also significantly vulnerable to climate change impacts occurring in the surrounding areas (Hunt and Watkiss, 2011; McEvoy et al., 2010).

Thus, due to the variability of climate phenomena in the European regions and to the peculiar features of cities, impacts may be very heterogeneous, ranging from floods to droughts, from cold snaps to heat waves, with serious consequences for human health, livelihood and urban assets. Cities in low-elevation coastal zones have also to deal with the combined threat of sea-level rise and storm surges.

Although detailed quantitative analyses of climate-related hazards on a city scale are still at an early stage, in the last decade, numerous scholars and institutional documents have focused on the potential impacts of climate change on cities. Thus, referring to the existing studies for a detailed description of the main impacts of climate change on European cities (McEvoy, 2007; Wilby, 2007; Hunt and Watkiss, 2009; EEA, 2012), it is worth mentioning here only the most common ones.

Heat waves

Climate-change projections suggest that the length, the frequency and the intensity of summer heat waves will increase in the next future, affecting different European Regions, with significant effects on human health, mainly on vulnerable population (elderly, people affected by chronic respiratory diseases, etc.) (Schär et al., 2004; Meehl and Tebaldi, 2004; D'Ippoliti et al., 2010). The phenomenon can be worsened by the

features of cities themselves: the lack of blue and green areas, the population density, the additional heat production due to the concentration of human activities may aggravate the phenomenon in the cities located both in the South and in the North of Europe.

Sea-level rise

Sea-level rise is one of the most certain elements of climate change and probably the most studied impact of climate change on coastal cities (Hunt and Watkiss, 2009). Many European cities are close to coastal areas and will be highly vulnerable to rising sea levels and associated increases in extreme events such as storm surges. A rise of 20 centimeters (possible by the year 2030) could threaten the coastal settlements, wetlands, and lowlands. The entire Dutch coast, Hamburg, Copenhagen, and Venice could be affected. Raising dams could be very expensive for individual countries and regions. Moreover, sewage treatment in coastal cities is geared to a certain range of water levels and the rising sea levels may contribute to make this infrastructure obsolete.

Flooding

Many scholars agree that climate change will affect precipitation pattern worldwide, with serious impacts on cities. Nevertheless, there is still a great deal of uncertainty in findings about climate-change impacts on future extreme precipitation and considerable differences among estimates of precipitation in different climate models and for different emission scenarios. Floods have caused the greatest economic losses in Europe in the last years (EEA, 2012). Flooding phenomena result from the interaction of rainfall, surface run-off, evaporation, wind, sea level, and local topography: hence, due to the changes in climate conditions, they can be significantly increased in cities. Most European cities are already committed to address flood risk issues, even though the types of flooding they have to face are heterogeneous, from flash floods to urban drainage floods or to coastal floods, occurring during storm surges when there are temporary increases in sea levels above the normal tidal range (EEA, 2008).

Water scarcity and droughts

Water availability is crucial for urban development: “fresh water is used for drinking,by industry (production processes and cooling), energy production, recreation, transport and nature. Sufficient water of good quality is therefore indispensable to ensure human health and to fuel the economy” (EEA, 2012).

Water is a crucial issue for Europe. In 2007, the European Commission adopted a Communication on Water Scarcity & Drought (WS&D) (EC, 2007), which identified seven policy areas that had to be addressed in order to move Europe towards a water-efficient economy. In 2012, “A Blueprint to Safeguard Europe's Water Resources”, addressed “to tackle the obstacles which hamper action to safeguard Europe's water resources and based on an extensive evaluation of the existing policy” (EC, 2012) has been issued.

At present, water scarcity and droughts represent a threat not only to the drier areas in Europe, although dry conditions reduce water availability for drinking and sanitary purposes, but also for central and eastern European regions. Moreover, water resources might further decrease in Europe due to the “increasing imbalance between water demand and water availability” and climate change may reduce the availability and reliability of the water supply and exacerbate the adverse impacts, “with the occurrence of more frequent and severe droughts in many parts of Europe” (EEA, 2012).

Thus, climate-related hazards, combined with the high vulnerability of cities to extreme meteorological events, will induce an increase in the frequency and in the consequences of the existing risk levels and, consequently, in the damage costs, as largely demonstrated by the heat waves that affected numerous cities in Central and Western Europe (2003) and in Eastern Europe (2010) or by the urban drainage flood in Copenhagen (2011).

The pivotal role of cities in addressing climate change has been largely recognized in the last decade (Betsill, Bulkeley, 2007; Bulkeley et al. 2011). Nevertheless, while numerous European cities have joined the Covenant of Majors, giving rise to a mitigation strategy, few of them have started an adaptation process addressed to establish local strategies - closely related to the existing disaster risk reduction and to land use

planning strategies - for enhancing urban resilience in face of "the unavoidable climate impacts and their economic, environmental and social costs" (EC, 2013).

Based on these premises, this paper explores the potential of Adaptation Plans to promote a smart growth in the European cities, translating the challenge of climate change into a chance for a better urban development (Birkmann et al, 2010). The term "smart" is referred, on the one hand, to the principles established by the Smart Growth Network[1] and addressed to the development of sustainable communities and places that are attractive, convenient, safe, and healthy (ICMA, EPA, 2006; Inam, 2011). On the other hand, it refers to the current debate on "smart cities", meant as cities where investment in human and social capital and in communications infrastructure actively promote the overall urban performances and, above all, the quality of life of citizens and the management of natural resources (Caragliu, Del Bo, Nijkamp, 2009; Papa, Gargiulo, Galderisi, 2013).

Hence, being sustainable development one of the most urgent challenges that smart cities have to deal with (Schaffers et al. 2011), by optimizing energy and water usage and by offering safer cities, climate adaption plans, through an effective use of ICTs, could largely contribute to make European cities safer and, above all, to effectively integrate environmental issues (from energy saving to risk prevention and mitigation) into sustainable land use planning processes, capable of enhancing the quality of life and prosperity for current and future generations as well as to protect and improve the quality of urban environment.

2 EUROPEAN STRATEGIES IN FACE OF CLIMATE CHANGE: FROM MITIGATION TO ADAPTATION

Europe has been defined as one of the world leaders in the global mitigation policies, whereas only recently the focus of European policies has been shifted towards adaptation issues. As remarked by the EU Strategy on adaptation to climate change, although three quarters of the population of Europe live in urban areas, European cities "are often ill-equipped for adaptation" (EC, 2013).

Mitigation and adaptation strategies, although complementary, differ both in their objectives and in their temporal and spatial scales of references. Mitigation strategies, which aim at reducing GHG emissions, generally result from international agreements, although implemented at national or local levels, and refer to a long-term perspective. Adaptation strategies, which aim at adjusting natural or human systems in response to actual or expected climatic stimuli or their effects (UNISDR, 2009), are strongly characterized as site-specific measures. Moreover, as they generally refer to the scale of the impacted system, they are defined and implemented at local level - although sometimes based on wider common platforms at national or upper level - and provide local benefits (Bulkeley et al. 2009; Walsh, 2010; EEA, 2012).

Focusing on mitigation issues, it is worth mentioning that the two milestones of the European path for reducing GHG emissions can be identified in the "20-20-20" Strategy and in the "Roadmap for moving to a competitive low carbon economy in 2050" (Galderisi, Ferrara, 2012; Gargiulo, Pinto Zucaro, 2012). The first one, adopted in 2007 by the European Council, established ambitious energy and climate change objectives, consisting of three key objectives to be achieved by 2020:

- a 20% reduction in EU GHG emissions from 1990 levels;
- an increase in the share of renewable energy up to 20%
- an improvement of 20% in energy efficiency.

Currently, the EU is on track to meet the first target, good results have been recorded in respect to the second one, but the third one is still far from being achieved.

1 The Smart Growth Network is a partnership of government, business and civic organizations that support smart growth. It has been created in the late Nineties and, based on the experience of communities that have used smart growth approaches to create and maintain livable neighborhoods, has developed a set of ten basic principles (http://www.epa.gov/smartgrowth/about_sg.htm).

The Roadmap 2050, issued in February 2011, has established new targets, related to a long-term scenario and addressed to reduce GHG emissions by 80-95% by 2050 compared to 1990.

Moreover, the EU has started numerous initiatives addressed to improve knowledge and awareness in respect to adaptation issues. The numerous reports published since 2007 by the European Environment Agency (EEA) on adaptation to climate change, the White Paper "Adapting to climate change: Towards a European framework for action", issued in 2009, the web-based European Climate Adaptation Platform (Climate-ADAPT), launched by the EU and the EEA in 2012 and the related EU Cities Adapt Project - addressed to support European cities in developing and implementing a climate change adaptation strategy by exchanging knowledge and good practices, and by developing tools and guidelines - the EU projects on climate adaptation (e.g. BaltCICA, 2009-2012; RAMSES, 2012-2017) show the growing attention to climate adaptation and, mainly, the growing awareness of the need to enhance cities' resilience in face of climate related risks. Furthermore, on the 16th of April 2013, the EU Strategy on adaptation to climate change, addressed to enhance preparedness and capacity to respond to the impacts of climate change at different levels, from the European one up to the local level, was issued (EC, 2013).

The strategy promotes coordination and information-sharing among the Member States, also through a further development of the European climate adaptation platform (Climate-ADAPT); encourages the State Members to adopt adaptation strategies, providing funds for improving national adaptation capacities; supports adaptation in cities by launching a voluntary commitment based on the Covenant of Mayors initiative; guarantees that adaptation issues are considered in different sectors of EU policies. The Strategy represents a key step towards the adoption and the implementation of effective adaptation strategies at different levels, since in Europe, "adaptation is in most cases still at an early stage, with relatively few concrete measures on the ground. Some Member States have developed sector-specific plans, such as plans to cope with heat waves and droughts, but only a third carried out a comprehensive vulnerability assessment to underpin policy" (EC, 2013).

At present, referring to the national level, it is worth noting that more than half of the European Member States have adopted an adaptation strategy, in many cases followed by action plans.

Shifting to the city level, which represents the focus of this study, although cities are considered as pivotal both to mitigation and adaptation issues, the European cities that have drawn up an adaptation plan are still few and mainly located in North-Central Europe (UK, Finland and Germany). A recent study highlights that, on a sample of 200 large and medium sized cities located in 11 European countries, the "35 % of European cities studied have no dedicated mitigation plan and 72 % have no adaptation plan. No city has an adaptation plan without a mitigation plan. One quarter of the cities has both an adaptation and a mitigation plan and set quantitative GHG reduction targets, but those vary extensively in scope and ambition" (Reckien et al., 2013).

The obstacles to an effective climate change adaptation at city level are numerous and heterogeneous (Adger et al., 2009; Bulkeley et al. 2009; Corfee-Morlot et al. 2011). First of all, it is worth underlining that adaptation has to be conceived not as a one-time effort but as a process articulated in different interrelated phases (fig. 4) (Hennessy et al., 2007; The World Bank Group, 2011, UN, 2013): a knowledge phase, addressed to assessing climate impacts and risks at urban scale; a preparation phase, addressed to define strategies and measures for adaptation; a response and revision phase, addressed to implement, monitor and update the defined measures. In the knowledge phase, the main difficulties are related both to the downscaling of climate change models to urban scale and to the assessment of urban vulnerability to climate-related phenomena. Scientific information about the future climate conditions is generally characterized by high uncertainty.

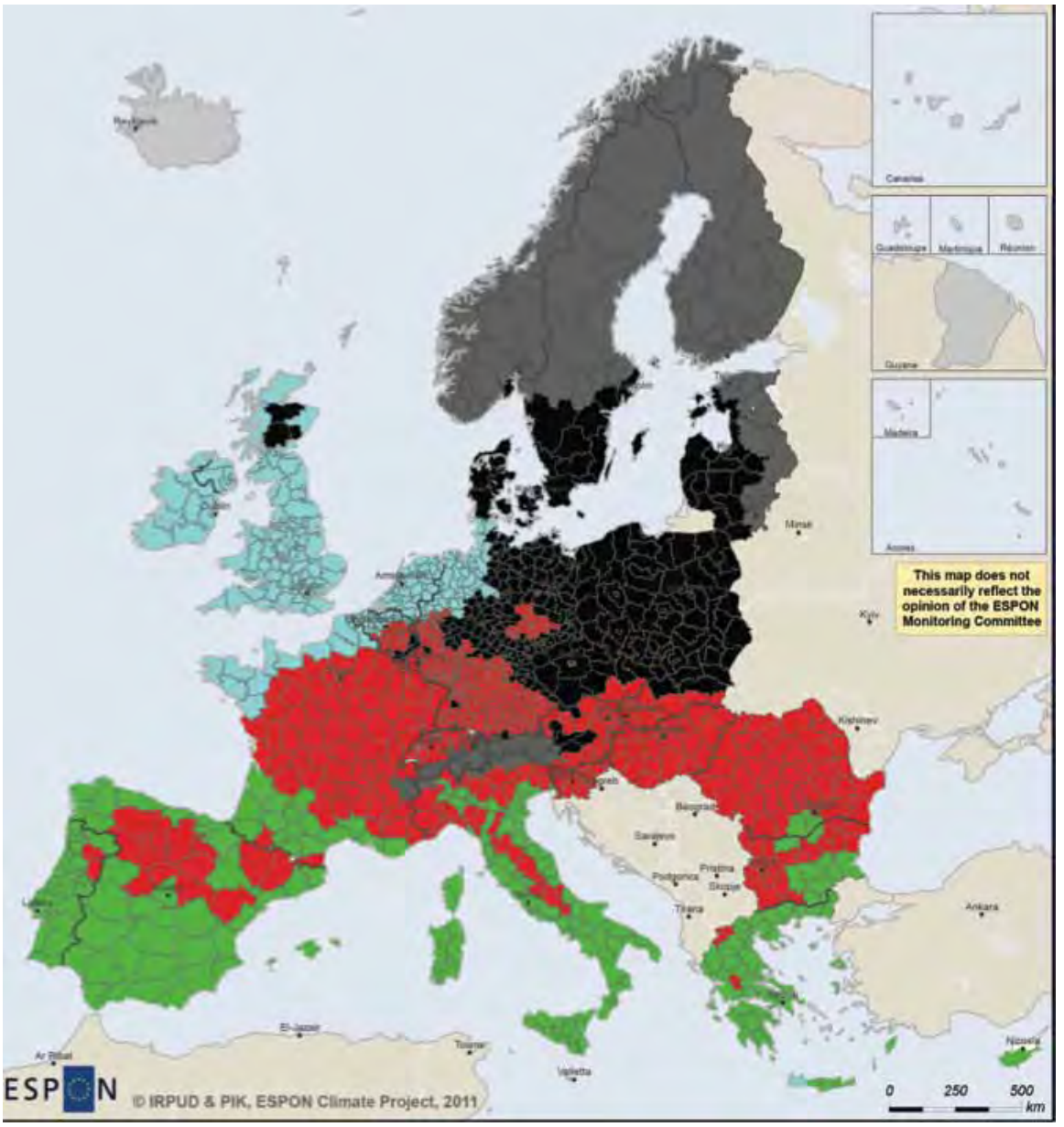

Fig. 3 European Climate Change Regions

The uncertainties that characterize large/regional scales climate models are generally exacerbated when these models are downscaled at city scale, which is the crucial step for identifying the city-specific impacts and, consequently, to identify vulnerabilities. Furthermore, on a city level, the climate impact assessment should take into account both the gradual/long term climate-related impacts (increases in the mean temperature or sea level rise) and the sudden shocks due to the changes in the intensity and frequency of extreme events (Wilbanks et al., 2007; Corfee-Morlot et al, 2011; Hunt and Watkiss, 2011).

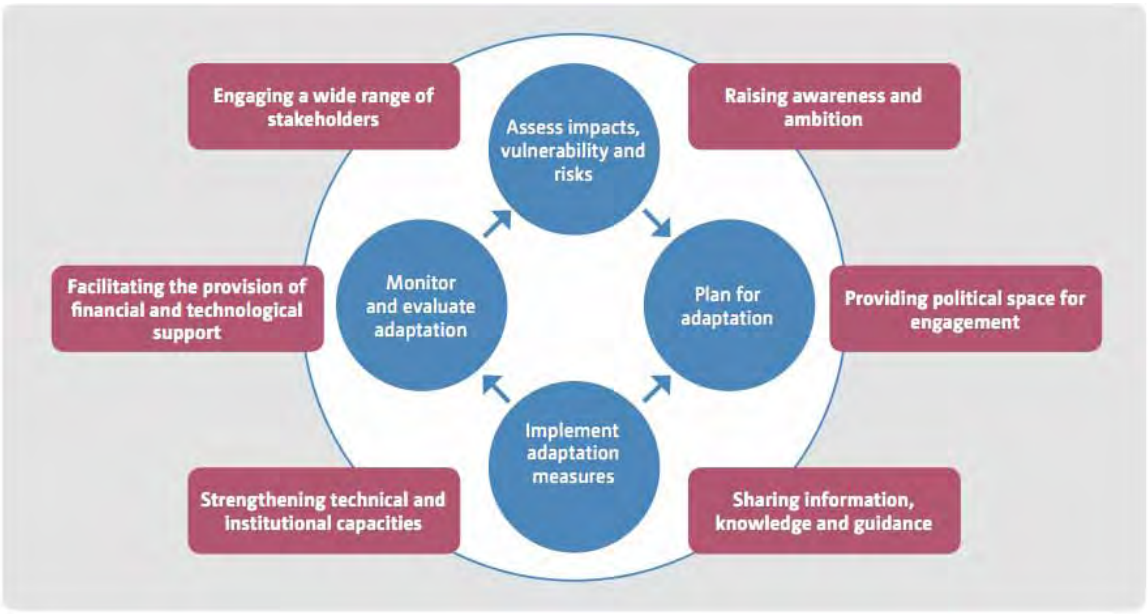

Fig. 4 (a, b, c) Examples of Adaptation Processes

Further difficulties in the knowledge phase arise from the assessment of urban vulnerabilities to the heterogeneous impacts of climate change. The assessment of the multi-dimensional concept of vulnerability shows difficulties and uncertainties largely debated in the field of natural hazards and related, for example, to the need for taking into account the different facets of vulnerability (physical on built and natural environment, systemic, economic, etc.) as well as the adaptive capacities of an urban context (Birkmann, 2006; Galderisi et al., 2008; UNISDR, 2009; Menoni et al. 2011). The different temporal perspectives of climate change impacts, combined with the uncertainties that affect long-term urban development trajectories, make even more difficult the assessment of urban vulnerability to the climate-related phenomena.

The uncertainties that characterize the knowledge phase have also repercussions on the preparation phase, addressed to single out effective adaptation strategies. The availability of a reliable risk assessment is crucial, in fact, to identify priorities as well as the availability of in-depth and disaggregate information on the heterogeneous risk factors (hazards, exposure, vulnerabilities) is essential to outline appropriate adaptation strategies. Moreover, the heterogeneity of adaptation measures represent a significant difficulty in the preparation phase. Even though they can be grouped under some general categories – 'grey' measures, relying on technology and civil engineering projects; 'green' or nature-based measures and 'soft' measures addressed to alter human behavior (EEA, 2013) – urban adaptation measures have to be site-specific and tailored on the urban context. Thus, these measures have to be defined according to the peculiarities of local impacts and to the vulnerabilities arising from the physical, functional and socio-economic features of the considered city.

Moreover, climate change may affect different sectors (from land use to transportation, from water supply to energy). Hence, the need for coordination across different sectors and for broad partnerships including local communities, nonprofit organizations, academic institutions and the private sector has been largely emphasized as a potential barrier to an effective adaptation. Numerous scholars have pointed out, in fact, the importance and at the same time the difficulty in coordinating policies and measures across both local agencies and levels of government, as well as among institutions, private stakeholders and communities, (Bulkeley et al, 2009; Corfee-Morlot et al., 2011).

Finally, the need for integrating adaptation strategies, disaster risk reduction (DRR) policies and land use and transportation planning choices at local level has been also emphasized. According to Corfee-Morlot et al. (2009), adaptation strategies could be important for reducing "vulnerability to current and future hazards such as floods, water shortage or heat waves, even though "cities should also consider incremental or gradual changes in climate that affect government operations or community life in less immediate and visible ways than conventional disasters" (The World Bank Group, 2011). Moreover, Hallegatte et al. (2011) emphasize that "land use decisions and zoning may exacerbate or limit the vulnerability of urban dwellers and of infrastructures to the growing threat of climate change".

Obviously, an effective integration of adaptation policies into existing tools for risk reduction as well as for urban and transportation planning is a key challenge for cities, given the difficulties that they currently face in guaranteeing an integration of DRR policies into land use planning tools (Galderisi, Menoni, 2007).

Nevertheless, such integration could be a great opportunity for cities and communities, generally dealing with significant resource constraints, to access financial resources and to reduce potential conflicts between climate change issues and other local priorities. According to the Guidelines for Climate Change Adaptation in Cities provided by the World Bank, "cities that are able to integrate adaptation well with a broad spectrum of existing planning processes and goals - including priorities in disaster risk reduction, sustainable development, and poverty reduction - will be best positioned to thrive in this new era of climate change" (The World Bank Group, 2011).

The complexity and long-term horizon of climate change phenomena, of the evolution of cities as well as of the adaptation processes assign a key role to the revision phase, important for ensuring the effectiveness of the whole process.

The implementation of the adaptation measures have to be constantly monitored, evaluated and revised, according both to the updating of the available knowledge on climate change and climate-related phenomena and to the effectiveness of policies, programs and measures. Nevertheless, "monitoring and evaluation is proving to be particularly difficult, as indicators and monitoring methodologies have hardly been developed" (EC, 2013). Hence, the revision phase has an inherent complexity and is currently considered one of the weakest areas of adaptation process, due to the difficulties of monitoring heterogeneous measures (grey, green or soft ones), affecting different sectors, acting on different scales and over different time spans. Moreover, the common lack of financial, human and technical resources, of baseline data and historical trends as well as the insufficient sharing of information across different sectors have to be considered.

3 ADAPTION PLANS: TOOLS FOR SMART GROWTH?

This paragraph will be focused on three Adaptation Plans: the London Mayor's Climate Change Adaption Strategy "Managing Risks and Increasing Resilience, (2011); the Copenhagen Climate Adaptation Plan (2011); the Rotterdam Climate Adaption Strategy (2013).

The selected cities are defined as climate leader cities, being very active both on mitigation and adaptation issues: they belong to the C40-network of the world's cities engaged in mitigation actions (Reckien et al., 2013) and can count on adaptation strategies established on a national level.

Since the selected Plans have been approved very recently, we do not intend here to provide an assessment of their effectiveness. Based on the available on-line documents, we will try to point out and compare their main features and, so doing, we will seek to understand their potential for overcoming obstacles and barriers previously discussed and, above all, to answer the main research question posed by this paper: may adaptation plans contribute to the promotion of a smart growth in the European cities?
To this aim, in respect to each case-study, the capacity to integrate smart solutions in the different phases of the adaptation process as well as to improve the quality of life of the citizens, to preserve and enhance the quality of natural environment, to promote participatory processes - increasing the awareness of communities and decision-makers about the climate-related phenomena and consequent risks - to integrate adaptation policies into DRR and land use planning processes will be explored.

London

The Greater London, with a population of 8,173,941 (Census data, 2011), is the biggest city in the UK and the largest one in Europe. According to the UK legislation, in 2007, the responsibility for climate change mitigation, adaptation, and energy strategies have been transferred from central government to the Greater London Authority (GLA), which includes the Mayor and the Assembly.
The GLA has the duty to assess the consequences of climate change and to define adequate strategies. It has also extensive planning powers and is responsible for producing London-wide strategies for spatial planning and environment (the latter includes adaptation, mitigation and energy policies). Thus, according to the current legislation, the GLA has the opportunity to coordinate the actions of different partners and to guarantee that proposed actions are effectively implemented (Davoudi et al., 2011). Recently, the GLA has played a key role at both international and local level: it "has acted as a driving force at the international level, through putting its weight behind the C40 Climate Leadership Group and its association with the Clinton Climate Initiative"; moreover, at local level, it "has taken steps to address the various climate challenges" (Davoudi et al., 2011).
The milestones of the London strategy for addressing climate change issues can be identified in The Mayor's climate change mitigation and energy strategy, "Delivering London's Energy Future", and in The Mayor's Climate Change Adaption Strategy, "Managing Risks and Increasing Resilience", both of them issued in the October 2011. The former details the Mayor's strategic approach to reduce London's CO2 emissions by 60% of the 1990 levels by 2025 and to secure a low carbon energy supply for London. The latter, on which we will focus here, is addressed to evaluate the consequences of climate change on the city of London, to prepare the city for dealing with the impacts of climate change and extreme weather and, in the meanwhile, to protect and enhance the quality of life of citizens.
The London Strategy emphasizes that adaptation has to be shaped as a dynamic and flexible process, capable of dealing with the many uncertainties related to the future of climate and of city development. In fact, "measures that address the impacts of our climate today may not provide an acceptable level of protection in the future, or enable us to make the most of the opportunities that arise, and so new measures will be needed. There is, therefore, no steady-state of being adapted" (London Mayor's Climate Change Adaption Strategy, 2011). Moreover, the Strategy emphasizes that climate change adaptation
not require new policies or new planning tools but the capacity of understanding "how climate change may affect the world around us and then routinely integrating that understanding into our decision-making processes to make better choices" (The Mayor's Climate Change Adaption Strategy, 2011).
The London Strategy grounds on the UK Climate Projections 2009 (UKCP09), which updates the UK Climate Impacts Programme 2002 (UKCIP02), and provides probabilistic projections for a number of atmospheric variables (such as temperature, rainfall and humidity) according to different emission scenarios, temporal and geographic scales. It focuses on three main climate-related risks: flooding, drought and overheating. In respect to each risk, a wide range of actions and measures has been provided.

All the measures are organized into a framework stemming from the Emergency Planning: the Prevent-Prepare-Respond-Recover (P2R2) framework. The prevention measures aim at preventing the events through structural measures as well as through spatial planning.

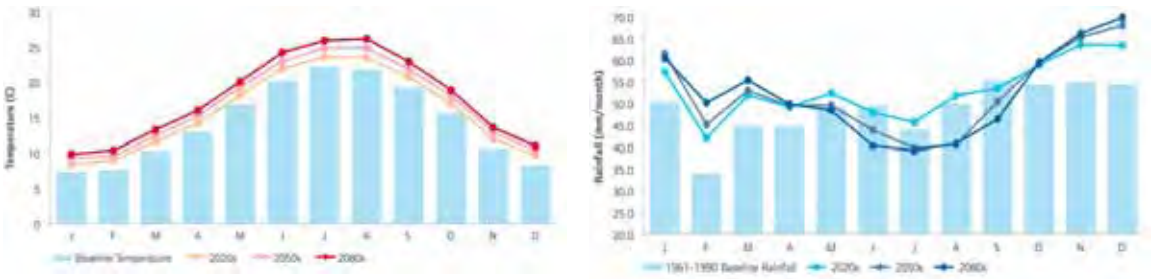

Figure 5 Average monthly maximum temperatures (°c) in London over the century, under a medium emissions scenario, compared to baseline period (left); Average monthly rainfall (mm of rainfall per month) in London over the century, under a medium emissions scenario, compared to baseline period (right)

The preparation measures are addressed to improve the preparedness of institutions, communities and individuals in face of the different risk factors through Risk Management Plans, Early Warning Systems, insurances mechanisms, etc.

The response measures aim at reducing the consequences of events through an effective emergency planning, while the recovery phase refers to post-event interventions and is addressed to guarantee a "rapid, cost-effective and sustainable return to normality" (Davoudi et al., 2011).

Grounding on the these premises, the Adaptation Strategy focuses on each risk, in order to assess current and future impacts, taking into account the probability of the hazardous events, their consequences, the exposed people and assets and their vulnerability.

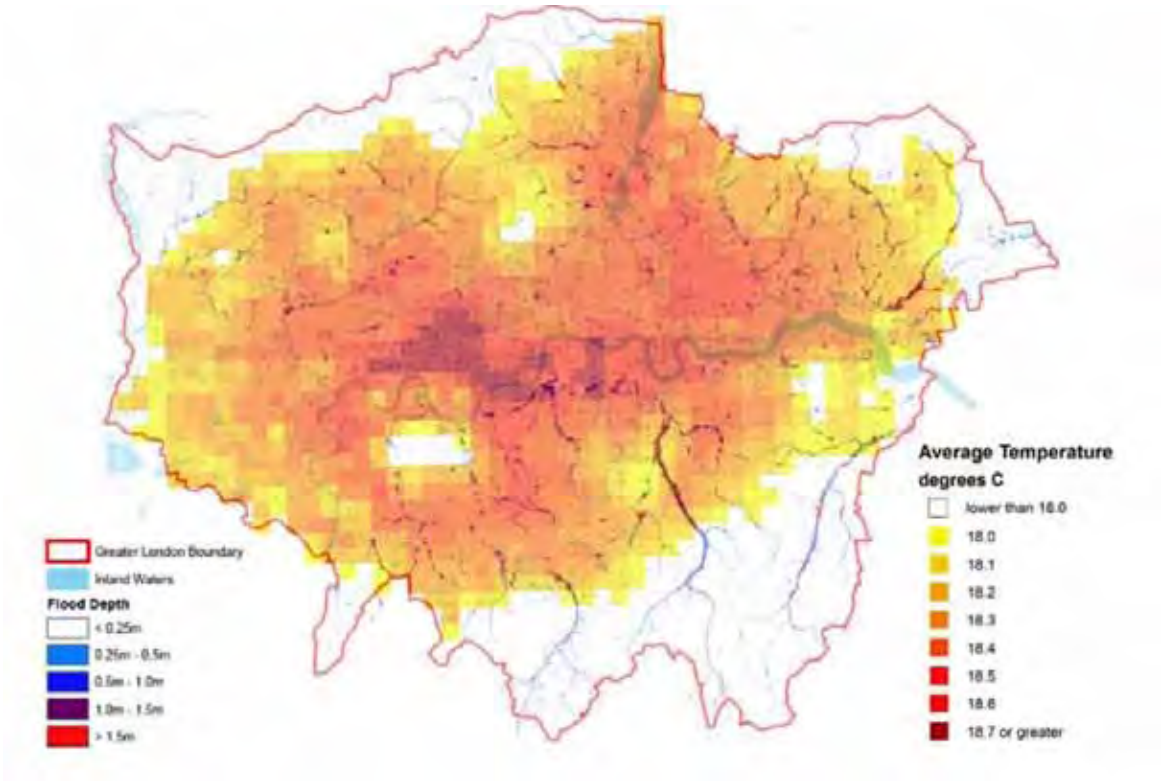

Fig. 6 The Combined Flood and Overheating Risk in London

For each risk, the Plan outlines the general vision and, according to it, the main policies and actions to be put in place. Then, the Plan focuses on the impacts of the different climate-related hazards on four key aspects - health, environment, economy and infrastructures - providing specific actions for each aspect.
Finally, in the last section, a roadmap to build up a resilient London in face of the different threats has been outlined: the Plan provides in fact a detailed list of the objectives to be achieved in the time span 2010-2013, specifying the related actions and the subjects in charge of their implementation.

Copenhagen

It is the capital city and the most populated city in Denmark, with a population of 559.440 in 2013 and more than one million inhabitants in the urban area. In the last years, the city of Copenhagen has devoted large attention to climate issues.
Copenhagen aims to be the first carbon neutral capital city in the world, with a reduction of city's CO_2 consumption from current level of around 2.5 million tonnes to 1.2 million tonnes in less than two decades.
To achieve such an ambitious goal, the city has adopted the CPH Climate Plan 2025, focused on energy consumption, energy production, mobility, and city administration: "wind farms, citywide efficient heating systems, energy efficiency, and the development of public transportation networks and bike routes are some of the initiatives in the works to bring Copenhagen closer to its carbon-neutral goal" (CPH Climate Plan 2025). Moreover, in 2009, the city started the adaptation process, with the draft of the City of Copenhagen Climate Plan. In 2011, in order to continue to be a safe and attractive city to live and spend time in, despite the expected changes in the future climate, Copenhagen has adopted its Climate Adaptation Plan. The local climate projections are based on the IPCC's reports as well as on the reports from the Danish Meteorological Institute (DMI) in connection with the climate strategy for the Capital Region, on the publications of the Water Pollution Committee of the Society of Danish Engineers and on the high-water statistics of the Danish Coastal Authority.
Nevertheless, uncertainties due both to climate projections as well as to urban development trajectories are largely emphasized. The Plan highlights that the "IPCC's projections for the development of climate are relatively certain for the next 30 to 40 years" and that "no one knows precisely how the world will develop technologically, in population terms, politically etc., or precisely how this will affect the climate, and whether this will be overlain by natural disasters etc." (Copenhagen Climate Adaptation Plan, 2011).
Therefore, the Plan provides a flexible strategy capable of meeting uncertainties, by incorporating new knowledge and technology as and when they emerge.

Fig. 7 The Copenhagen Climate Adaptation Process

Adaptation strategy identifies as primary challenges the impacts of heavier precipitations, sea-level rise and storm surges, while as secondary challenges focuses on the impacts of higher temperatures and consequent urban heat islands and on the indirect impacts affecting human health, biodiversity, air quality.

In respect to the primary challenges, the Plan includes a detailed risk analysis, outlining different risk scenarios according to the magnitude of the hazardous events, to different time spans and taking into account the potential effects of protecting measures.

Risk analysis provides a comparison among the potential damage, in monetary terms, of the different scenarios, according to the land use of the affected areas. Nevertheless, an in depth analysis of exposure and vulnerability to the different hazard factors is missing.

According to the different risk scenarios, the Plan outlines three different adaptation levels:

- level 1, aiming at reducing the likelihood of the event up to its complete prevention, includes structural measures as well as building regulations (e.g. dikes, building higher above sea level, etc.);
- level 2, aiming at reducing the impacts of the event, includes for example warning systems for rain, adaptation of public spaces in order to store rainwater etc.;
- level 3, aiming at reducing the consequences of the event, includes for example measures addressed to improve emergency preparedness.

Moreover, adaptation measures are structured in respect to different geographical scales, from the regional one up to the district, street and building levels.

Although the Plan is primarily concerned with the safeguard of the city and its inhabitants against climate change impacts, it is firstly intended as an opportunity to promote urban development so that Copenhagen may continue to be one of the world's best cities to live in (Copenhagen Climate Adaptation Plan, 2011).

Fig. 8 The Hazard Scenarios: Floods In A 100-Year Rain Event In 2110

Thus, the Plan outlines a wide range of measures and projects, all of them clearly framed into the proposed vision for future development: the "Greener Copenhagen". Such a vision contributes to strengthen a tradition started in the late 1940s, with the "Copenhagen Finger Plan", which has shaped urban development on a regional scale, by limiting built-up areas to linear corridors starting from the central core and separated by green areas.

	Level 1	Level 2	Level 3
Measure Geography	Reduce probability	Reduce scale	Reduce vulnerability
Region	Establishment of dikes	Establishment of warning system for high waters	Protection of vulnerable infrastructure, metro, S-trains, tunnels
Municipality	Establishment of dikes	Planning, warning	Planning, preparedness
District	Raised building elevation, dikes	Preparedness, sandbags etc.	Moving of vulnerable functions and installations
Street	Raised building elevation, dikes	Preparedness, sandbags etc.	Moving of vulnerable functions and installations
Building	Raised building elevation	Backwater valves, sealed basements, preparedness, sandbags etc.	Moving of vulnerable functions and installations

Fig. 9 The Articulation by Levels and Geographical Scales of the Adaptation Measures

According to such a vision, the Adaptation Plan suggests measures addressed to:

- preserve and look after existing green spaces;
- provide the city with more green and blue spaces;
- create continuous green networks in the city.

Finally, it is worth noting that the Adaptation Plan pays large attention to integrate the climate adaptation measures into existing planning tools at local level as well as into existing tools for disaster risk reduction and emergency preparedness; it provides a detailed overview of costs and the time scheduling of all the foreseen measures and projects, although in respect to a short time span (2011-2015).

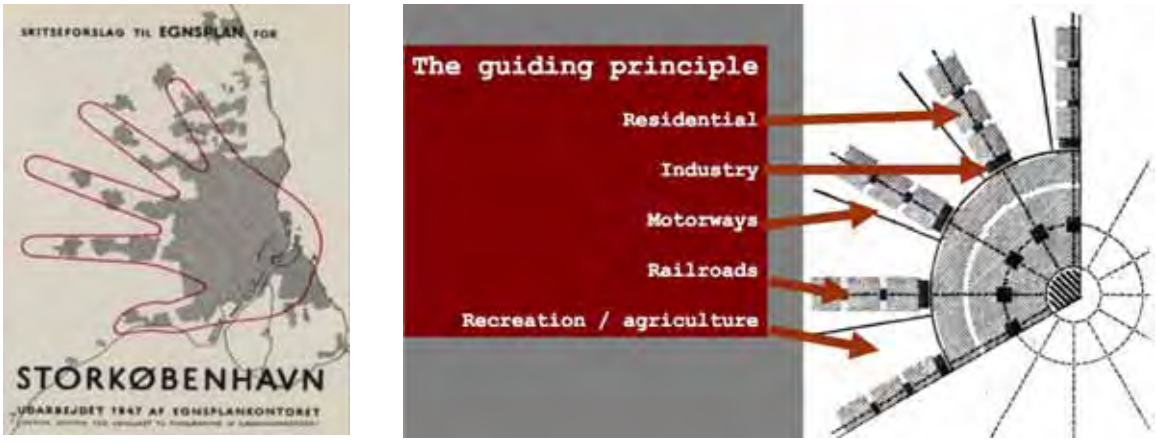

Fig. 10 The Copenhagen Finger Plan: Principles

Rotterdam

The city, with a population of approximately 600.000 inhabitants, is the second-largest city in the Netherlands and the biggest port city in Europe.

As Copenhagen, Rotterdam has outlined a comprehensive strategy to address climate change aimed, on the one hand, at reducing by 50% CO_2 emissions in 2025 in respect to the levels in 1990; on the other hand, to adapt to climate change effects, in order to guarantee a fully climate change resilient city by 2025. Rotterdam has always lived with the threat of water: “the dams, dikes and land reclamation have brought the dangers

and the risk of flooding under control (…). This has made Rotterdam, although still vulnerable, one of the safest delta-cities in the world" (Rotterdam Climate Adaption Strategy, 2013).

Nevertheless, in face of a changing climate and of a city that is still growing and continuously developing, the likelihood of casualties, losses and economic damage in case of flooding, might significantly increase.

Hence, the main goal of the Adaptation Strategy is to build up a climate-proof Rotterdam by 2025. To achieve such a goal, the city's strategy is addressed to develop smart solutions, capable of integrating technical innovation and urban development, technology and nature, large-scale and small-scale solutions. The Rotterdam strategy points out the need for increasing robustness of the complex system of storm surges barriers and dikes, canal and lakes, sewers and pumping stations, even though it clearly emphasizes that structural measures, although essential, are not sufficient for dealing with a changing climate. Hence, the need for solutions capable of involving all the aspects of urban development and, above all, of enhancing urban resilience is outlined.

The Adaptation Strategy grounds on the climate scenarios developed by the Royal Meteorological Institute of the Netherlands in 2006 and on the considerable knowledge developed within the Delta Programme, a national program issued in 2013 and addressed to protect the Netherlands from flooding and to secure a sufficient supply of freshwater for generations ahead.

Based on this knowledge, the Plan identifies the main climate-related phenomena affecting the city:

- higher sea and river levels;
- more intensive rainfall;
- longer period of droughts;
- heat waves.

For each phenomenon and in respect to different temporal spans, the Plan provides risk maps, singling out vulnerable areas and elements. Moreover, the main interactions among the different phenomena are taken into account. In face of the different risks, the Plan provides an articulated adaptation strategy, a framework to promote, favor and stimulate initiatives of different actors. The provided strategy combines, indeed, top-down and bottom up initiatives, as well as large-scale and small-scale solutions, ordinary actions of management and maintenance and new developments projects, general guidelines and detailed projects.

The adaptive measures are based on the risk features and the peculiarities of each urban area (outer and inner dike areas; compact city; port area, etc.) and range from the flood-proof buildings and public spaces to the floating communities, from the green roofs and facades to the green-blue corridors.

Moreover, in respect to each considered risk, the Plan provides a sample project, generally an on-going one, which represents a sort of "guide-project" for tackling the phenomenon at stake.

The Rotterdam Climate Adaptation Strategy devotes large attention to the development of smart solutions capable of increasing city's smartness. The integration of ICTs into an innovative and adaptive flood control system as well as tools for promoting community's involvement have been developed and tested.

"Smart gaming, a war room like 'demonstrator', decision support systems, application of sensor technology in dikes and many other tools will be developed and integrated into one system to make Rotterdam a smarter and safer city in the future" (Dircke, Molenaar, 2010). Among the smart solutions it is worth mentioning the "Interactive Climate Atlas", which is accessible to different stakeholders, provides general information about climate scenarios, vulnerable areas and buildings and allows the comparison among the consequences of various climate scenarios; the "Climate Adaptation Tool Box", a key tool for project managers, urban and building designers, which provides an overview of potential adaptation measures for different spatial scale-levels and objectives.

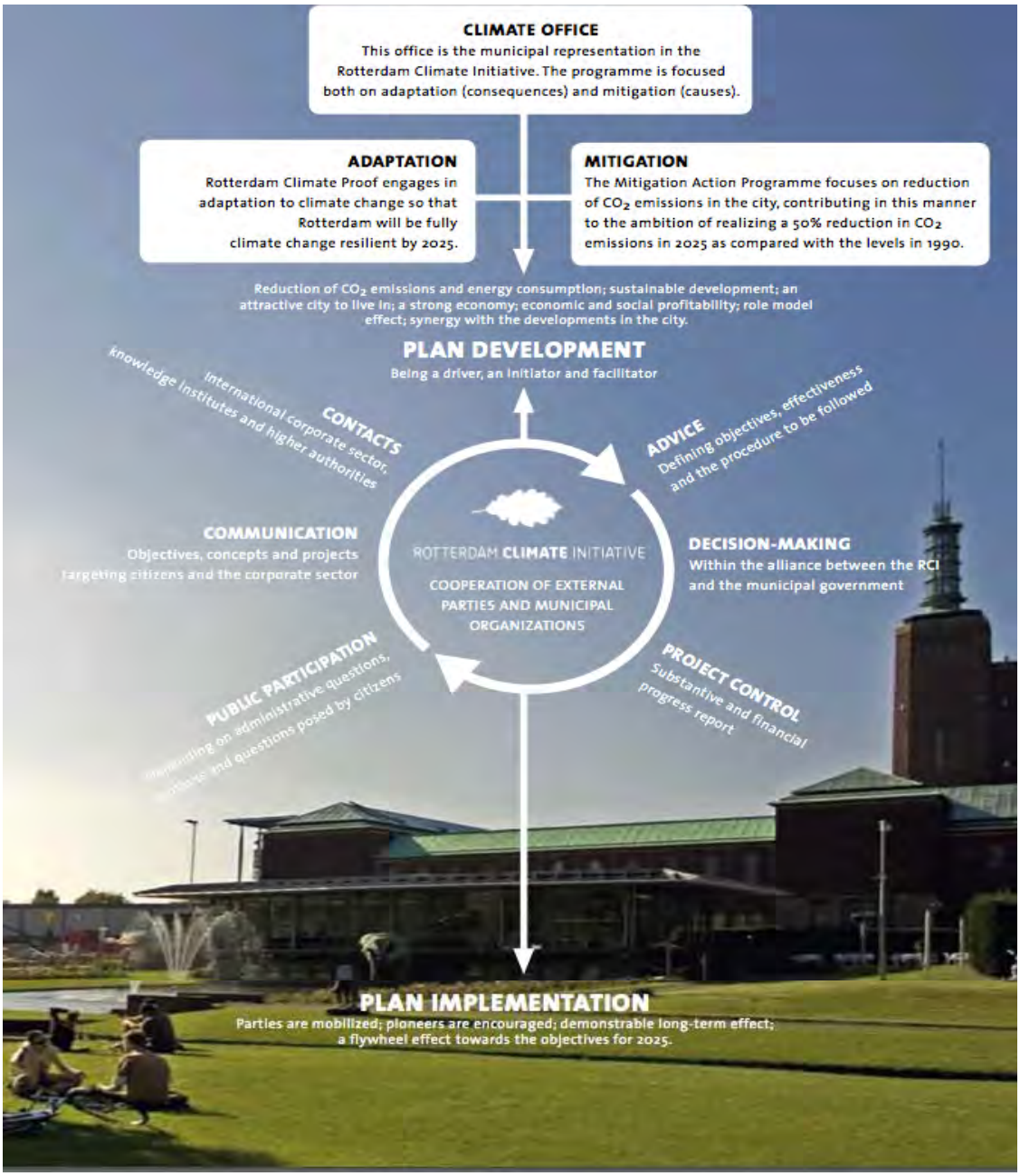

Fig. 11 The Rotterdam Climate Strategy

Fig. 12 Urban Heat Island: Risk Map

Moreover, based on the opportunities offered by the digital environment, the potential of new communication tools - such as the apps for smart phones or the social media - has been explored. In the same line, the "Climate Game" - which allows users to play an active role in the adaptation process, learning more about the various involved interests and stakeholders and about the consequences of different choices - has been developed. All these tools are addressed to inform people, improving the awareness of the community about the climate-related phenomena and consequent risks, but also to favor and sustain bottom-up initiatives and to build up consensus on adaptation measures. Moreover, they largely contribute to disseminate knowledge, which represents a key issue for enhancing urban resilience in face of climate change (Davoudi, 2013; Galderisi, 2014).

Summing up, based on the case studies here briefly described, adaption plans seem to have a great potential for starting innovative processes, addressed to make European cities safer and, above all, to integrate environmental issues (from energy saving to risk prevention and mitigation) into sustainable land use planning processes, also through an extensive use of ICTs.

The proposed examples are addressed not only to prevent or reduce the impacts of the numerous climate-related hazards but, above all, to preserve and enhance the quality of life and prosperity for current and future generations as well as to protect and improve the quality of urban environment. Moreover, they seem to have the potential for overcoming most of the obstacles that currently curb adaption processes. Nevertheless, even though the selected Adaptation Plans represent a cutting edge in the European context, they present strengths and weaknesses that will be briefly discussed in the following.

First of all, the proposed case studies result from multilevel and integrated climate policies, developed according to a clear structure of competences and duties both at national and at local level. In the UK the responsibility for climate change mitigation, adaptation, and energy strategies have been transferred from central government to the Greater London Authority, which has extensive planning powers and is responsible for producing London-wide strategies for spatial planning and environment. Denmark is characterized by a close cooperation among national and local government. In 2008, the Danish Ministry of Climate, Energy and Building published the general strategy for climate change adaptation, which promotes and supports the coordination among Local Authorities and favors informed decisions at lower levels.

The Netherlands has a long tradition of cooperation among different government bodies, stakeholder organizations and citizens. National government, provinces, municipalities and regional water boards work together, indeed, with inputs from the social organizations and the business community, in order to realize climate resilient urban areas. Moreover, in the 2012, the "Delta Act", a nationwide programme addressed to coordinate adaptation strategies at the local level, entered into force. On the local scale, the three case studies have developed an integrated climate policy, since Mitigation and Adaptation Plans have been issued together or within a few years. Such a circumstance is important in order to guarantee synergies and to reduce the conflicts, which often arise between mitigation and adaptation policies. For example, compact settlements may reduce energy demand and transport emissions; on the opposite, the increase in built mass would intensify the urban heat island effect, posing serious problems to urban drainage. Furthermore, the increasing urban heat island effect would lead to an increased use of air-conditioning and, consequently, to an increase in emissions (Walsh et al., 2010).

As for the knowledge phase, the case studies present relevant strengths in respect to the assessment of the climate-related hazards. Despite the difficulties related to the downscaling of large-scale climate models, the selected plans provide in-depth analyses of the climate-related phenomena on an urban scale, based on large-scale scenarios and in-depth studies at local scale.

Fig. 13 The Rotterdam Climate Game

On the opposite, they show some weaknesses in the vulnerability assessment, since they do not provide any definition of vulnerability and do not refer to the long and rich tradition of studies and researches on vulnerability carried out in the field of natural hazards. In this field, although methodologies for analyzing and assessing vulnerability are still heterogeneous, the concept has been widely recognized as a multi-dimensional one, comprising different aspects (physical, systemic, social, economic, environmental, institutional, etc.), constantly interacting in time and space (Birkmann, 2006; Galderisi et al., 2013; UNISDR, 2009; Menoni et al., 2011).

Unfortunately, based on the available on-line documents, the examined Plans provide aggregate risk evaluations, generally expressed in monetary terms, paying scarce attention to the different aspects of urban vulnerability and including little or no vulnerability maps (generally only maps of the exposed elements to the different hazard factors are available). This represents a weak point in current adaptation plans. Even though risk assessment is important to identify priority areas and sectors, in fact, vulnerability analysis is crucial to outline appropriate adaptation policies. Moreover, although some of the case studies explicitly refer to resilience, the latter is not defined and no indicators for measuring resilience are provided.

As for the preparation/response phase, all the selected Plans show a great awareness of the uncertainties that, characterizing the knowledge phase, reflect on the preparation phase. Indeed all of them refer to a short-term time horizon and emphasize that adaptation does not represent a steady state. The selected Plans outline dynamic and flexible adaptation processes in face of the uncertainties related to changing climate projections, to urban development trajectories as well as to future technical development and capable of continuously incorporating new knowledge and revising, accordingly, their goals, objectives and actions. Although with reference to a short time span, most of them provide a detailed economic and temporal program of adaptation measures, articulated in respect to different geographical scales or to different urban areas, singling out subjects and tools for their implementation.

In respect to the obstacles that generally characterize the preparation phase - related to the heterogeneity of policies, to the need for integrating adaptation policies into existing planning tools and, consequently, for coordinating different stakeholders - it is worth noting that all the sample Plans emphasize that climate change adaptation does not require new policies or new planning tools. On the opposite, all of them clearly state that adaptation requires a clear understanding of how climate change may affect the context at stake and the integration of such understanding into all decision-making processes affecting urban development. Furthermore, they emphasize the need for linking adaptation strategies to other policies and projects, as well as to existing management and maintenance programs and, namely, for mainstreaming adaptation policies into existing disaster risk management and land-use planning process. As mentioned above, such integration requires an intensive cooperation among different stakeholders. Therefore, it is crucial to have shared aims for a climate-proof urban development and the capability of coordinating all the involved stakeholders.

As for the revision phase, it has to be noticed that whereas the Mitigation Plans, grounding on international or European thresholds, may constrain their strategies to precise targets - which facilitates the control on the effectiveness of the implemented strategies and actions – the Adaptation Plans generally include site-specific measures, referred to the peculiarities of the impacted systems. Hence, both the comparison among different Plans and the monitoring of the adaptation process are generally more difficult.

Furthermore, even though the analyzed Plans provide a detailed economic and temporal planning of the proposed actions, none of them provide indicators capable of monitoring the effectiveness of the foreseen actions. Finally, a weak area of the analyzed adaptation plans can be related to the usage of smart tools for improving the awareness of climate-related impacts among different stakeholders.

Only the Rotterdam Plan provides smart solutions (e.g. sensor technologies, decision support systems, interactive knowledge tools, etc.) for collecting and disseminating knowledge as well as for building up consensus on adaptation measures and sustaining bottom-up initiatives.

4 CONCLUSION

In face of the impacts of the climate-related phenomena (floods, heat waves, etc.) that numerous European countries are already suffering and following the initiatives started by the EU for improving knowledge and awareness of adaptation issues, numerous European cities have recently started an adaptation process, despite the significant obstacles due to the uncertainties in the future climate scenarios.

This contribution, after a brief description of the main impacts of climate change on urban areas and of the main hints provided by the European Community to improve urban adaptation to climate change, has been focused on three Adaptation Plans:

- the London Mayor's Climate Change Adaption Strategy "Managing Risks and Increasing Resilience, (2011);
- the Copenhagen Climate Adaptation Plan (2011);
- the Rotterdam Climate Adaption Strategy (2013).

The three selected Plans represent a cutting edge in the European context where, although cities are widely recognized as pivotal both to mitigation and adaptation issues, up to now most of them do not have an adaption plan (Reckien et al., 2013).

The selected case studies have allowed a better understanding of the challenges and opportunities arising from the adaptation processes. On the one hand, in fact, they shed light on the numerous difficulties related to the different phases of the process.

On the other hand, they clearly underline that adaptation planning might be a great opportunity for promoting a sustainable and smart growth, enhancing urban resilience in face of "the unavoidable climate impacts and their economic, environmental and social costs" (EC, 2013).

Key-Aspects		Adaptation Plans		
		London (2011)	Copenhagen (2011)	Rotterdam (2013)
integrated Climate Policy	*Availiability of a National Climate Strategy*	✓	✓	✓
	Availiability and integration with a Mitigation Plan	✓	✓	✓
Knowledge phase	*Hazard assessment: availability of climate studies at local scale*	✓	✓	✓
	Definition of vulnerability as multidimensional concept			
	Availability of vulnerability maps (in the on-line documents)	Mainly Exposure maps		✓
	Risk assessment	Risk as a combination of probability and cost of damage	Cost of damage in respect to different hazard scenarios	Risk maps combining hazard and vulnerability
	Multi - Risk Assessment		A qualitative assessment combining different threats is available	
	Typology of available scenarios	Hazard	Hazard	Risk
Preparation/Response Phase	*Fexible strategy capable of meeting uncertainties*	✓	✓	✓
	Short term horizon for adaptation policies	✓	✓	✓
	Detailed economic and temporal planning of the adaptation measures	✓	✓	
	Measures articulated for geographical scale/urban areas		✓	✓
	Capacity of integrating large scale and small scale solutions	✓	✓	v
	Availability of Guide-Projects		✓	✓
	Integration with tools for Risk Prevention/Mitigation and Emergency Planning	✓	✓	✓
	Integration with tools for Land Use Planning	✓	✓	✓
Revision Phase	*Avaiability of indicators for monitoring the adaptation process*			
Smart tools	*Smart tools for disseminate knowledge among different stakeholders*			✓
	Smart tools for increasing people awareness			✓

Fig. 14 The key aspects of the London, Copenhagen and Rotterdam Adaptation Plans (*in green the main weaknesses*)

In respect to the opportunities, it is worth noting that climate change phenomena and their increasing impacts on urban areas are forcing planners to look behind, paying a renewed attention to the principles of environmental planning.

The concept of adaptation to the threats as well as to the opportunities arising form the natural environment has always represented, in fact, a crucial issue for environmental planners (Whiston Spirn, 1973; Michel, 2000; Steiner, 2006). Such issue can be currently revisited and improved according to the large debate developed in the last decades on sustainability and resilience.

In respect to the challenges, it is worth stressing that the selected experiences do not seem to fully benefit either by the significant results already achieved in the field of risk analysis or by the significant opportunities arising from the current debate on smart cities. As for the first point, despite the numerous projects funded by the European Community and addressed to promote the building up of a shared knowledge and common methodologies among the scholars working in the field of natural hazards and the scholars involved in studies and research on climate change, a difficulty in transferring concepts, methods and results from one field to the other still persists. This is even more troubling in the light of the close relationships between climate related impacts and the increasing occurrence of natural hazards (e.g. floods) and of the consequent need, largely emphasized in current experiences, for better integrating adaptation

strategies and DRR policies and for including both of them into the wider framework of urban planning processes. As for the second point, according to some scholars a city can be defined smart when investments in human/social capital and IT infrastructure fuel sustainable growth and enhance a quality of life, through participatory governance (Nam and Pardo, 2009; Papa, Galderisi, Gargiulo, 2013). Unfortunately, the application of ICTs in the adaptation processes, although they could play a key role in each phase of the process, seems to be still at an early stage. Only the Rotterdam Climate Adaption Strategy, in fact, explicitly focuses on the opportunities arising from the ICTs in disseminating knowledge, improving the awareness of the climate change consequences among different stakeholders, favoring the information exchange and sustaining bottom-up initiatives.

REFERENCES

Adger, W. N., Lorenzoni I., O'Brien K. L., eds., (2009), Adapting to Climate Change: Thresholds, Values, Governance. Cambridge University Press, Cambridge.

Birkmann, J., ed., (2006), Measuring vulnerability to natural hazards. Towards disaster resilient societies. United Nation, University Press.

Birkmann J., Garschagen M., Kraas F., Quang N. (2010), "Adaptive urban governance: new challenges for the second generation of urban adaptation strategies to climate change", Sustainable Science 5(2):185-206. http://ihdp.unu.edu/file/get/10637.pdf

Birkmann J. (2011), First- and second-order adaptation to natural hazards and extreme events in the context of climate change, Natural Hazards, 58:811-840. http://www.bonn-dialogues.com/file/get/10626.pdf

Bulkeley, H, Schroeder, H., Janda, K., Zhao, J., Armstrong, A., Yi Chu, S. and Ghosh, S. (2009), Cities and Climate Change: The role of institutions, governance and urban planning. Report prepared for the WorldBank Urban Symposium on Climate Change, Durham, Oxford. http://www.eci.ox.ac.uk/publications/downloads/bulkeley-schroeder-janda09.pdf

Caragliu, A., Del Bo, C., Nijkamp, P. (2009), Smart cities in Europe. Series Research Memoranda 0048. VU University Amsterdam, Faculty of Economics, Business Administration and Econometrics.

Copenhagen Climate Adaptation Plan (2011) https://subsite.kk.dk

Corfee-Morlot, J., Kamal-Chaoui L., Donovan M.G., Cochran I., Robert A., Teasdale P. J. (2009), "Cities, Climate Change and Multilevel Governance", OECD Environmental Working Papers N° 14.

Corfee-Morlot, J., Cochran I., Hallegatte, S., Teasdale P. J. (2011) Multilevel risk governance and urban adaptation policy, Climatic Change (2011) 104:169–197 DOI 10.1007/s10584-010-9980-9.

Davoudi, S., Mehmood, A., Brooks, E. (2011) The London Climate Change Adaptation Strategy: Gap Analysis. Available from: http:// www.ncl.ac.uk/guru/documents/EWP44.pdf

Davoudi S., Brooks E., Mehmood A., (2013) Evolutionary Resilience and Strategies for Climate Adaptation, Planning Practice & Research, 28:3, 307-322, http://dx.doi.org/ 10.1080/02697459.2013.787695

Delta Programme 2013. Working on the Delta. The road towards the Delta Decisions (2012), http://www.deltacommissaris.nl/english/Images/Delta%20Programme%202013%20 EN_tcm310-334162.pdf

D'Ippoliti, D., Michelozzi, P, Marino, C. et al. (2010), The impact of heat waves on mortality in 9 European cities: results from the EuroHEAT project, Environmental Health, 9:37, http://www.ehjournal.net/content/9/1/37

Dircke, P., Molenaar, A. (2010) Smart Climate Change Adaptation in Rotterdam, Delta City of the Future, Water Practice & Technology Vol 5 No 4, IWA Publishing, DOI: 10.2166/WPT.2010.083, http://www.iwaponline.com/wpt/005/0083/0050083.pdf

EC (2007), Communication on Water Scarcity & Drought (WS&D), COM(2007) 414 final 18.7.2007

EC (2011), A Roadmap for moving to a competitive low carbon economy in 2050, Brussels, 8.3.2011 COM(2011) 112 final. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri= COM:2011:0112:FIN:EN:PDF

EC (2012) "A Blueprint to Safeguard Europe's Water Resources", COM(2012) 673 final.

EC (2013), An EU Strategy on adaptation to climate change, COM(2013) 216 final, Brussels, 16.4.2013 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0216:FIN:EN: PDF

EU (2011), Climate Friendly Cities. A Handbook on the Tasks and Possibilities of European Cities in Relation to Climate Change. http://politicadecidades.dgotdu.pt/news/Documents/Climate-friendly_cities_2011[1].pdf

EEA (2008) Impacts of Europe's changing climate - 2008 indicator-based assessment. Joint EEA- JRC-WHO report. Published by the European environment agency. EEA report. no 4/2008. ISBN:978-92-9167-372-8. http://reports.eea.europa.eu/eea_report_2008_4/en/

EEA (2012), "Urban Adaptation to Climate Change in Europe, Challenges and opportunities for cities together with supportive national and European policies", EEA Report n° 2, Copenhagen. http://www.eea.europa.eu/publications/urban-adaptation-to-climate-change

EEA (2013) Adaptation in Europe. Addressing risks and opportunities from climate change in the context of socio-economic developments, EEA Report n° 3, http://www.eea.europa.eu/ publications/ adaptation-in-europe

Egenhofer C., Alessi M., (2013), "EU Policy on Climate Change Mitigation since Copenhagen and the Economic Crisis", CEPS Working Document, ISBN 978-94-6138-290-0. http://www.ceps.eu

Galderisi, A., Menoni S. (2007), Rischi Naturali, Prevenzione, Piano, in Urbanistica 134.

Galderisi A., Ferrara F.F. (2012), Enhancing Urban Resilience in Face of Climate Change, TeMa Journal of Land Use, Mobility and Environment, Vol. 5/2, pp. 69-87. http://www.tema.unina.it/index.php/tema/article/view/936/1057

Galderisi A., Bonadonna C., Delmonaco G., Ferrara F.F., Menoni S., Ceudech A., Biass S., Frischknecht C., Manzella I., Minucci G., Gregg C. (2013) Vulnerability Assessment and Risk Mitigation: The Case of Vulcano Island, Italy, Landslide Science and Practice, Volume 7: Social and Economic Impact and Policies, Springer Berlin Heidelberg, 55-64, DOI: 10.1007/978-3-642-31313-4_8

Galderisi, A. (2014), Urban Resilience: a framework for empowering cities in face of heterogeneous risk factors, A|Z Journal - Cities at risk - Vol. 11 Issue 2 (forthcoming).

Gargiulo, C., Pinto, V., Zucaro, F. (2012), City and Mobility. Towards an Integrated Approach to Resolve Energy Problems, TeMA Journal of Land Use, Mobility and Environment vol. 5/2, pp.23-53, http://www.tema.unina.it/ index.php/tema/article/view/920/1055

Greiving et al. (2011), ESPON Climate Change and Territorial Effects on Regions and Local Economies, Applied Research 2013/1/4 Draft Final Report|Version 25/2/2011 Summary Report. http://www.espon.eu

Hallegatte, S., Henriet, F., Corfee-Morlot, J. (2011), The economics of climate change impacts and policy benefits at city scale: a conceptual framework, Climatic Change (2011) 104:51–87 DOI 10.1007/s10584-010-9976-5

Hennessy, K., Fitzharris, B. et al. (2007), Australia and New Zealand. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, 507-540. http://www.ipcc.ch/

Hunt A., Watkiss, P. (2011), Climate change impacts and adaptation in cities: a review of the literature, Climatic Change (2011) 104:13–49 DOI 10.1007/s10584-010-9975-6

ICLEI, 2011. Financing the Resilient City. A Demand Driven Approach to Development, Disaster Risk Reduction and Climate Adaptation – An ICLEI White Paper. International Council for Local Environmental Initiatives (ICLEI), Bonn.

ICMA, EPA (2006), This is Smart Growth, http://www.smartgrowthonlineaudio.org/ pdf/TISG_2006_8-5x11.pdf

Inam, A. (2011), Smart growth: a critical review of the state of the art, in Banerjee T. and Loukaitou-Sideris A. Companion to Urban Design, Routledge, NY.

IPCC (2007), "Climate change 2007: Synthesis Report", Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC, Geneva, Switzerland. http://www.ipcc.ch/ipccreports/ar4-syr.htm

IPCC (2011), Special Report on Renewable Energy Sources and Climate Change Mitigation, Working Group III of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, New York, USA. http://srren.ipcc-wg3.de/report/IPCC_ SRREN_Full_Report.pdf

Klein, R.J.T., Schipper E. L. Dessai S. (2003), Integrating mitigation and adaptation into climate and development policy:

three research questions, Tyndall Centre for Climate Change Research, Working Paper 40, http://www.tyndall.ac.uk

Lehmann P., Brenck M., Gebhardt O., Schaller S., Süßbauer E. (2012), Understanding Barriers and Opportunities for Adaptation Planning in Cities, Discussion Paper, Helmholtz-Zentrum für Umweltforschung GmbH – UFZ. http://www.ufz.de/export/data/global/45989_19%202012%20Lehmann%20et%20al_%20Urban%20Adaptation_internet_gesamt.pdf

London Mayor's Climate Change Adaption Strategy (2011), Managing Risks and Increasing Resilience, http://www.london.gov.uk/sites/default/files/Adaptation-oct11.pdf

Magee, N., Curtis, J., Wendler, G., (1999), The urban heat island effect at Fairbanks, Alaska. Theoretical and Applied Climatology 64, 39-47.

McEvoy D (ed.) (2007) Climate change and cities. University of Maastricht. Built Environ 33(1).

McEvoy, D., Matczak, P., Banaszak, I., Chorynski, A., (2010), Framing Adaptation to Climate- related Extreme Events. Mitigation and Adaptation Strategies for Global Change 15, 779-795.

McCarthy, M. P., Best M. J., Betts R. A. (2010), Climate change in cities due to global warming and urban effects, Geophys. Res. Lett., 37, L09705, doi:10.1029/ 2010GL042845.

Menoni, S., Costa, L., Galderisi A., and Margottini C. (2011), Deliverable 4.1- Methodological framework for an Integrated multi-scale vulnerability and resilience assessment, Ensure Project, http://www.ensureproject.eu/ENSURE_Del4.1.pdf

Meehl, G. A., Tebaldi, C. (2004), More intense, more frequent, and longer lasting heat waves in the 21st century. Science 305, 994-997.

Michel, C., ed. (2000), Environmentalism in Landscape Architecture, Dumbarton Oaks, Washinghton D.C.

Müller, A. (2012), Areas at Risk - Concept and Methods for Urban Flood Risk Assessment. A case study of Santiago de Chile. Franz Steiner Verlag, Stuttgart.

Nguyen Xuan A. (2011) "Cambiamento climatico, adattamento, vulnerabilità e resilienza: orizzonti per la pianificazione"in "Abitare l'Italia - Territori, Economie, Disuguaglianze" XIV Conferenza SIU – 24/25/26 marzo 2011.

Papa, R., Gargiulo, C., Galderisi, A. (2013) Towards an Urban Planners' Perspective on Smart City, TeMA Journal of Land Use, Mobility and Environment vol.6/1, pp.5-17. http://www.tema.unina.it/index.php/tema/article/view/1536/1615

Reckien D., Flacke J., Dawson R. J., Heidrich O., Olazabal M., Foley A., Hamann J. J.P., Orru H., Salvia M., De Gregorio Hurtado S., Geneletti D., Pietrapertosa F. (2013), Climate change response in Europe: what's the reality? Analysis of adaptation and mitigation plans from 200 urban areas in 11 countries, Climatic ChangeDOI 10.1007/s10584-013-0989-8, Springer Science+Business Media Dordrecht 2013

Rotterdam Climate Adaption Strategy, (2013) http://www.rotterdamclimateinitiative.nl/documents/Documenten/RCI_RAS_samenvatting_UK_2013%20definitief%20per%20pagina%20lowres.pdf

Schär, C. Vidale, P., Lüthi, D., Frei, C., Häberli, C. Liniger, M.A., Appenzeller, C. (2004), The role of increasing temperature variability in European summer heatwaves. Nature 427, 332-336.

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., Oliveira, A. (2011) Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation, The Future Internet Lecture Notes in Computer Science Volume 6656, pp 431-446, SpringerLink http://link.springer.com/chapter/10.1007%2F978-3-642-20898-0_31

Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M., Miller, H.L. (2007), Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK.

Steiner, R.F. (2006), The Essential Ian McHarg, Writings on Design and Nature, Island Press.

The World Bank Group (2011), Guide to Climate Change Adaptation in Cities, http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1318995974398/GuideClimChangeAdaptCities.pdf

UN, Department of Economic and Social Affairs, Population Division (2012) World Urbanization Prospects, the 2011 Revision. New York, 2012

UN, Adaptation Committee (2013), The State of Adaptation under the United Nations Framework Convention on Climate Change 2013 Thematic Report. http://unfccc.int/

UN (2014), Framework Convention on Climate Change https://unfccc.int/adaptation/items/ 7006.php

UNISDR (2009), UNISDR Terminology on Disaster Risk Reduction, http://www.unisdr.org/ eng/terminology/terminology-2009-eng.html.

Vejre, H., Skov-Petersen, H., Henschel K.L. (2007), The Copenhagen 1948 Finger Plan – a comprehensive plan for urban growth, infrastructure and open space, Forest & LandscapeUniversity of Copenhagen, http://www.plurel.net/images/MURI_Vejre.pdf

Walsh C.L., Dawson, R.J., Hall J.W., Barr S.L., Batty M., Bristow A.L., Carney S., Dagoumas A.S., Ford A.C., Harpham C., Tight M., Watters H., Zanni A.M. (2011), "Assessment of Climate Change Mitigation and Adaptation in Cities", Urban Design and Planning, Vol.164, Issue DP2.

Whiston Spirn, A. (1973), Woodlands New Community, Guidelines for site Planning, http://www.annewhistonspirn.com/pdf/Spirn-Woodlands-1973.pdf

Wilbanks T.J., Romero Lankao P., Bao M., Berkhout F., Cairncross S., Ceron J.-P., Kapshe M., Muir-Wood R., Zapata-Marti R. (2007), Industry, settlement and society. Climate change 2007: impacts, adaptation and vulnerability. In: Parry M.L., Canziani O.F., Palutikof J.P., van der Linden P.J., Hanson C.E., eds., Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, pp 357-390.

Wilby RL (2007) A review of climate change impacts on the built environment. Built Environ 33(1):31-45

IMAGE SOURCES

Fig. 1: http://commons.wikimedia.org/wiki/File:ArcticYearlongTempAnom_HR.jpg

Fig. 2: UN, Department of Economic and Social Affairs, Population Division (2012)

Fig. 3: Greiving et al., 2011

Fig. 4: 4a) United Nations (2013); 4b) http://weadapt.org/knowledge-base/adaptation-decision-making/adaptation-planning-process; 4c) Hennessy, Fitzharrisì et al. (2007)

Fig. 5, 6: London Mayor's Climate Change Adaption Strategy (2011)

Fig. 7, 8, 9: Copenhagen Climate Adaptation Plan (2011)

Fig. 10: Vejre, Skov-Petersen, Henschel (2007)

Fig. 11, 12: Rotterdam Climate Adaption Strategy, 2013

Fig. 13: Source: http://vimeo.com/68119632

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LIMITS TO ECOLOGICAL-BASED PLANNING IN ZIMBABWE

THE CASE OF HARARE

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ABSTRACT

This paper explores the feasibility of adopting ecological based planning in low-income residential development. It explicates that in developing countries efforts by housing authorities have been on housing provision irrespective of the environmental threats to sustainability. As these houses are built, future of urban ecology is under threat. The questions regarding this phenomenon are several: how do low-income populations perceive environmental issues of urban settlements? How capable and willing are the local authorities to embrace and apply ecological based planning in residential development? What are the facilitating instruments of ecological-based planning? What are the prospects of integrating ecological based planning to low-income residential development? What are the restraining factors towards embracement of ecological based planning and how best can they be harnessed towards future ecological cities? The case study of Hatcliffe residential area in Harare shows that there are many challenges to overcome uncoordinated planning approaches, ineffective policies and legislative frameworks, weak institutional settings, financial constraints, outdated planning standards and regulations, poverty, lack of environmental stewardship and lack of political will among others. The study findings call for robust environmental conservation strategies, strong environmental stewardship, responsive institutional and funding mechanism backed by realistic legislative frameworks and robust policy rectification.

KEYWORDS:
Ecological-based planning, low-income residential areas, sustainability, urbanisation

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津巴布韦的生态规划限制

哈拉雷案例

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摘要

本文探讨了在低收入住宅区开发中采用生态规划的可行性。本文揭示发展中国家的房管部门一直以来只注重房屋供应，而忽略了环境给可持续发展带来的威胁。随着这些房屋的建成，城市生态的前景受到威胁。针对这种状况有如下几个问题：低收入群体如何认知城市居住区的环境问题？地方当局如何有能力并愿意在住宅开发中接受和应用生态规划？生态规划的促进手段有哪些？集成化生态规划在低收入住宅开发中的前景如何？对于生态规划的接受有哪些制约因素，以及对于未来的生态城市如何更好地驾驭这些制约因素？对哈拉雷Hatcliffe住宅区的案例研究表明，在克服僵化的规划方法、无效的政策和立法架构、薄弱的机构设置、财政制约、过时的规划标准和规定、贫穷、环境管理和政治意愿匮乏等方面，仍面临诸多挑战。研究结果表明亟需强大的环境保护战略、有力的环境管理工作、能够做出响应的机构和筹资机制，这些均需要有效的立法架构和稳健的政策调整来提供支持。

关键词
生态规划；低收入住宅区；可持续性；城市化

1 INTRODUCTION

In the time of rapid urbanisation process, residential development has been of critical concern to cater for expanding populace within the urban space. In efforts to accommodate the exploding population, nature has been 'designed out' of the residential development equation. As well, low-income residential areas constitute the largest space of the built environment in most cities of the developing countries. Departing from such a complexity, this paper makes a feasibility study on the applicability of Ecological Based Planning (EBP) to low-income residential development. Conceptually, EBP entails the sustainable marriage of the hard and soft space that is development of environmentally sensitive settlements. EBP constitutes components of green space enhancement, wildlife conservation, green architecture as well as green energy within urban settlements. These components holistically shape the syntax of urban environmental planning.

The study notes that there is inherent environmental crisis globally of rapid growth of the human population; the depletion of both non-renewable and renewable resources; and extensive and intensive damage caused to ecology. This is being exacerbated mainly by a generally huge influx of population in cities.

In the developed world, such a trend of huge population influx is explained by increasing exilic and Diaspora populations in urban territories (Mbiba, 2000). In the developing countries, rural-to-urban migration is rampant (Simone, 2003; Toriro, 2011). Overall, cities in developing countries are experiencing spontaneous expansion of low-income residential areas (Maphosa *et al*, 2008). Once they arrive in the cities, the migrants require somewhere 'to put their heads' hence the logic of low-income housing. Low-income residential areas have thus tended to occupy a critical space, normally reserved for 'nature'. In this regard, the 'invasion' of ecologically sensitive areas (ESA) has been inevitable and to the detriment of urban ecosystems. In cities of the developing world, little emphasis has been paid to low-income residential areas, which account for the largest proportion of the urban land. Likewise, policy makers have been reluctant, if not resisting, addressing facets of environmental sustainability of low-income residential areas (Muderere, 2011; Maphosa *et al,* 2008). Urban nature does not seem to be incorporated into urban planning. Thus, the hard and soft space appears as two rivers flowing parallel whilst eroding the banks of each other.

This paper relates ecological-based planning components to low-income residential areas with the methodological lens of Hatcliffe case study in Harare, Zimbabwe. The paper maps out the capacities, opportunities and constrains of adopting EBP in low-income residential development. The qualitative methodologies used to construct the discourse are the key informant interviews and observations. Key informants were local planning authorities, environmental boards and the local residents of Hatcliffe. The study provokes a discussion on capabilities of the local authorities to embrace the adoption of EBP as well as scrutiny of low-income residents as enemies of ecological sustainability, reasons for ecological exploitation. This leads to a discussion on the nature of residential development in Zimbabwe as well as the feasibility study of incorporating EBP as an environmental planning tool for sustainable human settlements. The paper concludes by suggesting possible policy options to be espoused for robust integration of EBP in low-income residential areas towards environmentally sensitive settlements.

2 CONCEPTUAL AND ANALYTICAL FRAMEWORK

The concept of Ecological-Based Planning has been a critical approach in the anthropocene epoch. EBP is an approach of creating environmentally sensitive human settlements, which means living in harmony with nature through use of its principles.

Contemporary urban environmental praxis has broadened intergenerational inequalities and there is need for moderation through robust planning intervention (Shu-Yang *et al,* 2004). EBP constitute the enhancement of green space of green, wildlife protection, green energy, wetland protection as well as green architecture (Gilbert *et al,* 1996).

Globally ecological based planning is practiced with cornerstones as green space enhancement, urban wildlife protection, sustainable construction, environmentally friendly energies and protection of environmentally sensitive areas (Said *et al,* 2009). The package of ecological based planning is multifaceted but for it to work effectively it requires integrated approach of applying them holistically. In conquest to conserve nature, these components seek to marry the built space with urban ecology. Within the realm of ecological based planning, green space enhancement is crucial.

Green space plays a vital role in enhancing the quality of urban life by creating attractive cityscapes; improve health, sustainable neighbourhood renewal and better community cohesion in deprived communities (House of Commons, 2009). It also offers environmental benefits, including pollution control, water management, wildlife havens and biodiversity. Naturalising urban ecosystems by increasing or maintaining the dominance of native species and their communities have been of great importance (Shu-Yang *et al,* 2004). Green space enhancement also encompasses the protection of ecologically sensitive areas (ESAs) such as wetland areas. Green architecture is another crucial component of ecological based planning. It entails the construction of buildings that are environmentally friendly throughout their life cycle from construction, use and demolition. Ecologically friendly houses facilitate more affordable living in the end, as they minimize energy costs (Said, *et al,* 2009).

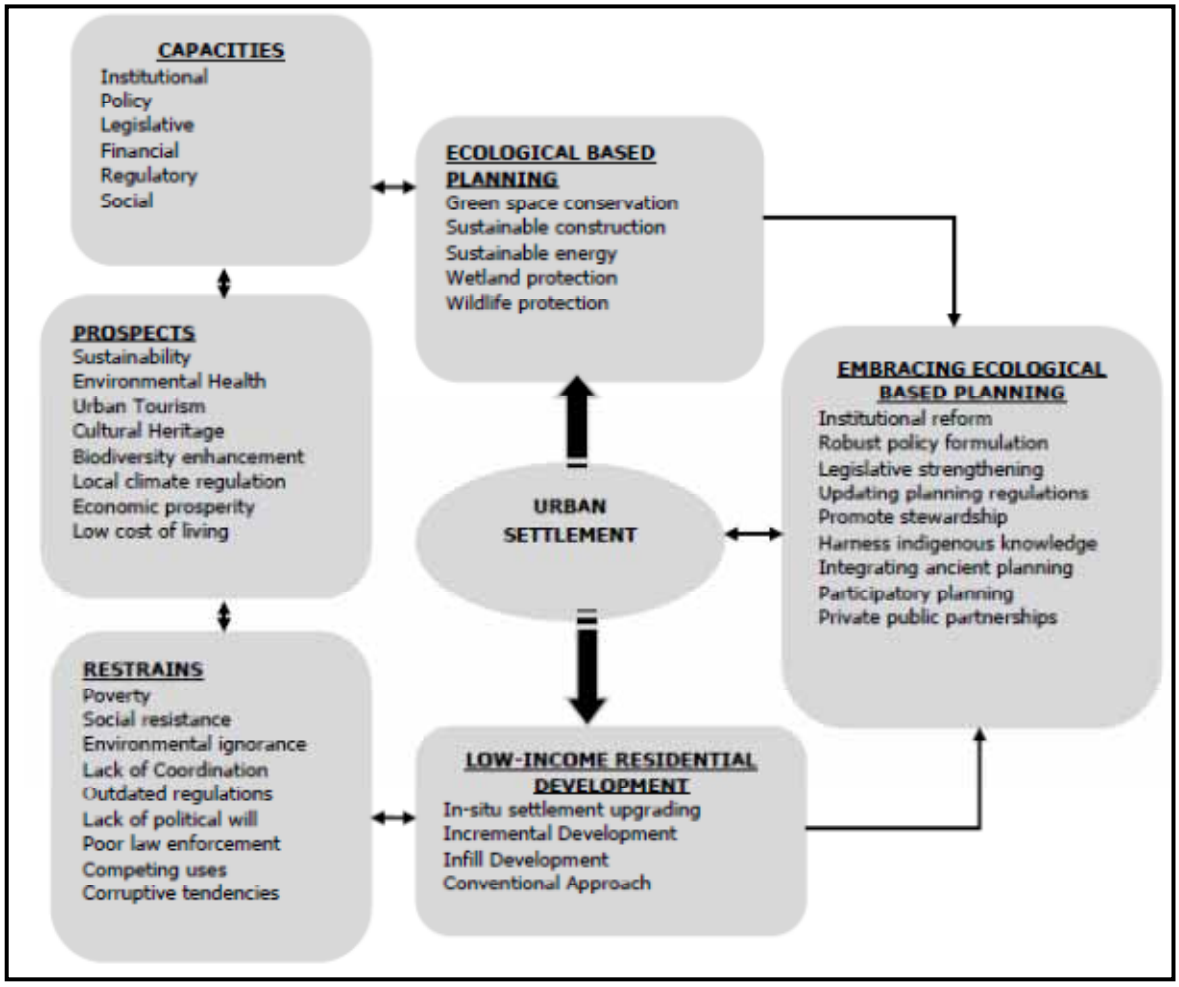

Fig. 1 Ecological-based planning conceptual framework

Nevertheless, neither the private nor the public housing providers have shown much interest in environmentally friendly housing provision and this has raised the eyebrows of environmentalists globally. Ecological construction is also contemplated in several traditional building designs where local materials are used in their construction in order to become more energy and resource efficient. The American architect

Frank Lloyd Wright who introduced “organic architecture” at the beginning of the twentieth century marked the revolution of green architecture within urban settlements (Hough, 1991). He initiated the design of houses constructed of local building materials, also known as vernacular architecture. Whilst made much progress, there is still need for more attention to energy and resource efficiency in the construction and operation of residential buildings as a crucial component of ecological based planning.

In addition, other components of ecological urbanism are the use of green energy, and sustainable waste management. Globally use of sustainable energies has become a crucial necessity in order to avoid the depletion of non-renewable energies. The concept of green energy constitutes use of energy with minimum or no negative impact on the natural environment. These include the use renewable clean energy such as solar, wind energy in substitution of fossil fuels, which have an adverse environmental damage. Waste management and waste reduction have been of great concern to environmentalists (Said *et al,* 2009). The mechanism of waste minimisation comes in three modes of Re-use, Reduce and Recycle (Beer, 2003). The reduction of the garbage has been a major global concern. Thus, there is continuous increase of their huge bulk, because of the modern society and the urban and one of modern societies' greater challenges. Also the increasing tendency of global consumption on secondary consumable (Pieterse, 2011), thus call for ecological based planning intervention in the realm of urban development with regard to waste management.

Whilst unpacking ecological based planning components, urban wildlife protection has been of great concern to urban planning as urban wildlife has been hastening towards extinction. Conservation of urban fauna has been of less attention in the discussion table of the developing world but its importance rang the bell of the global community (Hough, 1991). Muderere (2011) as well notes that, through ecological networks and nature sanctuaries, urban wildlife had been habituated in urban places either by natural existence or by confinement. Conceptually, ecological based planning comprises several principles which include meeting the needs of humans and the economy, sustaining ecosystem integrity, the use of renewable resources, natural debt elimination, nature conservation and biodiverstity enhancement (Shu-Yang *et al,* 2004). It also seeks to increase environmental literacy to build social support for sustainable development, resource conservation, and protection of ecology. These principles are fully espoused by enhancing the ecological based planning components (see Figure 1). The use of force field analysis realises the capacities, opportunities and constrains of ecological based planning - low-income residential areas conjugate.

Greening the environment for the planning of human settlements has been a continuous debate at international forums, but these debates are yet to be scaled down to low-income residential areas in cities of the developing world. Studies on the sustainability of residential development have been extensive, but the ecological development and operation of low-income residential areas lacked recognition (Maphosa, *et al,* 2009). The continuity of a dynamic balance between needs and demands of people for equity, prosperity as well as quality of life at the same time maintaining healthy ecologies are cornerstones of sustainable development (Castels, 2000). The housing realm is multi-faceted as it depletes natural resources as well as producing impact on the natural environment (Said, *et al* 2009). As the poor population is the most dependent on the environment, Low-income residential areas have become hubs of massive ecological destruction. While globally planning has acquired a more "ecological" conscience, in conquest to face the matters of environmental defects, the legislators in cities of the developing countries are still concerned with survival of the current generation regardless of compromising the needs of the future.

Ecological based planning has long history of praxis being practiced by early ancient societies. Regarding the population, they had considerable impact on the natural environment in comparison to contemporary urban settlements. Ecological based planning reflected in several traditional building designs that use local materials in their construction, situated and designed to achieve optimalities of heating and cooling. Examples of such sophisticated architecture include traditional buildings constructed using adobe, animal

hides, or living spaces excavated from soft rock (Van der Ryn and Cowan 1995 cited in Shu-Yang *et al,* 2004). Scaling down to the local scale, ancient African societies had sophisticated ecological conservation practices. The concept of sacred controls on forests *(rambokutemwa)* was a way of creating ecological networks devoid of human disturbances and a form of biodiversity enhancement.

In relation to the African societies, the concept of totems was a cultural filtration strategy to wildlife consumption where every tribe had an animal devoid of human consumption leading to conservation of wildlife with even national emblem of bird species (*Hungwe)* as sacred. Ancient societies had fascinating architectural concepts of sustainable construction. Use of biodegradable building materials such as timber, thatch grass and mud proved environmentally beneficial as their high rate of migration left no prints of environmental disturbance thus, all building materials returned to nature. In a complex world, where human populations cluster in densely populated settlements with exorbitant pressure on the urban environment the challenge is; how these ancient ideas can be harnessed in formulation of robust environmental conservation strategies? Applicability of such sophisticated ideas in contemporary cities has been controversial due to several reasons amongst others being incompatible with modern bylaws and planning regulations as well as cultural change.

3 LOW-INCOME RESIDENTIAL DEVELOPMENT IN ZIMBABWE

While not blanking out the memories of prohibitive colonial city regulations, independence in 1980 in Zimbabwe witnessed a huge influx of rural migrants to urban areas (Mbiba, 2000). A compounding of 'rural push' and 'urban pull' elements defined the urbanization trends. Housing delivery has been a burning issue since the 1950s and limited governmental involvement in housing provision, which occurred during the early post-colonial period in Zimbabwe, has been the exacerbating factor (Chaeruka and Munzwa, 2009; Maphosa *et al* 2007). Demographically urban population has exorbitantly expanded as the 2002 Census placed the urban population at 35% with nearly half (46%) living in Harare (Chaeruka and Munzwa, 2009). The harsh macro-economic conditions have been main cause of poor residential development in Zimbabwe. The legislative instruments: Housing Standard Act, Model Building Byelaws and the Regional, Town and Country Planning Act missed environmental concerns regarding housing development, which gradually deteriorated residential space. As Chaeruka and Munzwa (2009) argue, the rapid urbanisation that Zimbabwe witnessed after 1980 put a strain on the physical, economic and social fabric of most towns and cities; they missed out hardly the environmental impact of rapid urbanisation. This led to a situation whereby the low-income residential development has been done haphazardly to the deteriment of environmental quality. In fact, most of the recently developed housing in the peri-urban of most Zimbabwean cities qualify as substandard housing given the lack of water and sanitation, and paved roads.

Thus, nationwide there has been galloping of over a million of populace on housing backlog (Chaeruka and Munzwa, 2009). This has pushed the shape of residential space to informal and peri urban settlements, putting the urban ecological space at jeopardy. More often than not, the existing settlements have exceeded their carrying capacity stressing the environment they rest upon and occupying ESAs in the name of "land dearth". Currently the sustainability of low-income residential development consists of more questions than answers. Low-income residential AREAS have been neglected and rejected as hubs for urban ecological treasure. As such, there have been reluctant reactions on the adoption of sustainable residential development. This issue emanates from city legislators who regard ecological based planning as a bureaucratic hurdle to urban planning (Chaeruka and Munzwa, 2009).

3.1 FACILITATING FACTORS

Zimbabwe has a broad legislative framework positioned to govern environmental management. The section 4 of Environmental Management Act, chapter 20:27, 2002 enhanced environmental rights to Zimbabwean

citizens. This instrument promotes environmental stewardship among urban residents. Also in relation to nature conservation, the Forest Act of 1949 chapter 19:05 protects the urban flora, and the Parks and Wildlife Act of 1975, chapter 20:14 protects the exploitation of urban wildlife (fauna). These instruments have failed to promote the conservation of urban ecology in low-income residential areas since they have been calling for updating as they are now outdated in regard to incorporation of environmental sustainability, reform, and strengthening for their operation to be fully functional. This has been a result of the local planning authorities not using them in their full capacity. Additionally there are various institutional and administrative structures in charge of environmental management. The Ministry of Environment and Natural Resource Management (MENRM) plays a pivotal role in management of environmental resources. The National Environmental Council (NEC) alternatively supports as an advisory board to allied institutions on environmental management. There is also Environmental Management Agency (EMA), which fosters environmental policies such as Environmental Impact Assessment policy of 1997 and the National Environmental Policy of 2003. However, having various institutions in charge of the environmental management creates a situation where a lack of a clear-cut of responsibilities compromises their effectiveness. As diversity leads to generalization, these institutions have proved to be aseptic to their responsibilities regarding state of environmental sustainability in low-income residential areas.

3.2 RESTRAINING FACTORS

Enforcing environmental instruments remains difficult because of inherent weaknesses in law enforcement and development control mechanisms. The prevailing environmental policies act as edentulous bulldogs in guarding against environmental exploitation. There are often repellent reactions in the forms of abnegation, resistance, relativism, and aseptic regulatory responses (Maphosa *et al,* 2009). As regards to local practice, this hinders the initiation and implementation of environmental conservation strategies for low-income residential areas. No direct legislative instruments exist to govern environmental sustainability of low-income residential areas as several legislative instruments and institutions lack clear responsibility of the low-income residential areas, which consequently leads to reluctance in their commitment. The Regional, Town and Country Planning Act (1996), Environmental Management Act (2000) lack concerted effort to relate with other allied supporting instruments towards embracement of environmental sustainability in low-income residential areas. The institutional responses have been naïve to embrace ecological based planning in residential areas thus their multiplicity led to generalization in role-playing (Maphosa *et al,* 2009). Corruption exists within the phase of striking a balance between low-income residential areas and ecological based planning. The low-income housing developers play unscrupulous development practices, greasing the hands of environmental bodies and agencies to be granted development permits regardless of their adverse environmental impacts. Hence, there is need for interplay cooperation among responsible stakeholders. The goal to achieve sustainable development is the greatest challenge humankind has ever faced, demanding a concentrated articulated effort among consumers, the housing industry and government itself (Said *et al,* 2009). For the sake of resources mobilization to foster the ecological based planning initiatives, lack of political will holds back progress. Environmental initiatives have been regarded as bureaucratic red tape to development and housing provision having an extortionate size of housing backlog in Zimbabwe (Maphosa *et al,* 2009). Referring back to the origin of the case area Hatcliffe, it is full of political rebuttals on its existence and development. On the other hand, interventions by international organizations in the environmental management of local resources are being restrained by political connotations of illegitimacy. Drawing from the case study of Hatcliffe residential area, there are several areas calling for discourse. Planning regulations are super-annuated to govern environmental protection. The Regional Town and Country Planning Act is backdated to 1996 where environmental aspects had not provoked hot debates globally hence, it lacks environmental aspects as a backbone of urban planning. Several local development plans and the master

plan at large are as outdated as 1984 where environmental aspects are poorly expressed if not excluded in these statutes. In addition, the current planning area characterised by high degree of inflexibility where they poorly respond to dynamics of environmental change. This invokes planning failure to address environmental issues in modern urban planning. Currently there are reluctant efforts to update these planning regulatory frameworks with speculation of persistence if no robust measures have been adopted.

The scaling down of global environmental initiatives to local levels such as the concept of ecological based planning in low-income residential development is facing hindrances of local resistance and ignorance. The developing world on the environmental discussion tables tends to favour the initiator rather than the concept. That is a great question of legitimacy rather than effectiveness, which conclusively is blind obedience rather than rational discussion. Several global environmental initiatives are rejected because of lacking legitimacy to the third world community (Potts, 2009; Termorshuzein *et al,* 2007). Worldwide environmental scientists are being blamed for interpreting global environmental issues poorly and for being poor communicators, who present environmental issues overcautiously. The management of urban settlements raises the crucial issue of environmental democracy. However, it goes further beyond urban management, into transparency, accountability, and the rule of law, participation, reciprocity, and trust (Castels, 2000). What makes democratisation particularly relevant is the fact that by virtue of various forms of environmental management, urban centres have obtained increasing formal authority over their areas of jurisdiction, although often stopping short of a genuine devolution of decision-making power towards environmental sustainability (Gilbert *et al,* 1996).

There have been doubts over the financial feasibility of fostering ecological based planning within low-income residential areas and this has been stimulated by adoption of the techno-centrism approach rather than eco-centrism approach to environmental chastening. In addition, repellent exists as well as repudiate reactions towards initiation of densification approach to residential development pointing fingers on financial incapacities of local authorities and local communities themselves (Brand, 2006). The current horizontal approach to residential development is exacerbating urban sprawl (encroaching to agricultural land and forestry space) which in turn is compromising the ecological networks of the urban settlements. The dearth of land is being used as an alibi as to why there has been the exploitation of ESAs for residential expansion in cities of developing countries. Having the restraining factors overweighing the facilitating instruments low-income residential areas is left at jeopardy of environmental exploitation.

4 CHARACTERISING THE STUDY AREA: HATCLIFFE

Hatcliffe is a high-density residential area situated twenty-two kilometres to the north of Harare city centre (see Figure 2). It was established in 1984 at the outskirts of Harare as a holding camp of urban migrants coming from different places in Harare: some from Churu farm, some from squatter camp in Mbare and others from nearby farms (Dirwai, 2000). A range of low-income dwellers posing strains on the environment comprises it. Being located on the former peri-urban farm of red soils, it is surrounded by suburbs of high-income earners, Hodget Hill and Philadelphia.

The residential area was originally designed to meet the housing needs of a small population, but housing demand increased rapidly (Chirisa and Muchini, 2011; Dirwai, 2000). The remarkable increase in housing demand has exceeded the ecological carrying capacity of the residential settlement considering the stress on the ecological treasures by residential development. The residential area comprises of ecologically sensitive areas of wetland bands (see Figure 2).

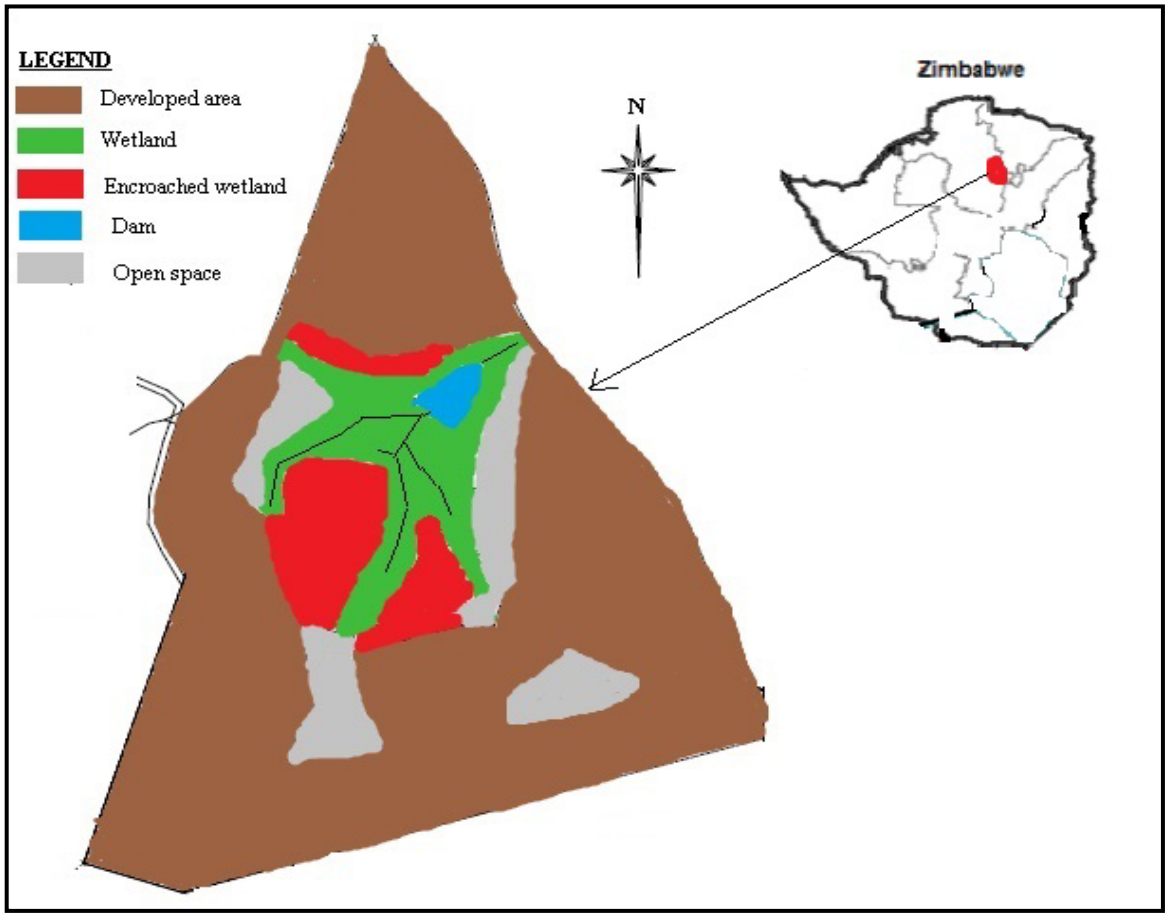

Fig. 2 Land-use simulation for Hatcliffe

Hatcliffe is characterised by several informal urban practices cross cutting urban agriculture, wildlife exploitation with negative implications on the urban environment. In terms of green space management, there has been exploitation of the major wetland area for urban agriculture by the local residents as a poverty eradication strategy. The local dam in Hatcliffe has majorly multifaceted with several indicators of environmental pollution such as water hyacinth (*Eichhornia crassipes*) as evidence of eutrophication from excessive use of agricultural chemicals in the practice of urban agriculture within wetland areas and idle pieces of land (see Figure 3). This depicts priority dilemma between environmentalism and urban poverty where there is need to strike a balance between the two poverty and environmentalism of which policy makers in the developing world prioritize poverty eradication for various rationalities.

Indiscriminate solid waste disposal has been remarkable on residential space due to inefficient and ineffective waste collection system; these wastes pose danger to aquatic lives and compromises environmental health for the local residents (see Figure 4). There are no waste recycling mechanisms in the residential area and lack of environmental stewardship cooked by inefficient municipal waste collection systems, which have led to dumping of waste haphazardly and aesthetically displeasing whilst compromising health of the community (see Figure 4). This problem has not received enough attention from local authorities.

The construction in the residential area rises certain environmental concerns since the manufacturing of commonly used farm bricks pose environmental defects emitting green house gases from firewood used on the manufacturing at the same time depleting forestry resources of the area (see Figure 5).

There is a pattern of gullied settlement landscape due to indiscriminate extraction of building materials for brick making and construction.

Fig 3: Eutrophication from urban agricultural chemicals

Fig 4: Indiscriminate Waste Dumping

Poverty has exacerbated environmental exploitation by the local residents, as they have no other option than exploiting the environment to subsist. Hatcliffe residential area is characterised by low density vegetation and high usage of firewood. Burning firewood is used as an alternative energy to compensate for electricity power cuts. This practice exacerbates the destruction of (ESAs) (see Figure 6). This also has been contributing to green house gases emissions posing adverse effects at both local and global scale. These practices have become the normal life of Hatcliffe inhabitants. Striking the status of the residential settlement as a hub of ecological treasure is perceived as towers of ivory.

The conscience of protecting the remaining ecological treasures among the local residents has been defused by such factors hence there need for tools of social mobilization towards environmental stewardship.

Wildlife seems to be non-existent in the residential areas, as the confined wildlife habitats have been exploited by agricultural practices and firewood harvesting (see Figure 7).

The local residents had no conscience of their extinction out of ignorance and lack of option to address urban poverty. There are no mechanisms in place to protect urban wildlife from human interference. The residential settlements are just conventional landscapes devoid of wildlife habitats, and the human species forget to incorporate what used to habitat there before artificial development due to agricultural practices (see Figure 7).

Fig. 5: Unsustainable conventional construction of houses

5 DISCUSSION

Priority dilemma subsists on whether to conserve urban nature, when the people are hungry in their stomachs and have a shortage of housing (Maphosa *et al,* 2009). This dilemma dilutes nature conservation priorities in an economy multifaceted with unaddressed problems that cut across economic, social and political realms. From the study area, one informant clarified that *"hatingachengete sora isu tichifa nenzara itsika yechitema kurima, zvakabva kumadzitateguru edu, varungu ndovanorimira mumasupermarket chete"* (we cannot conserve weeds while dying of hunger; it is our tradition to practice agriculture, only whites rely on food from supermarkets). When people lack financial resources, they often had a little choice but to take what they can from the environment as a survival strategy (Chenje and Johnson, 1994). It clarifies why the local populace exploit the wetland bands for agriculture and open space invasion in low-income residential areas.

Fig. 6 Brown landscapes in the residential space

Fig 7: Wetland exploitation for urban agriculture

This has led to a critical situation of "Farming houses, yielding exploited environment" which is detrimental to sustainability of urban space. At the same time ecological illiteracy has led to ecologically sensitive areas being regarded as waterlogged areas, unsuitable for development in the immediate and short-term, rather than areas rich in the flora and fauna species.

Social resistances are common where society perceives environmental conservation in a reluctant manner mimicking the parable of boiling frog. *If you take a frog and put it in hot water, it can quickly jump out with some injuries as a reaction to high temperatures, but if you put it in cool water and gradually heat, it you will get frog soup.* This is related to how the society react to challenges where instant (hot) problems receive quick attention and high priority whilst gradual problems such as environmental issues receive less concern. The society is blinded by short-term benefits of degrading the environment (*warmth*) until they are caught in the destruction of human life due to environmental destruction (*boiling water),* which will be too late.

5.1 POLICY ALTERNATIVES

For fruition of ecologically conscious low-income residential development, there is need to espouse the following measures into praxis:

- Incorporate traditional ecological conservation strategies into modern residential planning in Harare.
- Reform and revise town planning instruments towards ecological-based planning.
- Strengthen legislative frameworks that govern environmental management in low-income residential areas.
- Reform the building standards by-laws *vis-a-vis* residential development on environmental sustainability.
- Strengthen responsible institutions' proactive and reactive measures to environmental conservation.
- Promote ecological education awakening to enhance ecological literacy among local residents.
- Initiate and coordinate public, private partnerships in promoting environmental conservation to maximize financial and institutional capacities.

- Harness Indigenous knowledge of the development area in formulation of environmental conservation strategies.
- Adopt a participatory planning approach to environmental conservation to enhance public participation and environmental stewardship amongst environmental stakeholders.
- Formulate poverty eradication strategies devoid of ecological destruction in Hatcliffe residential area.

6 CONCLUSION

The paper explored the capacities, opportunities and constraints of implementing the principles of ecological-based planning into low-income residential development with the purpose of achieving sustainable settlements. It explores the existing legislative, policy and institutional approaches to the environmental planning of low-income residential settlements in Harare. Our study concludes that the restraints overweighed the capacities available, thus the development of low-income housing requires considerable planning intervention. The findings of this study call for a robust implementation of environmental conservation strategies, the propagation of a strong environmental stewardship, and the need for responsive institutional and funding mechanisms backed by realistic and updated legislative framework and robust policy rectification. The conjugate faces common urban challenges, which require uncommon treatment to celebrate the ecological cities' success story.

REFERENCES

Beer, Anne R; Tim Delshammar, and Peter Schildwacht. "A changing understanding of the role of greenspace in high-density housing - a european perspective." Built Environment, 29(2), 2003: 132 -143.

Brand, Partison. "Urban environmentalism: in the twilight between vice and virtue." Urban Design International, 1(4), 1996: 357-360.

Castels, Stephen. Ethnicity and globalisation: from migrant workers to translational citizen, London: Sage Publications, 2000.

Chaeruka, Joel, and Killan Munzwa. Assessing Regulatory Framework Bottlenecks for Low-cost Housing in Zimbabwe. Harare: UN-HABITAT and the Government of Zimbabwe, 2009.

Chenje, Munyaradzi, and Johnson Phyllis. State of the Environment in Southern Africa. Harare: IUCN-The World Conservation Union, 1994.

Chirisa, Innocent, and Muchini, Tawanda. "Youth, Unemployment and Peri-Urbanity in Zimbabwe: a snapshot of lessons from Hatcliffe." International Journal of Politics and Good Governance Volume 2, No 2.2, Quarter II (International Journal of Politics and Good Governance), 2011.

Dirwai, Charles. Demographic Study of a holding camp: The case of Hatcliffe Extension, Zimbabwe. Harare: Unpublished MSc thesis, Centre for Population Studies, University of Zimbabwe, 2000.

Gilbert, Richard; Stevenson Don; Girardet, Hebert; and Stren, Richard. Making cities work: The role of local authorities in the urban environment. London: Earth Scan publications, 1996.

Government of Zimbabwe. Statutory Instrument 7 of 2007, Environmental Management Regulations. Harare: Government Printers, 2007.

Government of Zimbabwe. Environmental Management Act (Chapter 20:27). Harare: Government Printers, 2000.

Government of Zimbabwe. The Regional Town and Country Planning Act Chapter 29:12. Harare: Government Printers, 1996.

Hough, Micheal. City Form and Natural Processes. London: Routledge, 1991.

House of Commons. Enhancing urban green Space: Fifty–eighth Report of Session 2005-06. London: The Stationery Office Limited, 2006.

Madanipour, Ali. Design of Urban Space: An Inquiry into a Socio-Spatial Process. New York: John Wiley and Sons, 1996.

Maphosa, France; Kujinga, Krasposy and Chingarande Sunungurai D. Zimbabwe's Development Experiences Since 1980: Challenges and Prospects for the Future. Addis Ababa: Organisation for Social Science Research in East Africa, 2008.

Mbiba, Beacon. “Beyond Abject Spaces: Enterprising Zimbabwean Disapora in Britian”, Africa Dispora 4 (2011), 50-75.

Muderere, Trymore. "Natural Co-Existence or Confinment:Challenges in integrating Bird Life Concerns into Urban Planning and Design in Zimbabwe." Journal of Sustainable Development in Africa (Volume 13, No.1, 2011) , 2011: 162-183.

O'Riordan, Timothy and Turner Kerry T. An Annoted Reader in Environmental Planning and Management. Oxford: Pergamon Press, 1983.

Pieterse, Edgar. "Recasting Urban Sustainability in the South." Society for International Development 1011-6370/11, 2011: 309–316.

Potts, Deborah. The slowing of sub-Saharan Africa's urbanization: evidence and implications for urban livelihoods. Environment and Urbanization 21(1), 2009: 253–259.

Said Ilias, Omar Osman, Mohd Wira, Mohd Shafiei, Arman Abd Razak, Tee Kuan Kooi. "Sustainability in the Housing Development Among Construction Industry Players in Malaysia". The Journal of Global Business Management Vol. 5, 15, 2009.

Simone, Abdou Maliq. “Moving Towards Uncertainty: Migration and the Turbulence of African Urban Life”. Paper prepared for Conference on African Migration in Comparative Perspective, Johannesburg, South Africa, 4-7, June, 2003. URL: http://time.dufe.edu.cn/wencong/africanmigration/2Simone. pdf.

Shu-Yang, Fan, Bill Freedman, and Raymond Cote. "Principles and practice of ecological design." Environ. Rev. Vol 12: , 2004: 97–112.

Termorshuizen, Jolande W, Paul Opdama, and Brink Adri van den. "Incorporating ecological sustainability into landscape planning." Landscape and Urban Planning 79, 2007: 374–384.

Toriro, Percy. “Town Planning in Zimbabwe: History, Challenges and the Urban Renewal Operation Murambatsvina”, Chapter 11 in Maphosa F, K Kujinga and S D Chingarande (eds.) Zimbabwe's Development Experiences since 1980: Challenges and Prospects for the Future, OSSREA: Addis Ababa 2007.

IMAGE SOURCES

Fig. 1: Authors' creation (2013)

Fig. 2: Adapted from Google Earth (2013)

Fig. 3: Field Surveys by authors (2013)

Fig. 4: Field Surveys by authors (2013)

Fig. 5: Field Surveys by authors (2013)

Fig. 6: Field Surveys by authors (2013)

Fig. 7: Field Surveys by authors (2013)

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LIMITS TO ECOLOGICAL-BASED PLANNING IN ZIMBABWE

THE CASE OF HARARE

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ABSTRACT

This paper explores the feasibility of adopting ecological based planning in low-income residential development. It explicates that in developing countries efforts by housing authorities have been on housing provision irrespective of the environmental threats to sustainability. As these houses are built, future of urban ecology is under threat. The questions regarding this phenomenon are several: how do low-income populations perceive environmental issues of urban settlements? How capable and willing are the local authorities to embrace and apply ecological based planning in residential development? What are the facilitating instruments of ecological-based planning? What are the prospects of integrating ecological based planning to low-income residential development? What are the restraining factors towards embracement of ecological based planning and how best can they be harnessed towards future ecological cities? The case study of Hatcliffe residential area in Harare shows that there are many challenges to overcome uncoordinated planning approaches, ineffective policies and legislative frameworks, weak institutional settings, financial constraints, outdated planning standards and regulations, poverty, lack of environmental stewardship and lack of political will among others. The study findings call for robust environmental conservation strategies, strong environmental stewardship, responsive institutional and funding mechanism backed by realistic legislative frameworks and robust policy rectification.

KEYWORDS:
Ecological-based planning, low-income residential areas, sustainability, urbanisation

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津巴布韦的生态规划限制

哈拉雷案例

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摘要

本文探讨了在低收入住宅区开发中采用生态规划的可行性。本文揭示发展中国家的房管部门一直以来只注重房屋供应，而忽略了环境给可持续发展带来的威胁。随着这些房屋的建成，城市生态的前景受到威胁。针对这种状况有如下几个问题：低收入群体如何认知城市居住区的环境问题？地方当局如何有能力并愿意在住宅开发中接受和应用生态规划？生态规划的促进手段有哪些？集成化生态规划在低收入住宅开发中的前景如何？对于生态规划的接受有哪些制约因素，以及对于未来的生态城市如何更好地驾驭这些制约因素？对哈拉雷Hatcliffe住宅区的案例研究表明，在克服僵化的规划方法、无效的政策和立法架构、薄弱的机构设置、财政制约、过时的规划标准和规定、贫穷、环境管理和政治意愿匮乏等方面，仍面临诸多挑战。研究结果表明亟需强大的环境保护战略、有力的环境管理工作、能够做出响应的机构和筹资机制，这些均需要有效的立法架构和稳健的政策调整来提供支持。

关键词
生态规划；低收入住宅区；可持续性；城市化

1 INTRODUCTION

In the time of rapid urbanisation process, residential development has been of critical concern to cater for expanding populace within the urban space. In efforts to accommodate the exploding population, nature has been 'designed out' of the residential development equation. As well, low-income residential areas constitute the largest space of the built environment in most cities of the developing countries. Departing from such a complexity, this paper makes a feasibility study on the applicability of Ecological Based Planning (EBP) to low-income residential development. Conceptually, EBP entails the sustainable marriage of the hard and soft space that is development of environmentally sensitive settlements. EBP constitutes components of green space enhancement, wildlife conservation, green architecture as well as green energy within urban settlements. These components holistically shape the syntax of urban environmental planning.

The study notes that there is inherent environmental crisis globally of rapid growth of the human population; the depletion of both non-renewable and renewable resources; and extensive and intensive damage caused to ecology. This is being exacerbated mainly by a generally huge influx of population in cities.

In the developed world, such a trend of huge population influx is explained by increasing exilic and Diaspora populations in urban territories (Mbiba, 2000). In the developing countries, rural-to-urban migration is rampant (Simone, 2003; Toriro, 2011). Overall, cities in developing countries are experiencing spontaneous expansion of low-income residential areas (Maphosa *et al*, 2008). Once they arrive in the cities, the migrants require somewhere 'to put their heads' hence the logic of low-income housing. Low-income residential areas have thus tended to occupy a critical space, normally reserved for 'nature'. In this regard, the 'invasion' of ecologically sensitive areas (ESA) has been inevitable and to the detriment of urban ecosystems. In cities of the developing world, little emphasis has been paid to low-income residential areas, which account for the largest proportion of the urban land. Likewise, policy makers have been reluctant, if not resisting, addressing facets of environmental sustainability of low-income residential areas (Muderere, 2011; Maphosa *et al,* 2008). Urban nature does not seem to be incorporated into urban planning. Thus, the hard and soft space appears as two rivers flowing parallel whilst eroding the banks of each other.

This paper relates ecological-based planning components to low-income residential areas with the methodological lens of Hatcliffe case study in Harare, Zimbabwe. The paper maps out the capacities, opportunities and constrains of adopting EBP in low-income residential development. The qualitative methodologies used to construct the discourse are the key informant interviews and observations. Key informants were local planning authorities, environmental boards and the local residents of Hatcliffe. The study provokes a discussion on capabilities of the local authorities to embrace the adoption of EBP as well as scrutiny of low-income residents as enemies of ecological sustainability, reasons for ecological exploitation. This leads to a discussion on the nature of residential development in Zimbabwe as well as the feasibility study of incorporating EBP as an environmental planning tool for sustainable human settlements. The paper concludes by suggesting possible policy options to be espoused for robust integration of EBP in low-income residential areas towards environmentally sensitive settlements.

2 CONCEPTUAL AND ANALYTICAL FRAMEWORK

The concept of Ecological-Based Planning has been a critical approach in the anthropocene epoch. EBP is an approach of creating environmentally sensitive human settlements, which means living in harmony with nature through use of its principles.

Contemporary urban environmental praxis has broadened intergenerational inequalities and there is need for moderation through robust planning intervention (Shu-Yang *et al,* 2004). EBP constitute the enhancement of green space of green, wildlife protection, green energy, wetland protection as well as green architecture (Gilbert *et al,* 1996).

Globally ecological based planning is practiced with cornerstones as green space enhancement, urban wildlife protection, sustainable construction, environmentally friendly energies and protection of environmentally sensitive areas (Said *et al,* 2009). The package of ecological based planning is multifaceted but for it to work effectively it requires integrated approach of applying them holistically. In conquest to conserve nature, these components seek to marry the built space with urban ecology. Within the realm of ecological based planning, green space enhancement is crucial.

Green space plays a vital role in enhancing the quality of urban life by creating attractive cityscapes; improve health, sustainable neighbourhood renewal and better community cohesion in deprived communities (House of Commons, 2009). It also offers environmental benefits, including pollution control, water management, wildlife havens and biodiversity. Naturalising urban ecosystems by increasing or maintaining the dominance of native species and their communities have been of great importance (Shu-Yang *et al,* 2004). Green space enhancement also encompasses the protection of ecologically sensitive areas (ESAs) such as wetland areas. Green architecture is another crucial component of ecological based planning. It entails the construction of buildings that are environmentally friendly throughout their life cycle from construction, use and demolition. Ecologically friendly houses facilitate more affordable living in the end, as they minimize energy costs (Said, *et al,* 2009).

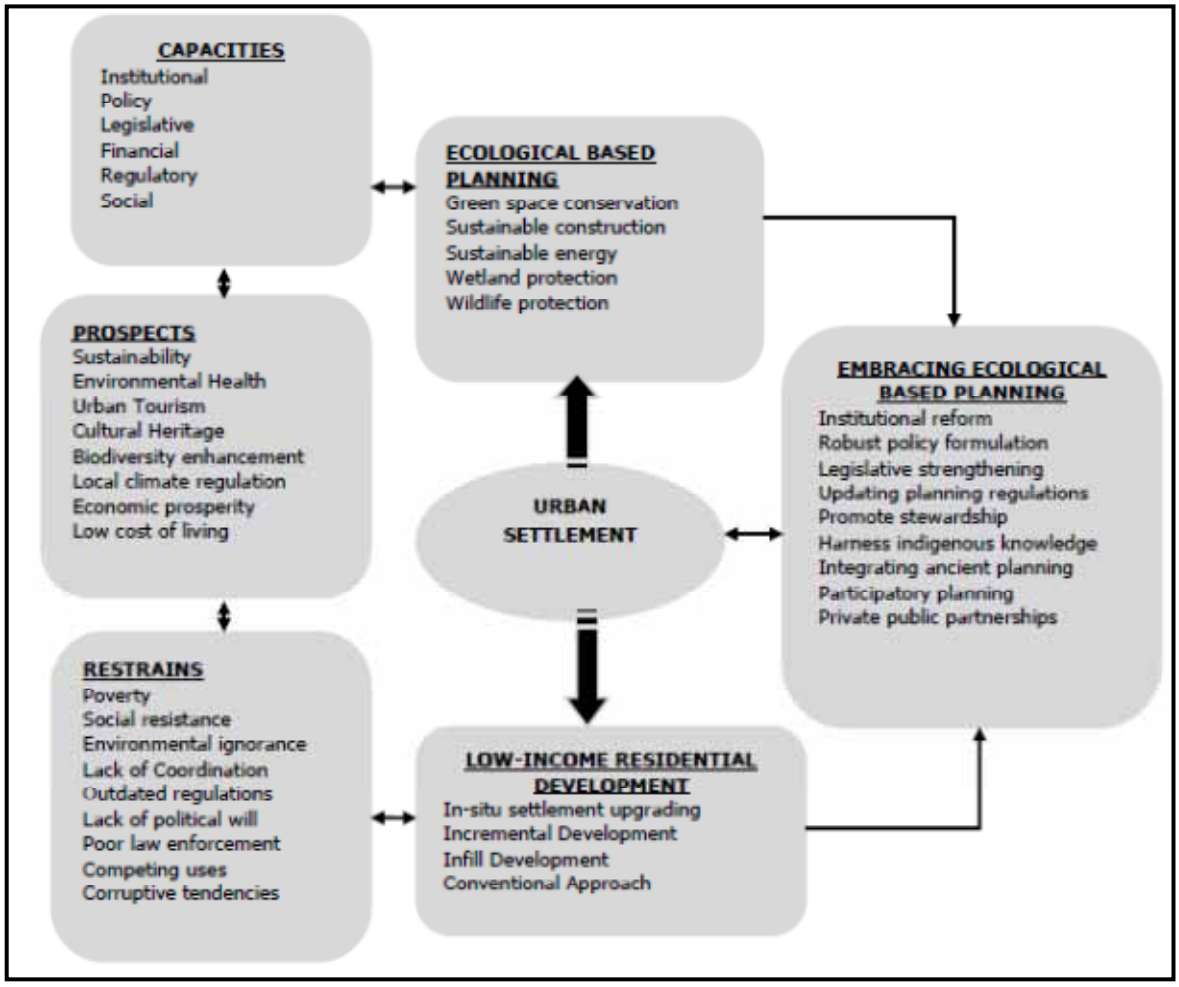

Fig. 1 Ecological-based planning conceptual framework

Nevertheless, neither the private nor the public housing providers have shown much interest in environmentally friendly housing provision and this has raised the eyebrows of environmentalists globally. Ecological construction is also contemplated in several traditional building designs where local materials are used in their construction in order to become more energy and resource efficient. The American architect

Frank Lloyd Wright who introduced “organic architecture” at the beginning of the twentieth century marked the revolution of green architecture within urban settlements (Hough, 1991). He initiated the design of houses constructed of local building materials, also known as vernacular architecture. Whilst made much progress, there is still need for more attention to energy and resource efficiency in the construction and operation of residential buildings as a crucial component of ecological based planning.

In addition, other components of ecological urbanism are the use of green energy, and sustainable waste management. Globally use of sustainable energies has become a crucial necessity in order to avoid the depletion of non-renewable energies. The concept of green energy constitutes use of energy with minimum or no negative impact on the natural environment. These include the use renewable clean energy such as solar, wind energy in substitution of fossil fuels, which have an adverse environmental damage. Waste management and waste reduction have been of great concern to environmentalists (Said *et al,* 2009). The mechanism of waste minimisation comes in three modes of Re-use, Reduce and Recycle (Beer, 2003). The reduction of the garbage has been a major global concern. Thus, there is continuous increase of their huge bulk, because of the modern society and the urban and one of modern societies' greater challenges. Also the increasing tendency of global consumption on secondary consumable (Pieterse, 2011), thus call for ecological based planning intervention in the realm of urban development with regard to waste management.

Whilst unpacking ecological based planning components, urban wildlife protection has been of great concern to urban planning as urban wildlife has been hastening towards extinction. Conservation of urban fauna has been of less attention in the discussion table of the developing world but its importance rang the bell of the global community (Hough, 1991). Muderere (2011) as well notes that, through ecological networks and nature sanctuaries, urban wildlife had been habituated in urban places either by natural existence or by confinement. Conceptually, ecological based planning comprises several principles which include meeting the needs of humans and the economy, sustaining ecosystem integrity, the use of renewable resources, natural debt elimination, nature conservation and biodiverstity enhancement (Shu-Yang *et al,* 2004). It also seeks to increase environmental literacy to build social support for sustainable development, resource conservation, and protection of ecology. These principles are fully espoused by enhancing the ecological based planning components (see Figure 1). The use of force field analysis realises the capacities, opportunities and constrains of ecological based planning - low-income residential areas conjugate.

Greening the environment for the planning of human settlements has been a continuous debate at international forums, but these debates are yet to be scaled down to low-income residential areas in cities of the developing world. Studies on the sustainability of residential development have been extensive, but the ecological development and operation of low-income residential areas lacked recognition (Maphosa, *et al,* 2009). The continuity of a dynamic balance between needs and demands of people for equity, prosperity as well as quality of life at the same time maintaining healthy ecologies are cornerstones of sustainable development (Castels, 2000). The housing realm is multi-faceted as it depletes natural resources as well as producing impact on the natural environment (Said, *et al* 2009). As the poor population is the most dependent on the environment, Low-income residential areas have become hubs of massive ecological destruction. While globally planning has acquired a more "ecological" conscience, in conquest to face the matters of environmental defects, the legislators in cities of the developing countries are still concerned with survival of the current generation regardless of compromising the needs of the future.

Ecological based planning has long history of praxis being practiced by early ancient societies. Regarding the population, they had considerable impact on the natural environment in comparison to contemporary urban settlements. Ecological based planning reflected in several traditional building designs that use local materials in their construction, situated and designed to achieve optimalities of heating and cooling. Examples of such sophisticated architecture include traditional buildings constructed using adobe, animal

hides, or living spaces excavated from soft rock (Van der Ryn and Cowan 1995 cited in Shu-Yang *et al,* 2004). Scaling down to the local scale, ancient African societies had sophisticated ecological conservation practices. The concept of sacred controls on forests *(rambokutemwa)* was a way of creating ecological networks devoid of human disturbances and a form of biodiversity enhancement.

In relation to the African societies, the concept of totems was a cultural filtration strategy to wildlife consumption where every tribe had an animal devoid of human consumption leading to conservation of wildlife with even national emblem of bird species (*Hungwe)* as sacred. Ancient societies had fascinating architectural concepts of sustainable construction. Use of biodegradable building materials such as timber, thatch grass and mud proved environmentally beneficial as their high rate of migration left no prints of environmental disturbance thus, all building materials returned to nature. In a complex world, where human populations cluster in densely populated settlements with exorbitant pressure on the urban environment the challenge is; how these ancient ideas can be harnessed in formulation of robust environmental conservation strategies? Applicability of such sophisticated ideas in contemporary cities has been controversial due to several reasons amongst others being incompatible with modern bylaws and planning regulations as well as cultural change.

3 LOW-INCOME RESIDENTIAL DEVELOPMENT IN ZIMBABWE

While not blanking out the memories of prohibitive colonial city regulations, independence in 1980 in Zimbabwe witnessed a huge influx of rural migrants to urban areas (Mbiba, 2000). A compounding of 'rural push' and 'urban pull' elements defined the urbanization trends. Housing delivery has been a burning issue since the 1950s and limited governmental involvement in housing provision, which occurred during the early post-colonial period in Zimbabwe, has been the exacerbating factor (Chaeruka and Munzwa, 2009; Maphosa *et al* 2007). Demographically urban population has exorbitantly expanded as the 2002 Census placed the urban population at 35% with nearly half (46%) living in Harare (Chaeruka and Munzwa, 2009). The harsh macro-economic conditions have been main cause of poor residential development in Zimbabwe. The legislative instruments: Housing Standard Act, Model Building Byelaws and the Regional, Town and Country Planning Act missed environmental concerns regarding housing development, which gradually deteriorated residential space. As Chaeruka and Munzwa (2009) argue, the rapid urbanisation that Zimbabwe witnessed after 1980 put a strain on the physical, economic and social fabric of most towns and cities; they missed out hardly the environmental impact of rapid urbanisation. This led to a situation whereby the low-income residential development has been done haphazardly to the deteriment of environmental quality. In fact, most of the recently developed housing in the peri-urban of most Zimbabwean cities qualify as substandard housing given the lack of water and sanitation, and paved roads.

Thus, nationwide there has been galloping of over a million of populace on housing backlog (Chaeruka and Munzwa, 2009). This has pushed the shape of residential space to informal and peri urban settlements, putting the urban ecological space at jeopardy. More often than not, the existing settlements have exceeded their carrying capacity stressing the environment they rest upon and occupying ESAs in the name of "land dearth". Currently the sustainability of low-income residential development consists of more questions than answers. Low-income residential AREAS have been neglected and rejected as hubs for urban ecological treasure. As such, there have been reluctant reactions on the adoption of sustainable residential development. This issue emanates from city legislators who regard ecological based planning as a bureaucratic hurdle to urban planning (Chaeruka and Munzwa, 2009).

3.1 FACILITATING FACTORS

Zimbabwe has a broad legislative framework positioned to govern environmental management. The section 4 of Environmental Management Act, chapter 20:27, 2002 enhanced environmental rights to Zimbabwean

citizens. This instrument promotes environmental stewardship among urban residents. Also in relation to nature conservation, the Forest Act of 1949 chapter 19:05 protects the urban flora, and the Parks and Wildlife Act of 1975, chapter 20:14 protects the exploitation of urban wildlife (fauna). These instruments have failed to promote the conservation of urban ecology in low-income residential areas since they have been calling for updating as they are now outdated in regard to incorporation of environmental sustainability, reform, and strengthening for their operation to be fully functional. This has been a result of the local planning authorities not using them in their full capacity. Additionally there are various institutional and administrative structures in charge of environmental management. The Ministry of Environment and Natural Resource Management (MENRM) plays a pivotal role in management of environmental resources. The National Environmental Council (NEC) alternatively supports as an advisory board to allied institutions on environmental management. There is also Environmental Management Agency (EMA), which fosters environmental policies such as Environmental Impact Assessment policy of 1997 and the National Environmental Policy of 2003. However, having various institutions in charge of the environmental management creates a situation where a lack of a clear-cut of responsibilities compromises their effectiveness. As diversity leads to generalization, these institutions have proved to be aseptic to their responsibilities regarding state of environmental sustainability in low-income residential areas.

3.2 RESTRAINING FACTORS

Enforcing environmental instruments remains difficult because of inherent weaknesses in law enforcement and development control mechanisms. The prevailing environmental policies act as edentulous bulldogs in guarding against environmental exploitation. There are often repellent reactions in the forms of abnegation, resistance, relativism, and aseptic regulatory responses (Maphosa *et al,* 2009). As regards to local practice, this hinders the initiation and implementation of environmental conservation strategies for low-income residential areas. No direct legislative instruments exist to govern environmental sustainability of low-income residential areas as several legislative instruments and institutions lack clear responsibility of the low-income residential areas, which consequently leads to reluctance in their commitment. The Regional, Town and Country Planning Act (1996), Environmental Management Act (2000) lack concerted effort to relate with other allied supporting instruments towards embracement of environmental sustainability in low-income residential areas. The institutional responses have been naïve to embrace ecological based planning in residential areas thus their multiplicity led to generalization in role-playing (Maphosa *et al,* 2009). Corruption exists within the phase of striking a balance between low-income residential areas and ecological based planning. The low-income housing developers play unscrupulous development practices, greasing the hands of environmental bodies and agencies to be granted development permits regardless of their adverse environmental impacts. Hence, there is need for interplay cooperation among responsible stakeholders. The goal to achieve sustainable development is the greatest challenge humankind has ever faced, demanding a concentrated articulated effort among consumers, the housing industry and government itself (Said *et al,* 2009). For the sake of resources mobilization to foster the ecological based planning initiatives, lack of political will holds back progress. Environmental initiatives have been regarded as bureaucratic red tape to development and housing provision having an extortionate size of housing backlog in Zimbabwe (Maphosa *et al,* 2009). Referring back to the origin of the case area Hatcliffe, it is full of political rebuttals on its existence and development. On the other hand, interventions by international organizations in the environmental management of local resources are being restrained by political connotations of illegitimacy. Drawing from the case study of Hatcliffe residential area, there are several areas calling for discourse. Planning regulations are super-annuated to govern environmental protection. The Regional Town and Country Planning Act is backdated to 1996 where environmental aspects had not provoked hot debates globally hence, it lacks environmental aspects as a backbone of urban planning. Several local development plans and the master

plan at large are as outdated as 1984 where environmental aspects are poorly expressed if not excluded in these statutes. In addition, the current planning area characterised by high degree of inflexibility where they poorly respond to dynamics of environmental change. This invokes planning failure to address environmental issues in modern urban planning. Currently there are reluctant efforts to update these planning regulatory frameworks with speculation of persistence if no robust measures have been adopted.

The scaling down of global environmental initiatives to local levels such as the concept of ecological based planning in low-income residential development is facing hindrances of local resistance and ignorance. The developing world on the environmental discussion tables tends to favour the initiator rather than the concept. That is a great question of legitimacy rather than effectiveness, which conclusively is blind obedience rather than rational discussion. Several global environmental initiatives are rejected because of lacking legitimacy to the third world community (Potts, 2009; Termorshuzein *et al,* 2007). Worldwide environmental scientists are being blamed for interpreting global environmental issues poorly and for being poor communicators, who present environmental issues overcautiously. The management of urban settlements raises the crucial issue of environmental democracy. However, it goes further beyond urban management, into transparency, accountability, and the rule of law, participation, reciprocity, and trust (Castels, 2000). What makes democratisation particularly relevant is the fact that by virtue of various forms of environmental management, urban centres have obtained increasing formal authority over their areas of jurisdiction, although often stopping short of a genuine devolution of decision-making power towards environmental sustainability (Gilbert *et al,* 1996).

There have been doubts over the financial feasibility of fostering ecological based planning within low-income residential areas and this has been stimulated by adoption of the techno-centrism approach rather than eco-centrism approach to environmental chastening. In addition, repellent exists as well as repudiate reactions towards initiation of densification approach to residential development pointing fingers on financial incapacities of local authorities and local communities themselves (Brand, 2006). The current horizontal approach to residential development is exacerbating urban sprawl (encroaching to agricultural land and forestry space) which in turn is compromising the ecological networks of the urban settlements. The dearth of land is being used as an alibi as to why there has been the exploitation of ESAs for residential expansion in cities of developing countries. Having the restraining factors overweighing the facilitating instruments low-income residential areas is left at jeopardy of environmental exploitation.

4 CHARACTERISING THE STUDY AREA: HATCLIFFE

Hatcliffe is a high-density residential area situated twenty-two kilometres to the north of Harare city centre (see Figure 2). It was established in 1984 at the outskirts of Harare as a holding camp of urban migrants coming from different places in Harare: some from Churu farm, some from squatter camp in Mbare and others from nearby farms (Dirwai, 2000). A range of low-income dwellers posing strains on the environment comprises it. Being located on the former peri-urban farm of red soils, it is surrounded by suburbs of high-income earners, Hodget Hill and Philadelphia.

The residential area was originally designed to meet the housing needs of a small population, but housing demand increased rapidly (Chirisa and Muchini, 2011; Dirwai, 2000). The remarkable increase in housing demand has exceeded the ecological carrying capacity of the residential settlement considering the stress on the ecological treasures by residential development. The residential area comprises of ecologically sensitive areas of wetland bands (see Figure 2).

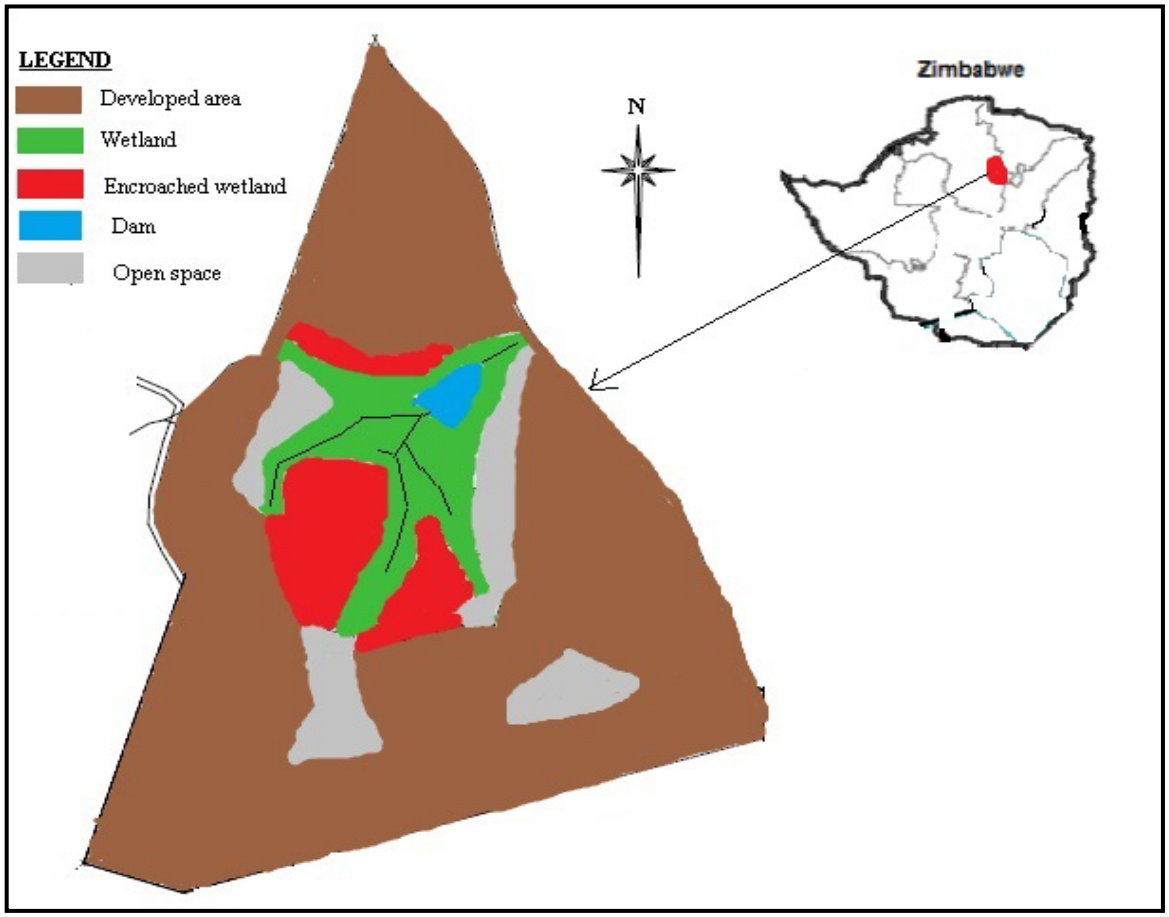

Fig. 2 Land-use simulation for Hatcliffe

Hatcliffe is characterised by several informal urban practices cross cutting urban agriculture, wildlife exploitation with negative implications on the urban environment. In terms of green space management, there has been exploitation of the major wetland area for urban agriculture by the local residents as a poverty eradication strategy. The local dam in Hatcliffe has majorly multifaceted with several indicators of environmental pollution such as water hyacinth (*Eichhornia crassipes*) as evidence of eutrophication from excessive use of agricultural chemicals in the practice of urban agriculture within wetland areas and idle pieces of land (see Figure 3). This depicts priority dilemma between environmentalism and urban poverty where there is need to strike a balance between the two poverty and environmentalism of which policy makers in the developing world prioritize poverty eradication for various rationalities.

Indiscriminate solid waste disposal has been remarkable on residential space due to inefficient and ineffective waste collection system; these wastes pose danger to aquatic lives and compromises environmental health for the local residents (see Figure 4). There are no waste recycling mechanisms in the residential area and lack of environmental stewardship cooked by inefficient municipal waste collection systems, which have led to dumping of waste haphazardly and aesthetically displeasing whilst compromising health of the community (see Figure 4). This problem has not received enough attention from local authorities.

The construction in the residential area rises certain environmental concerns since the manufacturing of commonly used farm bricks pose environmental defects emitting green house gases from firewood used on the manufacturing at the same time depleting forestry resources of the area (see Figure 5).

There is a pattern of gullied settlement landscape due to indiscriminate extraction of building materials for brick making and construction.

Fig 3: Eutrophication from urban agricultural chemicals

Fig 4: Indiscriminate Waste Dumping

Poverty has exacerbated environmental exploitation by the local residents, as they have no other option than exploiting the environment to subsist. Hatcliffe residential area is characterised by low density vegetation and high usage of firewood. Burning firewood is used as an alternative energy to compensate for electricity power cuts. This practice exacerbates the destruction of (ESAs) (see Figure 6). This also has been contributing to green house gases emissions posing adverse effects at both local and global scale. These practices have become the normal life of Hatcliffe inhabitants. Striking the status of the residential settlement as a hub of ecological treasure is perceived as towers of ivory.

The conscience of protecting the remaining ecological treasures among the local residents has been defused by such factors hence there need for tools of social mobilization towards environmental stewardship.

Wildlife seems to be non-existent in the residential areas, as the confined wildlife habitats have been exploited by agricultural practices and firewood harvesting (see Figure 7).

The local residents had no conscience of their extinction out of ignorance and lack of option to address urban poverty. There are no mechanisms in place to protect urban wildlife from human interference. The residential settlements are just conventional landscapes devoid of wildlife habitats, and the human species forget to incorporate what used to habitat there before artificial development due to agricultural practices (see Figure 7).

Fig. 5: Unsustainable conventional construction of houses

5 DISCUSSION

Priority dilemma subsists on whether to conserve urban nature, when the people are hungry in their stomachs and have a shortage of housing (Maphosa *et al,* 2009). This dilemma dilutes nature conservation priorities in an economy multifaceted with unaddressed problems that cut across economic, social and political realms. From the study area, one informant clarified that *"hatingachengete sora isu tichifa nenzara itsika yechitema kurima, zvakabva kumadzitateguru edu, varungu ndovanorimira mumasupermarket chete"* (we cannot conserve weeds while dying of hunger; it is our tradition to practice agriculture, only whites rely on food from supermarkets). When people lack financial resources, they often had a little choice but to take what they can from the environment as a survival strategy (Chenje and Johnson, 1994). It clarifies why the local populace exploit the wetland bands for agriculture and open space invasion in low-income residential areas.

Fig. 6 Brown landscapes in the residential space

Fig 7: Wetland exploitation for urban agriculture

This has led to a critical situation of "Farming houses, yielding exploited environment" which is detrimental to sustainability of urban space. At the same time ecological illiteracy has led to ecologically sensitive areas being regarded as waterlogged areas, unsuitable for development in the immediate and short-term, rather than areas rich in the flora and fauna species.

Social resistances are common where society perceives environmental conservation in a reluctant manner mimicking the parable of boiling frog. *If you take a frog and put it in hot water, it can quickly jump out with some injuries as a reaction to high temperatures, but if you put it in cool water and gradually heat, it you will get frog soup.* This is related to how the society react to challenges where instant (hot) problems receive quick attention and high priority whilst gradual problems such as environmental issues receive less concern. The society is blinded by short-term benefits of degrading the environment (*warmth*) until they are caught in the destruction of human life due to environmental destruction (*boiling water),* which will be too late.

5.1 POLICY ALTERNATIVES

For fruition of ecologically conscious low-income residential development, there is need to espouse the following measures into praxis:

- Incorporate traditional ecological conservation strategies into modern residential planning in Harare.
- Reform and revise town planning instruments towards ecological-based planning.
- Strengthen legislative frameworks that govern environmental management in low-income residential areas.
- Reform the building standards by-laws *vis-a-vis* residential development on environmental sustainability.
- Strengthen responsible institutions' proactive and reactive measures to environmental conservation.
- Promote ecological education awakening to enhance ecological literacy among local residents.
- Initiate and coordinate public, private partnerships in promoting environmental conservation to maximize financial and institutional capacities.

- Harness Indigenous knowledge of the development area in formulation of environmental conservation strategies.
- Adopt a participatory planning approach to environmental conservation to enhance public participation and environmental stewardship amongst environmental stakeholders.
- Formulate poverty eradication strategies devoid of ecological destruction in Hatcliffe residential area.

6 CONCLUSION

The paper explored the capacities, opportunities and constraints of implementing the principles of ecological-based planning into low-income residential development with the purpose of achieving sustainable settlements. It explores the existing legislative, policy and institutional approaches to the environmental planning of low-income residential settlements in Harare. Our study concludes that the restraints overweighed the capacities available, thus the development of low-income housing requires considerable planning intervention. The findings of this study call for a robust implementation of environmental conservation strategies, the propagation of a strong environmental stewardship, and the need for responsive institutional and funding mechanisms backed by realistic and updated legislative framework and robust policy rectification. The conjugate faces common urban challenges, which require uncommon treatment to celebrate the ecological cities' success story.

REFERENCES

Beer, Anne R; Tim Delshammar, and Peter Schildwacht. "A changing understanding of the role of greenspace in high-density housing - a european perspective." Built Environment, 29(2), 2003: 132 -143.

Brand, Partison. "Urban environmentalism: in the twilight between vice and virtue." Urban Design International, 1(4), 1996: 357-360.

Castels, Stephen. Ethnicity and globalisation: from migrant workers to translational citizen, London: Sage Publications, 2000.

Chaeruka, Joel, and Killan Munzwa. Assessing Regulatory Framework Bottlenecks for Low-cost Housing in Zimbabwe. Harare: UN-HABITAT and the Government of Zimbabwe, 2009.

Chenje, Munyaradzi, and Johnson Phyllis. State of the Environment in Southern Africa. Harare: IUCN-The World Conservation Union, 1994.

Chirisa, Innocent, and Muchini, Tawanda. "Youth, Unemployment and Peri-Urbanity in Zimbabwe: a snapshot of lessons from Hatcliffe." International Journal of Politics and Good Governance Volume 2, No 2.2, Quarter II (International Journal of Politics and Good Governance), 2011.

Dirwai, Charles. Demographic Study of a holding camp: The case of Hatcliffe Extension, Zimbabwe. Harare: Unpublished MSc thesis, Centre for Population Studies, University of Zimbabwe, 2000.

Gilbert, Richard; Stevenson Don; Girardet, Hebert; and Stren, Richard. Making cities work: The role of local authorities in the urban environment. London: Earth Scan publications, 1996.

Government of Zimbabwe. Statutory Instrument 7 of 2007, Environmental Management Regulations. Harare: Government Printers, 2007.

Government of Zimbabwe. Environmental Management Act (Chapter 20:27). Harare: Government Printers, 2000.

Government of Zimbabwe. The Regional Town and Country Planning Act Chapter 29:12. Harare: Government Printers, 1996.

Hough, Micheal. City Form and Natural Processes. London: Routledge, 1991.

House of Commons. Enhancing urban green Space: Fifty–eighth Report of Session 2005-06. London: The Stationery Office Limited, 2006.

Madanipour, Ali. Design of Urban Space: An Inquiry into a Socio-Spatial Process. New York: John Wiley and Sons, 1996.

Maphosa, France; Kujinga, Krasposy and Chingarande Sunungurai D. Zimbabwe's Development Experiences Since 1980: Challenges and Prospects for the Future. Addis Ababa: Organisation for Social Science Research in East Africa, 2008.

Mbiba, Beacon. “Beyond Abject Spaces: Enterprising Zimbabwean Disapora in Britian”, Africa Dispora 4 (2011), 50-75.

Muderere, Trymore. "Natural Co-Existence or Confinment:Challenges in integrating Bird Life Concerns into Urban Planning and Design in Zimbabwe." Journal of Sustainable Development in Africa (Volume 13, No.1, 2011) , 2011: 162-183.

O'Riordan, Timothy and Turner Kerry T. An Annoted Reader in Environmental Planning and Management. Oxford: Pergamon Press, 1983.

Pieterse, Edgar. "Recasting Urban Sustainability in the South." Society for International Development 1011-6370/11, 2011: 309–316.

Potts, Deborah. The slowing of sub-Saharan Africa's urbanization: evidence and implications for urban livelihoods. Environment and Urbanization 21(1), 2009: 253–259.

Said Ilias, Omar Osman, Mohd Wira, Mohd Shafiei, Arman Abd Razak, Tee Kuan Kooi. "Sustainability in the Housing Development Among Construction Industry Players in Malaysia". The Journal of Global Business Management Vol. 5, 15, 2009.

Simone, Abdou Maliq. “Moving Towards Uncertainty: Migration and the Turbulence of African Urban Life”. Paper prepared for Conference on African Migration in Comparative Perspective, Johannesburg, South Africa, 4-7, June, 2003. URL: http://time.dufe.edu.cn/wencong/africanmigration/2Simone. pdf.

Shu-Yang, Fan, Bill Freedman, and Raymond Cote. "Principles and practice of ecological design." Environ. Rev. Vol 12: , 2004: 97–112.

Termorshuizen, Jolande W, Paul Opdama, and Brink Adri van den. "Incorporating ecological sustainability into landscape planning." Landscape and Urban Planning 79, 2007: 374–384.

Toriro, Percy. “Town Planning in Zimbabwe: History, Challenges and the Urban Renewal Operation Murambatsvina”, Chapter 11 in Maphosa F, K Kujinga and S D Chingarande (eds.) Zimbabwe's Development Experiences since 1980: Challenges and Prospects for the Future, OSSREA: Addis Ababa 2007.

IMAGE SOURCES

Fig. 1: Authors' creation (2013)

Fig. 2: Adapted from Google Earth (2013)

Fig. 3: Field Surveys by authors (2013)

Fig. 4: Field Surveys by authors (2013)

Fig. 5: Field Surveys by authors (2013)

Fig. 6: Field Surveys by authors (2013)

Fig. 7: Field Surveys by authors (2013)

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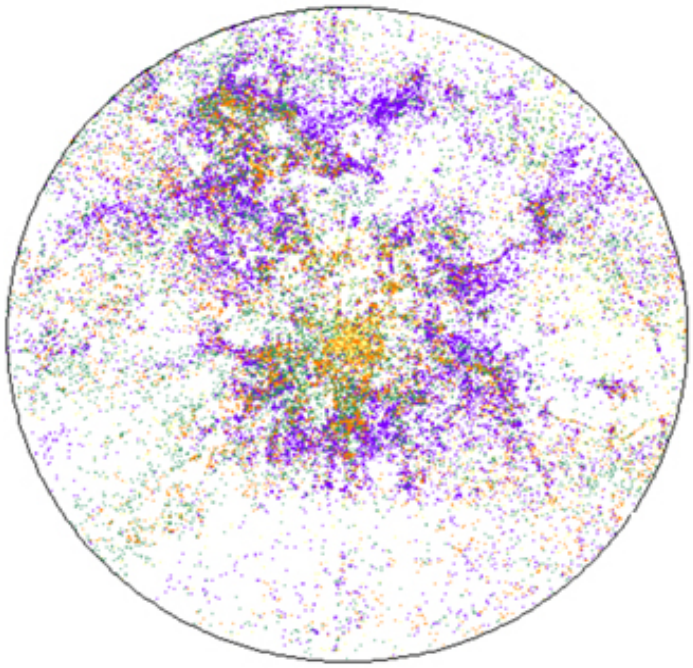

URBANISATION PATTERN OF INCIPIENT MEGA REGION IN INDIA

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ABSTRACT

Urbanisation refers to the growth of the towns and cities due to large proportion of the population living in urban areas and its suburbs at the expense of its rural areas. Unplanned urbanisation leads to the large scale land use changes affecting the sustenance of local natural resources. This necessitates an understanding of spatial patterns of urbanisation to implement appropriate mitigation measures. The focus of the current study is to analyse the spatial patterns of urbanisation and sprawl in Pune city with 10 km buffer using temporal remote sensing data through geo-informatics and spatial metrics. Land use analyses of the city with a buffer of 10km reveals that there has been a significant increase of built-up land from 2.96% (1977) to 20.4% (2013) with the reduction of vegetation from 22.49 to 17.96%. Shannon entropy reveal the tendency of sprawl in NW direction. Zone and Gradient-wise spatial metrics analysis is done to understand the spatial patterns of urbanisation at local levels. The analysis suggests that urbanisation has caused fragmentation with adjacencies in buffer zones. Spatial metrics substantiate rampant sprawl at the peri-urban regions and infilling at city centre. However, this value has reduced in 2013 indicating of reaching the threshold of urbanization. These analyses highlight of the significant changes in land cover with the decline in vegetation, water bodies, etc. This necessitates an integrated approaches in urban planning to ensure the sustenance of water, moderation of micro climate, etc. Conservative urban planning would take into account the sustenance of natural resources and people's livelihood aspects. Visualization of urban growth at local levels helps the urban planners and decision-makers in understanding the role of policy decisions (industrialization, etc.) on land use dynamics, which helps in evolving region specific development strategies to mitigate the potential impacts on the urban environment.
This research provides the details of land use and its development for guiding scientific-based decision support and policy making.

KEYWORDS: Pune, Urban sprawl, landscape metrics, Shannon entropy, India.

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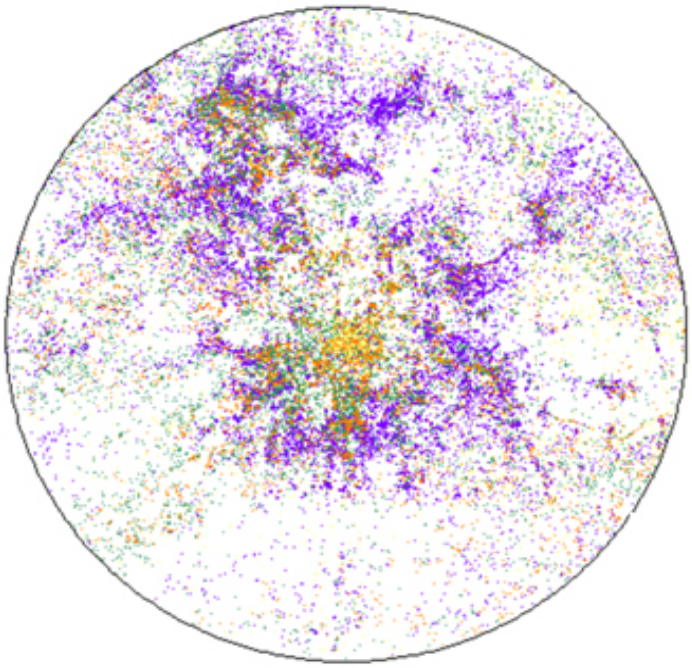

印度初期大都市圈的城市化模式

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摘要

城市化是指大部分人口居住在市区和郊区并以牺牲其农村地区利益为代价的城镇和城市的增长。无序的城市化可导致土地利用的大规模转变，从而造成当地的自然资源无法维系。因此，这就需要对城市化的空间模式有所了解，以便采取适当的缓解措施。此次研究的重点是分析普纳（Pune）市及其10公里缓冲带范围内的城市化和扩张的空间模式，采用的是通过地理信息学和空间测量得到的时相遥感数据。对该市及其10公里缓冲带范围内的土地利用分析发现，建设用地从2.96%（1977年）大幅增长至20.4%（2013年），而植被覆盖则从22.49%降至17.96%。香农熵揭示城市向西北方向蔓延的趋势。为了解局部层面的城市化空间模式，进行了区带和梯度式空间测量分。分析表明城市化已经在缓冲带内的毗邻区域造成破碎化。空间测量证实了城市化在城乡结合部的大肆蔓延和对城市中心的不断挤占。但此值在2013年已有所降低，表明城市化进程达到临界点。该项研究为科学决策和制定政策提供了土地利用和开发的详细资料。

关键词

GIS；熵；城市化； 大都市圈；普纳（Pune

1 INTRODUCTION

Cities origin can be traced back to the river valley civilizations of Mesopotamia, Egypt, Indus Valley and China. Initially these settlements were largely dependent upon agriculture, however with the growth of population the city size increased and the economic activity transformed to trading. The process of urbanisation gained impetus with industrial revolution 200 years ago and accelerated with globalization in 1990's.

Urbanisation refers to the growth of the towns and cities due to large proportion of the population living in urban areas and its suburbs at the expense of its rural areas. In most of the countries the total population living in the urban regions has extensively accelerated since the Second World War. Current global population is 7,057,075,000 billion (Population Reference Bureau, 2005; United Nations, 2011). The rapid urbanization of the world's population over the 20th century is evident (Revision of the UN World Urbanization Prospects report, 2005) from the dramatic increase in global urban population from 13% (220 million, in 1900), to 29% (732 million, in 1950), to 49% (3.2 billion, in 2005) and is expected to increase to 60% (4.9 billion) by 2030 (Ramachandra and Kumar, 2008; Ramachandra et. al., 2012) and 9.6 billion in 2050 (United Nations, 2011).Urban population has been increasing three times faster than the rural population, mainly due to migration in most parts of the world (Girardet 1996; Massey et. al., 1999).

People migrate to urban areas with the hope of a better living, considering relatively better infrastructural facilities (education, recreation, health centres, banking, transport and communication), and higher per capita income. However, rapid unplanned urbanization has led to serious problems in urban areas due to higher pollution (air, water, noise) inequitable distribution of natural traffic congestion, development of shanty towns and slums, unemployment, increased reliance on fossil fuels, and uncontrolled outgrowth or sprawl in the periphery

The direct implication of such urbanisation is the change in land use and land cover of the region. Urban ecosystems are the consequence of the intrinsic nature of humans as social beings to live together (Sudhira, et al., 2003). The process of urbanisation contributed by infrastructure initiatives and consequent population growth and migration results in the growth of villages into towns, towns into cities and cities into metros. However, in such a phenomenon for ecologically feasible development, planning requires an understanding of the growth dynamics. Nevertheless, in most cases there are lot of inadequacies to ascertain the nature of uncontrolled progression of urban sprawls.

Urban sprawl refers to the dispersed development along highways or surrounding the city and in rural countryside with implications such as loss of agricultural land, open space and ecologically sensitive habitats. Sprawl is thus a pattern and pace of land use in which the rate of land consumed for urban purposes exceeds the rate of population growth resulting in an inefficient and consumptive use of land and its associated resources. This phenomenon is characterized by an unplanned and uneven pattern of growth, driven by multitude of processes evident from lack of basic amenities. Urban sprawl is thus a term often used variously to mean the gluttonous use of land, uninterrupted monotonous development, leapfrog discontinuous development and inefficient use of land that are influenced by a myriad of factors, including land features, infrastructure, policies, and individual characteristics. This is characterised by low levels of some combination of eight distinct dimensions such as density, continuity, concentration, clustering, centrality, nuclearity, mixed uses and proximity (Sudhira, et al., 2004; Ramachandra, et al., 2012a).

Process of urbanisation bring the development of a region (Verzosa and Gonzalez, 2010), which could be planned (in the form of townships) or unplanned (organic). Unplanned urbanization leads to the haphazard or irregular growth with the loss of green spaces and water bodies. Dispersed urban growth without proper infrastructure and basic amenities is often referred as sprawl (Yeh and Li, 2001; Sudhira et al., 2004; Verzosa and Gonzalez, 2010, Bharath H A et al., 2012, Bharath S et al., 2012) and this phenomenon is widespread in developing countries (Bhatta et al., 2010a; 2010b). Implications of sprawl are excess demand

on natural resources, improper allocation of basic amenities and infrastructure, (Ramachandra et al., 2012b), deteriorating water quality, an increased potential for harboring disease vectors, etc. Large scale land use and land cover (LULC) changes, such as the loss of forests to meet the urban demands of fuel and land (Ramachandra and Kumar, 2009) has led to the changes in the ecosystem structure, impacting its functioning and thereby threatening sustainable development (Yeh and Li, 1999; Ji et al., 2001; Chen et al., 2005; Xiao et al., 2006; Liu et al., 2007; Ramachandra et al., 2013).

Urban expansion is one of the most direct forms of land use change, and refers specifically to changes in land use patterns and urban space distribution resulting from the social and economic pressures (Pathan et al. 1989, 1991; Gillies et al., 2003; Alphan et al., 2009; Bhatta 2009; Ramachandra and Bharath, 2012a). Land cover changes involving the disappearance of ecologically vital natural systems is the major concern in developing countries (Taubenbock, 2009; Ramachandra et al., 2012a). This has necessitated the understanding of spatial patterns of urbanisation and quantification of changes. Several earlier studies have addressed issues relating to urbanisation in relation to energy, land use and climate (Roth et. al., 1989; Grimm et. al, 2000; Voogt and Oke, 2003; Bharath H. A et al., 2012, Vinay et al., 2012).

Analysis of the urbanisation process and provision of appropriate management strategies requires monitoring of the spatial extent of urbanisation with the location (Kong et. al., 2012).Availability of temporal data through space borne sensors with geographic information system (GIS)has aided in the understanding of spatial patterns and visualization of urbanization with environmental implications (Clapman, 2003; Sutton, 2003; Gillies et al., 2003; Martinuzzi et. al., 2007; Yang et al., 2003; Lopez et al., 2001; Ramachandra et al., 2012b). Remote sensing data provides a birds-eye view of urban land-use changes at regular intervals. Geographic information system (GIS) enables spatial analysis of temporal data, which aid in understanding land use dynamics. Land use (LU) indicates the socio-economic use of land (for example, agriculture, forestry, recreation or residential use), which implies the purpose for which land is employed (Codjoe, 2004) or activities humans undertake inducing a change or maintain it (Di Gregorio and Jansen, 1997; Jansen and Di Gregorio, 1998; Codjoe, 2004).

The spatial patterns elucidate the heterogeneity and complexity of the urban patches in the landscape (Uuemaa et al., 2009) that can be measured using spatial metrics that help in quantifying and monitoring the urban growth (Sudhira et al., 2003; Ramachandra and Bharath., 2012b; Ramachandra et al., 2012a).Landscape structure is a prime factor in analysing the pattern and effects the various natural processes (Molles, 2006), which is determined by size, shape, composition of land use patches within the landscape. The analysis of structure of the landscape is essential to understand the implications of land use changes. In this regard, spatial metrics with a robust mathematical framework help to understand and quantify the spatial patterns of urbanisation (Gustafson, 1998; Sudhira et al., 2004; Herold et al., 2003; Uuemaa et al., 2009; Bharath H.A et al., 2012). Spatial metrics can be computed using Fragstats and Patch Analyst. Fragstats is designed to compute a wide variety of spatial metrics to understand landscape dynamics (McGarigal and Marks, 1995). India has been experiencing urbanisation subsequent to globalisation and opening Indian markets during 1990's. Pune city is the eighth populated Indian city with higher economic growth, industrial development and IT sectors has been experiencing rampant land use changes. However, unplanned urbanisation in most cities in India including Pune has enhanced the environmental concerns in recent years (Bhaskar, 2012). Pune city with sprawl is facing lack of infrastructure and basic amenities such as sanitation, housing, improper drainages, transportation, etc. (Desai et al., 2009). This has necessitated the analysis of spatio temporal patterns of urbanisation for implementing appropriate policy measures to mitigate environmental consequences. The focus of the current paper is to understand the spatial patterns of urbanisation through (I) the analysis of land use dynamics, (ii) investigation of sprawl through Shannon's entropy and (iii) patterns of urbanisation through spatial metrics using gradient and zonal approach.

2 STUDY AREA

Pune, earlier known as Poona is the cultural capital of Maharashtra and is also known as “Queen of Deccan” as it is located atop the Deccan Plateau and also “Oxford of East” and “Detroit of India”. Pune is located in the western part of Maharashtra state between 18°32´ N and 72° 51´E at a height of 560 m above mean sea level. It lies near the confluence of the Mula-Mutha River. Rivers Pavana and Indrayani flows along the north-western outskirts of the urban area. The Pune Municipal Corporation covers an area of 243.84 sq. kms. Pune has a tropical wet and dry climate, with three distinct seasons- Summer(March to May), Monsoon (June to September) and Winter (November to January).The River Bhima flows through the city and provide water supply for the domestic, commercial and irrigation purpose. Rice, Jowar, Bajra, sugarcane, groundnut and sunflower are major crops grown in the Pune. Fig. 1 depicts the population dynamics during 1901 to 2011 showing an increase by 347% during the last 110 years. Pune being one among incipient mega cities in India has seen the large scale development in recent times. Population of Pune has increased by 2 million to 9 million (Census 2011) from 7 million in 2001 (Census 2001, JNNURM, 2006-2012). Fig. 1 shows the population statistics of Pune in last 100 years.

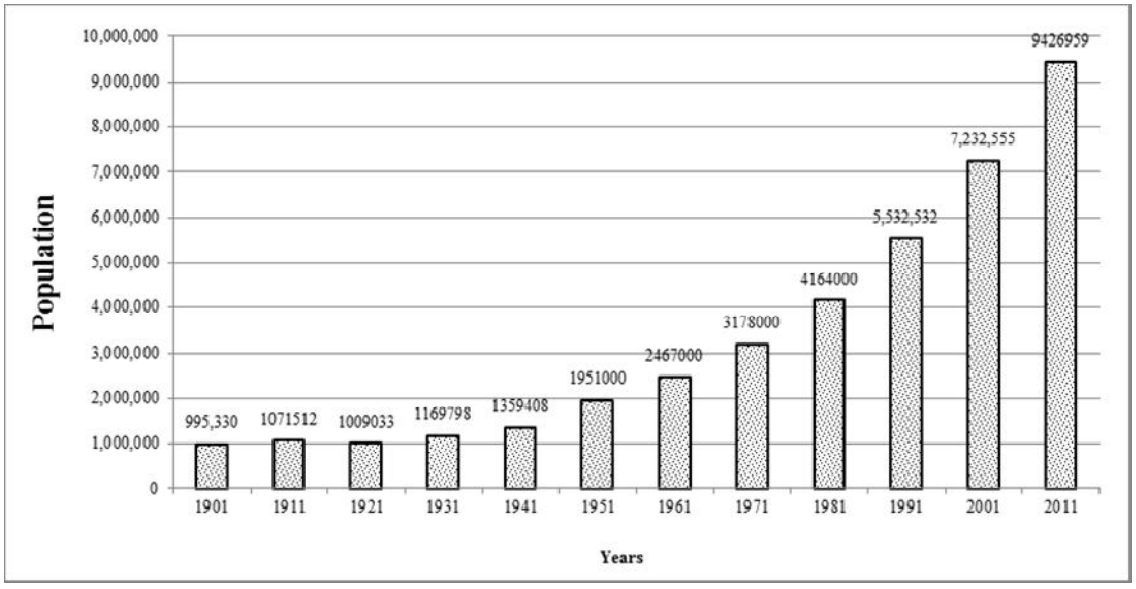


Fig. 1: Growth of population in Pune

Pune Municipal Corporation with forty-eight wards is the civic body that is responsible administration and infrastructure development of the city and it is known as the Pune Mahanagar Palika (PMP). The current study has been carried out in a region of 1524.4 sq. km consisting of municipal corporation administrative region with 10 km buffer. Buffer of 10 km is considered to account the growth in the peri-urban regions (Fig. 2). Time series spatial data acquired through Landsat Series Multispectral sensor (57.5m) and thematic mapper (30m) and Landsat 8 operational image scanner (30m) sensors for the period 1973 to 2013 were downloaded from a public domain Global Land Cover Facility (http://www.glcf.umd.edu/index.shtml) and (http://www.landcover.org/). Survey of India (SOI) topographic sheets of 1:50000 and 1:250000 scales were used to generate base layers of city boundary, training sites, etc.

3 METHOD

Spatial pattern of urbanisation is assessed using temporal remote sensing data of 1977 to 2013. The analysis is outlined in Fig. 3, which includes pre-processing, analysis of land cover and land use, and finally spatial patterns analysis through gradients and zones using spatial metrics.

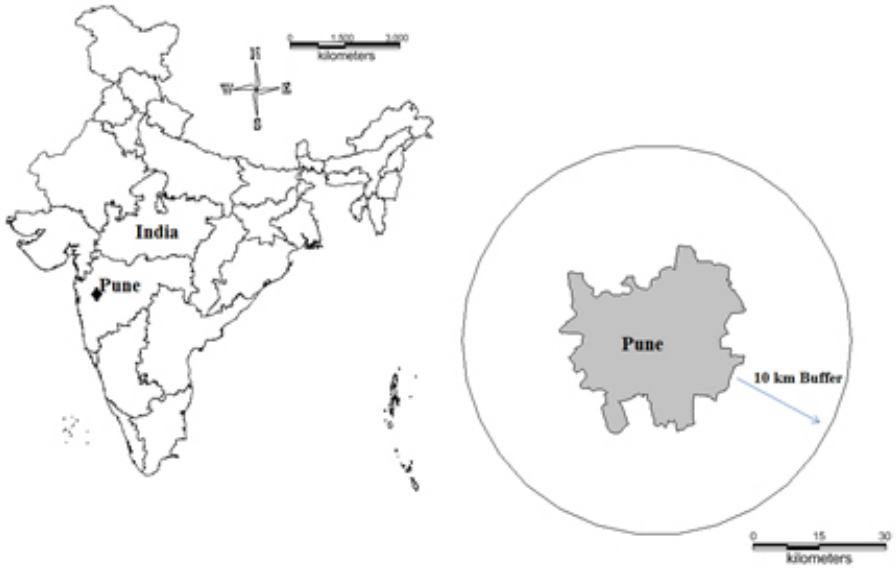


Fig. 2: Study area considered, Pune and 10km buffer.

The study region includes Pune administrative area with 10 km buffer to account pockets at city outskirts experiencing sprawl.

Pre-processing: Remote sensing data (Landsat series) for Pune, acquired for different time periods, were geo-corrected and cropped pertaining to the study area. Geo-registration of remote sensing data (Landsat data) has been done using ground control points collected from the field using pre calibrated GPS (Global Positioning System) and also from known points (such as road intersections, etc.) collected from geo-referenced topographic maps of the Survey of India. The Landsat satellite data of 1977 (with spatial resolution of 57.5 m x 57.5 m (nominal resolution) were resampled to 30 m in order to maintain uniformity in spatial resolution of data across time periods 1992 - 2013 (30 m x 30 m (nominal resolution)).

Land Cover analysis: Land cover analysis was performed to understand the changes in the vegetation cover through Normalised Difference Vegetation Index (NDVI), which ranges from -1 to +1. Very low values of NDVI (-0.1 and below) correspond to soil or barren areas of rock, sand, or urban built up. Zero indicates water cover. Moderate values represent low density vegetation (0.1 to 0.3), while high values indicate thick canopied vegetation (0.6 to 0.8).

Land use analysis: The method involves i) generation of False Colour Composite (FCC) of remote sensing data (bands – green, red and NIR). This helped in locating heterogeneous patches in the landscape ii) selection of training polygons (these correspond to heterogeneous patches in FCC) covering 15% of the study area and uniformly distributed over the entire study area, iii) loading these training polygons co-ordinates into pre-calibrated GPS, iv) collection of the corresponding attribute data (land use types) for these polygons from the field. GPS helped in locating respective training polygons in the field, v) supplementing this information with Google Earth, vi) 60% of the training data has been used for classification, while the balance is used for validation or accuracy assessment. Land use analysis was carried out using supervised pattern classifier -Gaussian Maximum Likelihood Classifier (GMLC) algorithm using various classification decisions based on probability and cost functions (Duda et al., 2000, Ramachandra et al., 2012a, Ramachandra et al., 2012d). Remote sensing data was classified using training data of all land use types as detailed in table 1. Mean and covariance matrix are computed using estimate of maximum likelihood estimator.

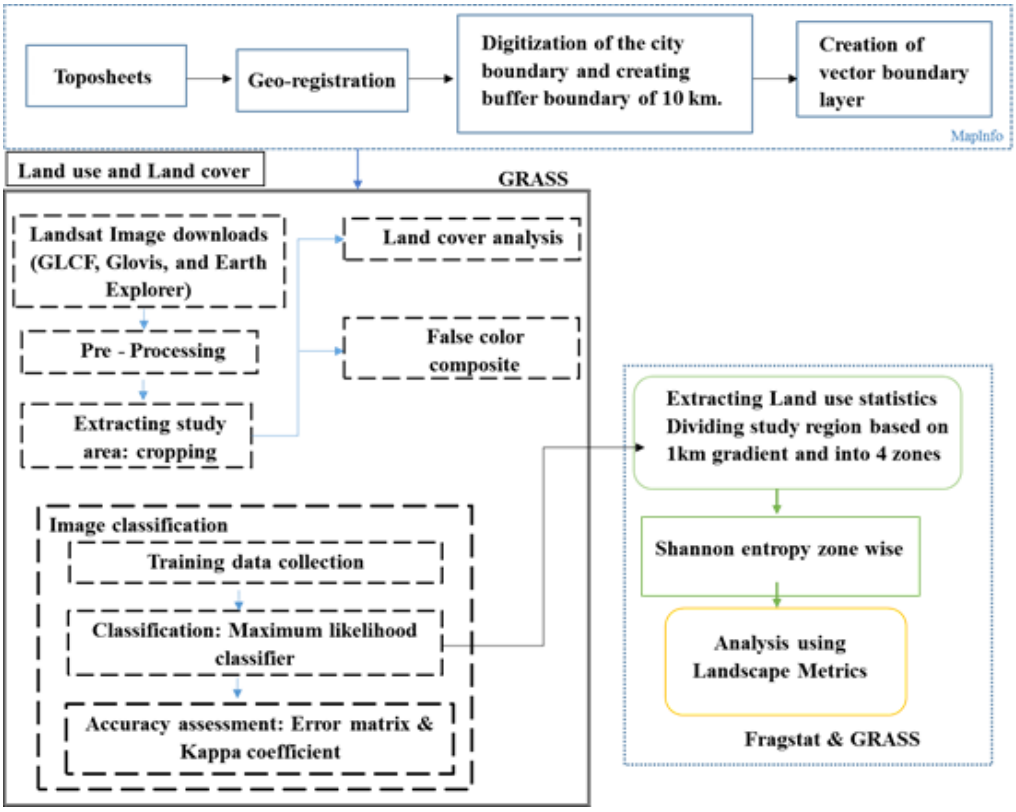


Fig. 3: Procedure followed in analysis

Land use Class	Land uses included in the class
Urban	This category includes residential area, industrial area, and all paved surfaces and mixed pixels having built up area.
Water bodies	Tanks, Lakes, Reservoirs.
Vegetation	Forest, Cropland, nurseries.
Others	Rocks, quarry pits, open ground at building sites, kaccha roads.

Table 1: Land use classification categories

Land use was computed using the temporal data through the open source program GRASS - Geographic Resource Analysis Support System (http://ces.iisc.ernet.in/foss). Signatures were collected from field visits and with the help of Google Earth. 60% of the total generated signatures were used in classification, 40% signatures were used in validation and accuracy assessment.

Statistical assessment of classifier performance based on the performance of spectral classification considering reference pixels is done which include computation of kappa (κ) statistics and overall (producer's and user's) accuracies (Mitrakis et al., 2008, Congalton et al., 1983).

Accuracy assessment and Kappa coefficient indicate the effectiveness of the classifier (Congalton, 1991; Lillesand & Kiefer, 2005). Recent remote sensing data (2013) was classified using the training data collected from field using GPS and earlier time period, training polygon along with attribute details were compiled from the previously published topographic maps, vegetation maps, revenue maps, etc.

Division of these zones to concentric circles (Gradient Analysis): All of the zones were divided into concentric circles with a consecutive incrementing radius of 1 km from the centre of the city. This analysis helped in visualising the process of change at local levels and understand the agents responsible for the changes. This helps in identifying the causal factors and locations experiencing various levels (sprawl, compact growth,

etc.) of urbanization in response to the economic, social and political forces. This approach (zones, concentric circles) also helps in visualizing the forms of urban sprawl (low density, ribbon, leaf-frog development).

The built up density in each circle is monitored over different time period through time series analysis. This helps the city administration in understanding the urbanization dynamics to provide appropriate infrastructure and basic amenities. Shannon's Entropy (Hn): Further to understand the growth of the urban area in a specific zone and to understand if the urban area is compact or divergent, Shannon's entropy (Lata et al., 2001; Ramachandra et al., 2012a) given in equation 1, was computed for each zone.

$$Hn = -\sum_{i=1}^{n} Pi \log(Pi) \quad \ldots\ldots (1)$$

Where, Pi is the proportion of the built-up in the i^{th} concentric circle. If the distribution is maximally concentrated, the Shannon's Entropy (H_n), of zero is obtained. If distribution is evenly among the concentric circles, H_n will have maximum of log n.

Computation of spatial metrics: Spatial metrics are helpful to quantify spatial characteristics of the landscape. Select spatial metrics with details given in Table 2, were computed to analyse and understand the urban dynamics through FRAGSTATS (McGarigal and Marks in 1995) at three levels: patch, class and landscape levels.

Indicator	Formula
Number of patches(Built-up)(NP)	$N = n_i$; Range: NP≥ 1
Patch Density (PD)	$PD = \frac{n_i}{A}(10{,}000)(100)$; Range: PD> 0
Normalised landscape shape Index (NLSI)	$NLSI = \frac{e_i - \min e_i}{\max e_i - \min e_i}$; Range: 0 to 1
Total edge	TE=E, E=no of edges, TE ≥ 0, without limit.
Edge Density	$ED = \frac{E}{A}$: Range: ED ≥ 0
Clumpiness Index (Clumpy)	$G_i = \left[\frac{g_{ii}}{(\sum_{k=1}^{m} g_{ik}) - \min e_i}\right]$ $CLUMPY = \begin{pmatrix} \left[\frac{G_i - P_i}{P_i}\right] \text{for } G_i < P_i P_i < 5; else \\ \frac{G_i - P_i}{1 - P_i} \end{pmatrix}$ Range: Clumpiness ranges from -1 to 1
Percentage of Land adjacencies (Pladj)	$PLADJ = \left(g_{ii} / \sum_{k=1}^{m} g_{ik}\right)(100)$ g_{ii} = number of like adjacencies (joins) between pixels of patch type (class) i based on the *double-count* method. g_{ik} = number of adjacencies (joins) between pixels of patch types (classes) i and k based on the *double-count* method. 0<=PLADJ<=100
Cohesion Index	$Cohesion = \left[1 - \left(\sum_{j=1}^{n} P_{ij} \Big/ \sum_{j=1}^{n} P_{ij}\sqrt{a_{ij}}\right)\right]\left[1 - \frac{1}{\sqrt{A}}\right]^{-1} * 100$ Range:0≤cohesion<100

Table 2. Landscape Metrics used in analysis

4 RESULTS

Land cover analysis: Land cover computed through NDVI, shows a decline of vegetation from 26.62% (1977) to 21.32% (2013) and year wise changes are tabulated in table 3 and depicted in Fig. 4.

Land use analysis: Land use analysis was performed to classify into four categories through GMLC using training data collected from the field, Google earth and SOI toposheets. Fig. 5.The statistics calculated is as tabulated in table 4. The results show that the urban paved surface increased by around 689 times from 3%

to 10%. The analysis showed the increase in vegetative cover which can be attributed to increase in agricultural area with crop. Water class remained fairly constant and other class which included open area, agricultural plots without crop decreased overtime from 73% to 60 %. Urban growth in past 4 decades in the study region can be seen in Fig. 6, this explains growth of urban land use in every decade. Assessment of land use dynamics helps in understanding the trends of urban expansions. This illustrates the maximum growth in South-East, North-East and North-West directions and occurs mainly in the gradients near the centre. Minimal growth or marginal growth compared to central gradients is seen in buffer zones and the periphery.

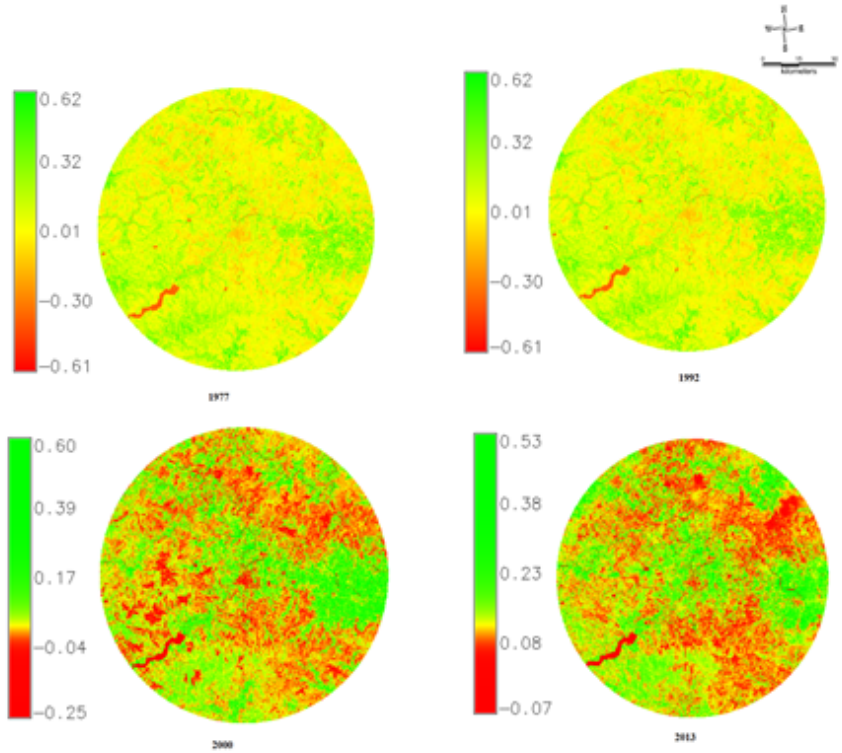


Fig. 4 land cover of Pune with 10 km buffer

Land cover in %	Vegetation	Non-Vegetation
1977	26.62	73.38
1992	16.74	83.26
2000	16.42	83.58
2013	21.32	78.68

Table 3: Land covers statistics for the study region

Accuracy assessment: Accuracy assessment of the classified images was done through the computation of overall accuracy and kappa statistics as shown in table 5. Overall accuracy ranges from 81% to 94%.

Urban growth in each decade is as represented in Fig. 6.

Shannon entropy: Shannon entropy was computed zone wise (by dividing the region into 4 parts based on cardinal directions and with one km incremental radius from the center). The Values close to log of the gradients in each direction explains that the region is completely fragmented and has experienced sprawl. The values close to zero indicated clumped central core growth.

The results of the analysis are as shown in Fig. 6. The values show that there is influence sprawl in the region especially in NW and NE directions.

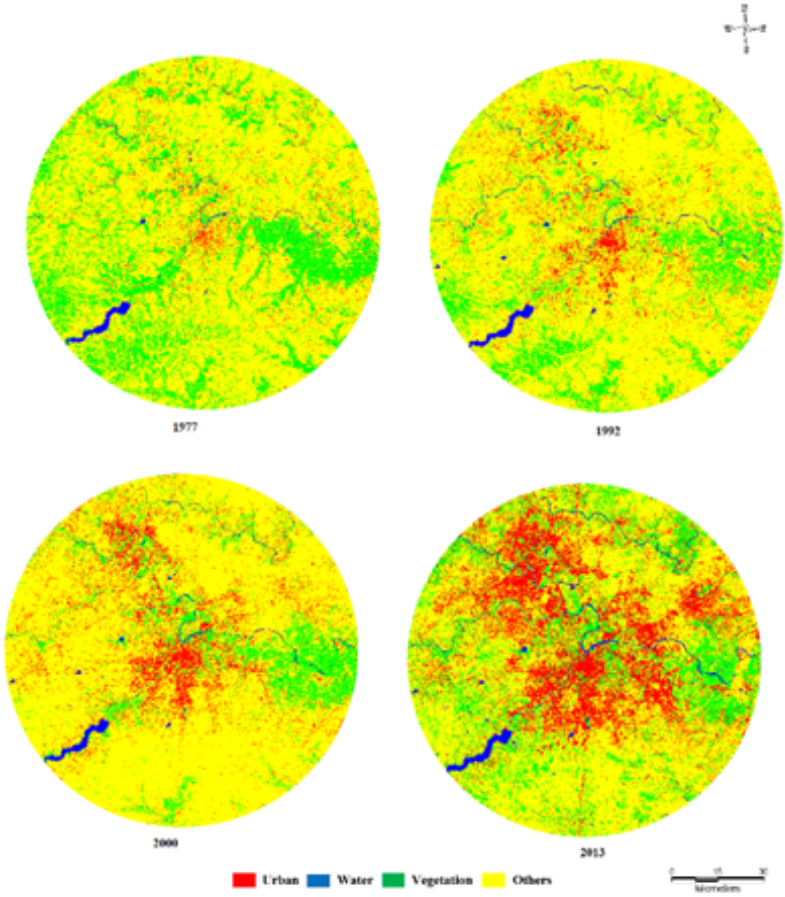


Fig. 5 Land use of Pune with 10 km buffer

Land use in %	Urban	Water	Vegetation	Others
1977	2.96	0.92	22.49	73.63
1992	5.09	1.33	14.09	79.49
2000	9.46	1.21	12.13	80.10
2013	20.40	1.75	17.96	59.89

Table 4: Land use statistics for the study region

1977		1992		2000		2013	
OA	κ	OA	κ	OA	κ	OA	κ
81	0.82	91.2	0.9	93.1	0.9	94.6	0.91

Table 5: Overall Accuracy and kappa statistics of classified images

The values are as high as 0.52 in NW and 0.41 in NE are just midway of log (22) (22 gradients) = 1.3. Shannon Entropy highlights that the region is experiencing land transformation from centric growth to multi-dimensional fragmented growth.

This growth might create more concentrated unconnected patch growths, leading to haphazard development without basic facilities, thereby impacting the local environment.

This indicates that the region has to be monitored gradient wise to understand the specific pockets of growth that will help city managers to plan further developments (Fig. 7). Thus an analysis of landscape metrics gradient wise and zone wise was carried out.

Spatial patterns of urbanisation: Spatial pattern of urbanization were assessed zone-wise for each gradient through select spatial metrics.

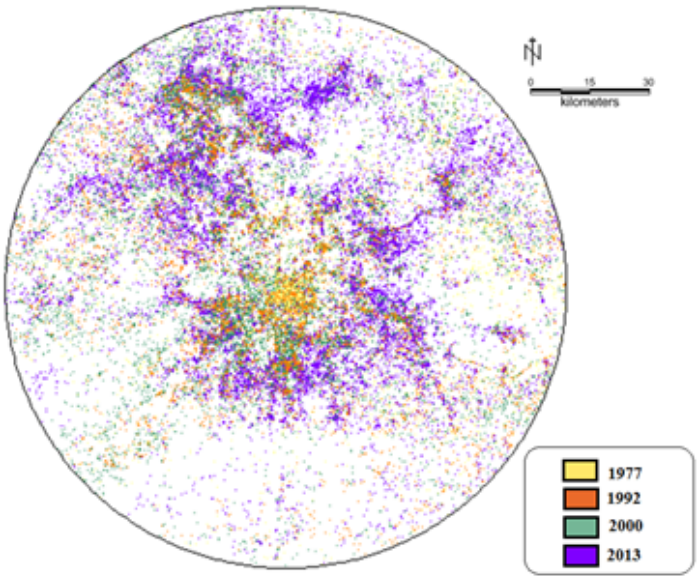


Fig.6 Urban growth pattern

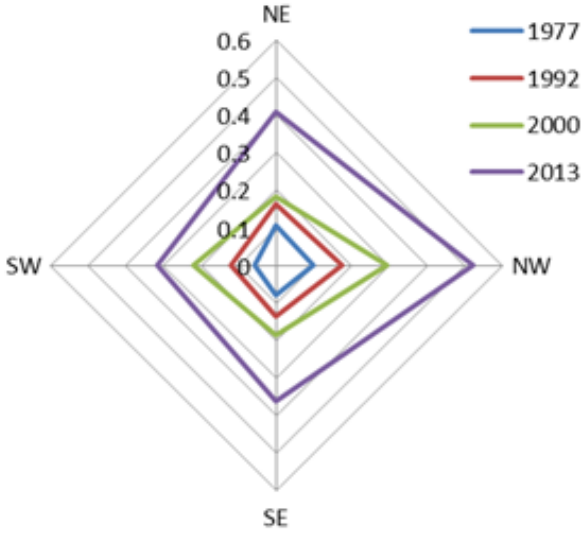


Fig. 7 Shannon entropy index calculated

Number of Urban patches (NP) and Patch density (PD): These metric quantifies patches that helps to identify the level of fragmentation (Fig. 8a). Higher the number of patches, then the region is under fragmentation. Patch density analogous to NP reflects number of patches per unit area is given in Fig. 8(a) and Fig. 8(b). Highlights that Pune had clumped growth during 70's and 90's in all zones and confined to the core areas of the city. Post 2000 the city showed the signs of fragmentation especially in north-west and north-east directions with values reaching 500 patches in near periphery. Buffer zones also show similar trends with approximately 200 patches on an average, and 800 patches (2013) in all directions resulting in higher patch densities which indicates of sprawl in the region.

Total edges and edge density: Edges and edge density basically are indicator of fragmentation in the landscape. Edge density represents denseness of the patches/edges in the landscape. Edges in 1977 across all zones and circles indicates that the core of the city are clumped. Further, post 1992 edges have increased highlighting fragmented out growth. In 2013, Gradients covering the inner core are clumped in the north-east and north-west directions, and the outskirts are with large number of edges (~300000 edges) in NW and NE directions. Density of 1.5 signify higher edges. Fig. 8c and 8(d) represents outputs of Total edge and Edge density.

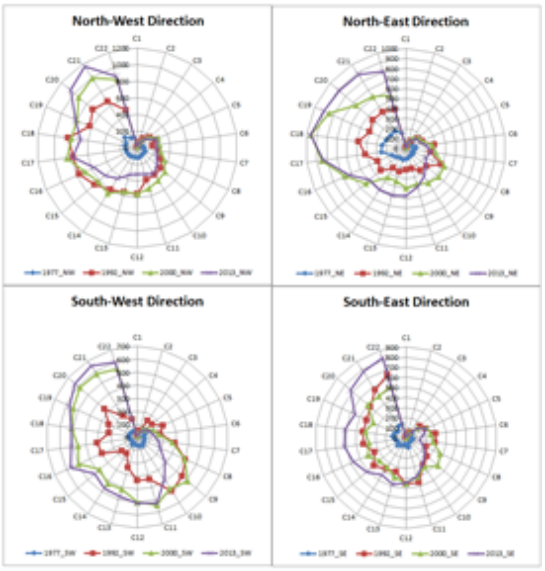


Figure 8(a) Number of urban patches

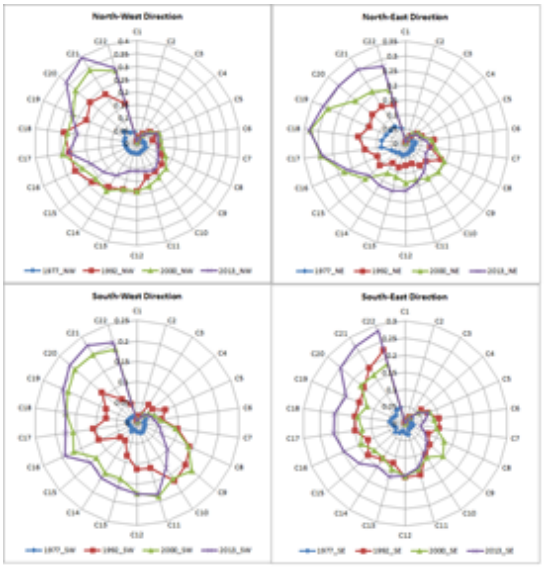


Figure 8(b) Patch density

Normalized shape index (NLSI): NLSI describes the shape of the particular class in the landscape. It is 0 when the landscape consists of a maximally compact patch and increases as the patch type becomes increasingly disaggregated and is 1 when the patch type is maximally disaggregated (Fig. 8(e)). The results of the analysis show that the gradients near the core with aggregations are forming a compact patch, whereas outer gradient in all direction with the spurt in urban activities show a value closer to 0.9 in almost all zones in the buffer zones indicating of sprawl as the shape of landscape is irregularly disaggregated and fragmented.

Cohesion index: Cohesion index implies the physical connectedness of the focal class and the value is 0 with the decline of the proportion of urban class in the landscape, which is indicative of fragmented outgrowth else increases monotonically, evident in Fig. 8f, indicating the emergence of urban sprawl in buffer zones and the decrease of the physical connectedness near the core similar to earlier metrics.

Clumpiness index (Clumpy) and Percentage of like adjacencies (Pladj): CLUMPY metric directly measure aggregation and disaggregation of the class in the landscape, equals -1 when the class is maximally disaggregated; and equals 0 when the class is distributed randomly, and approaches 1 when the patch type is maximally aggregated. PLADJ equals 0 when the focal class is maximally disaggregated and no like adjacencies and is equal to 100 when the focal class is a single patch is adjacent between same classes. These metrics are dependent on adjacent characteristics of the focal class in the landscape.

Fig. 8g and 8h shows that gradients reaching aggregation or single patch class from 1977 to 1992 in all zones. However, post 2000 the initiation of fragmentation value reaches 0 for Clumpy and Pladj signifying the fragmentation due to urban outgrowth. This phenomena can be mostly seen in the buffer zones and in regions under extreme pressures of sprawl.

Spatial metrics indicates of sprawl especially in the periphery and the buffer zones. These regions requires an immediate attention by the decision makers to provide appropriate infrastructure and basic amenities.

Metrics computed in each temporal gradients equip the decision-makers with fundamental information about the growth, the role of agents (for example policy decisions to setup industrial layouts, etc.), rate of growth, spatial patterns of growth and information about site specific details such as patches or clumpiness or shapes in the landscape.

This knowledge helps in visualizing the extent and patterns of future growth, which helps in adopting strategies to control or mitigate potential impacts on the sustenance of natural resources due to large scale land cover changes.

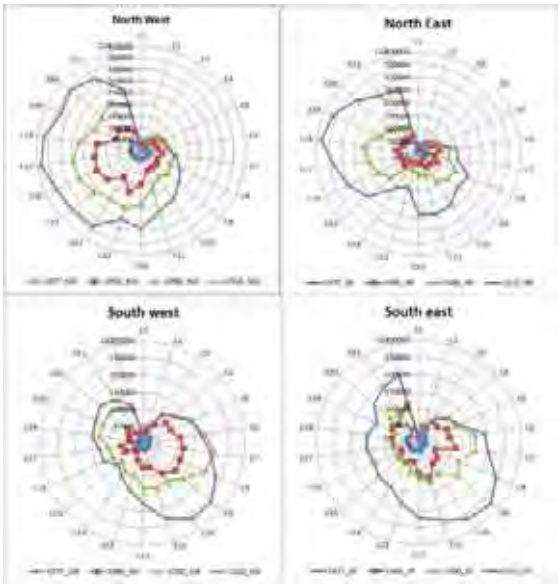


Figure 8(c) Total edge

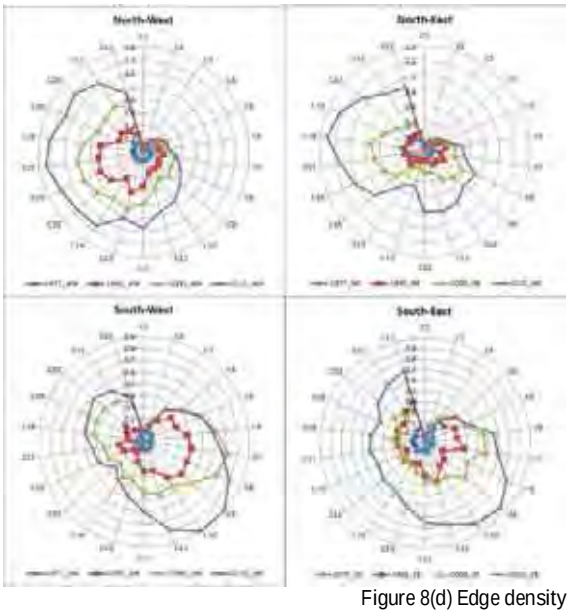


Figure 8(d) Edge density

Spatial pattern dynamics elucidation throws light on the role of earlier government policies (Fig. 9) in urban sprawl or urbanisation process in the region. This also helps in assessing the effectiveness of earlier urban policy measures to address sprawl and development of a city. Integrated management of natural resources involves understanding the rationale of development and making decisions of placing the regions specific development trajectory while maintaining the urban open spaces (parks, lakes, vegetation, etc.), natural water drains and resources.

Localities such as Pimpri, Chinchwad, Kahdakwasla, Dhayari phata, Katruj, Yerwada, Pashan, Lavale, Warje, Baner, Khadki, Tharwade, Pirangut etc., in and around Pune are experiencing large scale land cover changes due to the government push for industrialization in 1990's are now facing the problem due to sprawl and associated problems such as lack of basic amenities, etc.

The spatial analyses establishes that gradient based metrics computation helps in understanding thespatial patterns of a dynamically evolving urban landscape (Keiner and Arley, 2007, Aguilera, 2008) like Pune given the momentum of growth and pressing need to characterize and plan in efficient manner. Fig. 9 illustrates the potential of gradient based spatial pattern analysis in understanding the land use dynamics due to policy interventions.

Pimpri Chinchwad was established in 1988 and developed to cater the requirement of industrial needs. This region is located in gradients 11, 12 and 13 in the north-west zone.

These gradients had higher vegetative cover in the pre-1990. But post 2000 it can be seen extensive conversion of vegetative area urban land use. Landscape metrics for this gradients show that the urban impervious surface were located as a continuous simple shape concentrated surface pre-2000 (Fig. 9a). Post 2000 these regions have experience significant land use change and conversion in to highly fragmented area. In 2013 these regions have changed into most fragmented gradients in North West zone.

Warje (Fig. 9b) is located close to periphery of the Pune municipal boundary. Gradient 6-9 represents this industrial region in the south west zone. The land use before 1990 was dominated by other land use class and post 2000 is dominated by the urban land use. Post 2000, the region formed a clumped simple patch, which indicates of prevalence of urban patch dominance.

Yerawada and Nagar road (Fig. 9c) is located in north east region of Pune and 7-8 gradient of North east zone and contribute about 10% to the industrial output of Pune. Landscape metrics of urban land use highlights that these gradients (post 2000) are in the verge of forming a single dominant urban class with simple shapes.

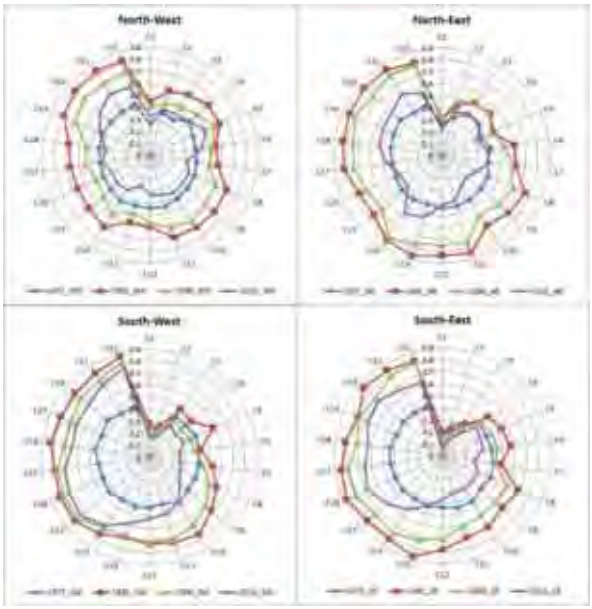


Fig. 8(e) Normalized landscape shape index

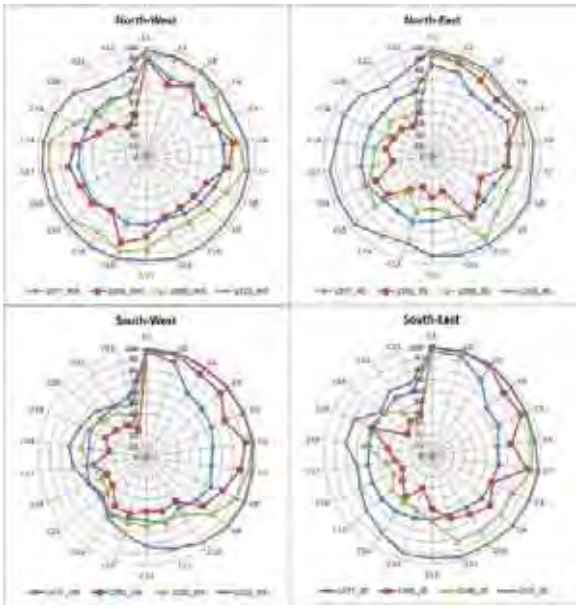


Figure 8(f) Cohesion index

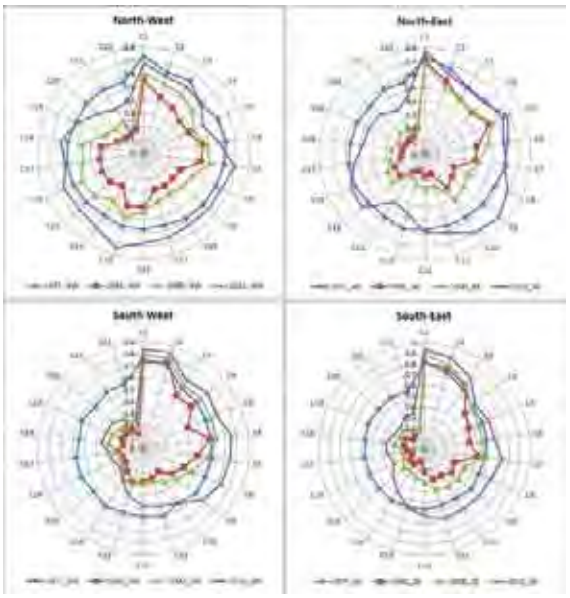


Fig. 8(g) Clumpiness index

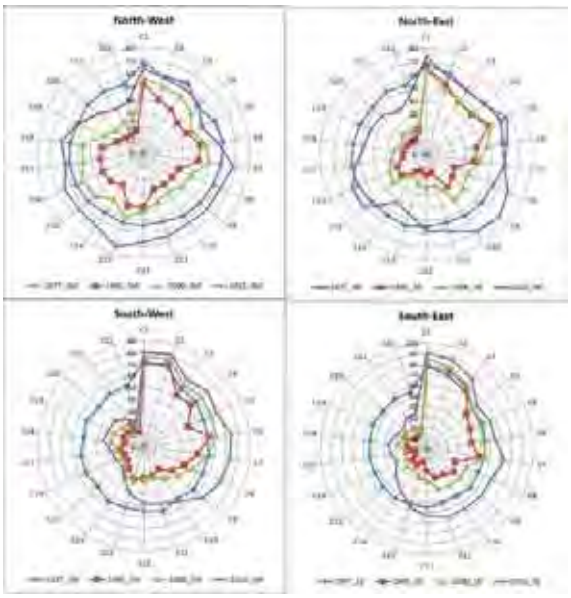


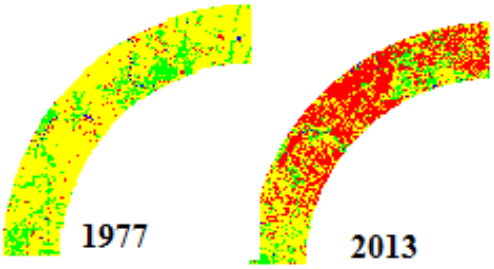
Fig. 8(h) Percentage of like adjacencies

These spatial analyses confirm that policy and socio-economic factors fuel URBANIZATION. Urban planning require essential up-to-date knowledge of spatial patterns of land use changes to regulate and plan the city's expansion as well as infrastructure development. Access to consistent and integrated spatial information about land use dynamics aids in the strategic understanding of the region specific growth for formulating effective cognitive decision on natural resources management by city planners with all stakeholders. Location specific information enhances the planning process through multitude of factors having decisive role in the land use sustainability.

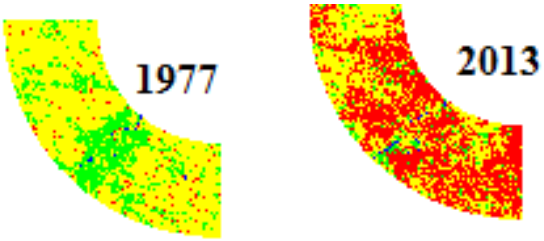
5 CONCLUSION

Spatial patterns of urbanisation and sprawl in Pune city with 10 km buffer has been analysed zone wise gradients using temporal remote sensing data through Geoinformatics and spatial metrics during 1977 to 1992 there was infilling in the core city area. During 2000 and 2013 the fragmentation was quite evident at city outskirts. Spatial pattern dynamics analysed through patch, contagion, edge and shape metrics.

a). Pimpri chinchwad



b). Warje



C). Yerawada and Nagar

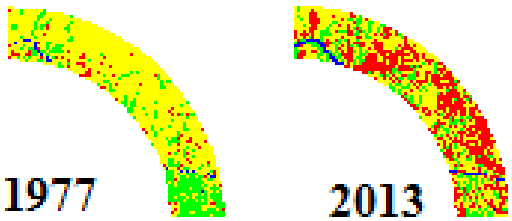


Fig.9 Spatial patterns of urbanization with industrialization in 1990's

The temporal pattern of the urbanization process of this region highlights the process of coalescence during the rapid urbanization decade (2000 to 2010). Results indicate the process of aggregation in the core compared to the periphery and the buffer zones. Globalisation and the reforms in the industrial sector during 1990's witnessed a spurt in urban growth, which is evident from the occurrence of large number of urban patches surrounded by other land uses, especially in industrial pockets such as Pimpri chinchwad, Warje, Yerawada, etc. Subsequent urban growth witnessed consolidation of fragmented patches with lower patch density and larger urban patch to form clumped urban pockets in NW and SE directions by 2010. Specifically, aggregation of patches is noticed in northwest at the outskirts and even at the buffer zone. Gradients with metrics provide vital information to the decision makers about level of urbanisation and the role of agents (policy issues, etc.). Information about the patterns of growth, rate of growth, patches, clumpiness etc. would help in evolving appropriate location specific strategies to mitigate environmental consequences. Visualisation of urban growth based on the behavior of agents with the temporal data help the city managers in help city planners and administrators to design towards achieving the goals of sustainable cities.

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REFERENCES

Alphan, H., Doygun, H., & Unlukaplan, Y.I. (2009). Post-classification comparison of land cover using multi-temporal Landsat and ASTER imagery: the case of Kahramanmara angstrom, Turkey, Environmental Monitoring and Assessment, 151(1 – 4), 327 – 336

Aguilera, F., 2008. Análisis espacial para la ordenación eco-paisajística de la Aglomeracion Urbana de Granada (Spatial analysis for the ecological landscape planning in the Metropolitan Area of Granada). PhD Thesis. University of Granada, Granada (in Spanish: English abstract).

Bharath, S., Bharath, H.A., Durgappa D.S., & Ramachandra T.V. (2012). Landscape Dynamics through Spatial Metrics, Proceedings of India Geo Spatial Conference, Epicentre, Gurgaon, India, 7-9 February, 2012.

Bharath, H. A., Bharath, S., Sreekantha, S., Durgappa D.S., Ramachandra, T. V., (2012) "Spatial patterns of urbanization in Mysore: Emerging Tier II City in Karnataka, Proceedings of *NRSC User Interaction Meet- 2012*, 16th & 17th, Hyderabad, February 2012.

Bhaskar, P., (2012). Urbanization and changing green spaces in Indian cities (Case study – City of Pune), International Journal of Geology, Earth and Environmental Sciences, 2, 148- 156.

Bhatta, B., (2009). Analysis of urban growth pattern using remote sensing and GIS: A case study of Kolkata, India. International Journal of Remote Sensing, 30(18), 4733–4746.

Bhatta, B., Saraswati, S., & Bandyopadhyay, D., (2010a). Quantifying the degree-of-freedom, degree-of-sprawl, and degree-of-goodness of urban growth from remote sensing data. Applied Geography, 30(1), 96–111.

Bhatta, B., Saraswati, S., & Bandyopadhyay, D., (2010b). Urban sprawl measurement from remote sensing data. Applied Geography, 30(4), 731–740.

Census of India, available at http://censusindia.gov.in. Last accessed 10th June 2013

Chen, H.Y., Ganesan, S. & Jia, B.S., (2005). Environmental challenge for Post-reform housing development in Beijing", Habitat International, Vol. 19, No. 3, pp. 571 – 589

City Development Plan (2006-2012), Jawaharlal Nehru National Urban Renewal Mission.

Clapman, Jr., W.B., (2003). Continuum-based classification of remotely sensed imagery to describe urban sprawl on a watershed scale, Remote Sensing of Environment, 86(3), 322 - 340

Codjoe, S.N.A., (2004). Population and land use/cover dynamics in the Volta River Basin of Ghana, 1960-2010, Ecology and Development Series No. 15, Cuvillier Verlag, Gottingen

Congalton, R. G., Oderwald, R. G., & Mead, R. A., 1983. Assessing Landsat classification accuracy using discrete multivariate analysis statistical techniques. Photogrammetric Engineering and Remote Sensing, 49, 1671-1678.

Congalton, R.G., & Green K., (2009). Assessing the Accuracy of Remotely Sensed Data: Principles and Practices. CRC Press Taylor & Francis Group, Boca Raton, FL

Congalton, R.G., (1991). A review of assessing the accuracy of classifications of remotely sensed data. Remote Sensing of Environment, 37 (1), 35-46.

Desai C.G, Patil M.B, Mahale V.D., & Umrikar, B., (2009). Application of remote sensing and geographic information system to study land use/land cover changes: a case study of Pune Metropolis, Advances in Computational Research, 1, 10 – 13.

Di Gregorio, A., & Jansen, L.J.M., (1997). A new concept for a land cover classification system, in Proceedings of the Earth Observation and Environmental Information 1997 Conference, held at Alexandria, Egypt, from 13-16 October, 1997

Duda, R.O., Hart, P.E., Stork, D.G., (2000). Pattern Classification, A Wiley-Interscience Publication, Second Edition, ISBN 9814-12-602-0.

Gillies, R.R., Box, J.B., Symanzik, J., Rodemaker, E.J., (2003). Effects of urbanization on the aquatic fauna of the Line Greek Watershed, Atlanta – a satellite perspective, Remote Sensing of the Environment, 86(3), 411 – 412

Girardet, H. (1996). The Gaia Atlas of Cities: new directions for sustainable urban living, Gaia Books Limited, London. 1st Edition, ISBN: 1856750973.

Global Land Cover Facility (http://www.glcf.umd.edu/index.shtml). Accessed on 10th January 2013.

Grimm, N.B., Grove, J.M., Pickett, S.T.A. and Redman, C.L. (2000). Integrated approach to long-term studies of urban ecological systems, BioScience, 50(7), 571 – 584

Gustafson, E.J., (1998). Quantifying landscape spatial pattern: what is the state of the art?, Ecosystems, 1, 143–156.

Herold, M., Goldstein, N., C., Clarke, K., C., (2003). The spatiotemporal form of urban growth: measurement, analysis and modeling. Remote Sensing of the Environment, 86, 286–302.

Jansen, L.J.M. & Di Gregorio, A., (1998). The problems with current land-cover classifications: development of a new approach, in Land-cover and land-use information systems for European Policy Needs, Office for the Official Publications of the European Communities, Luxembourg, 21 – 23

Ji, C.Y., Lin, P., Li, X., Liu, Q., Sun, D., & Wang, S., (2001). Monitoring urban expansion with remote sensing in China, International Journal of Remote Sensing, 22(8), 1441 – 1455

Kong, F., Yin, H., Nakagoshi, N., James, P., (2012). Simulating urban growth processes incorporating a potential model with spatial metrics, Ecological Indicators, 20, 82-91

Lata, K.M., Sankar Rao, C.H., Krishna Prasad, V., Badrinath, K.V.S., & Raghava Swamy, (2001). Measuring urban sprawl: a case study of Hyderabad, GIS Development, 5(12).

Lillesand T., Kiefer R., Chipman J. (2003). Remote sensing and image interpretation. Wiley, New York, Fifth edition.

Liu, J., Dietz, T., Carpenter, S.R., Alberti, M., Folke, C., Moran, E. & Taylor, W.W., (2007). Complexity of coupled human and natural systems, Science, 317(5844), 1513 – 1516.

Lopez, T. del M., Aide, T.M., & Thomlinson, J.R., (2001). Urban expansion and the loss of prime agricultural lands in Puerto Rico, Ambio, 30(1), 49-54

Keiner M. and Arley K., Transnational city networks for sustainability, Eur. Plann. Stud., 15 (2007), pp. 1368–1395

Martinuzzi, S., Gould, W.A., & Gonzalez O.M.R., (2007). Land development, land use, and urban sprawl in Puerto Rico integrating remote sensing and population census data, Landscape and Urban Planning, 79(3 – 4), 288-297

Massey, D. S., Arango, J., Hugo, G., Kouaouci, A., & Pellegrino, A., (1999). Worlds in Motion: Understanding International Migration at the End of the Millennium, Oxford university press, ISBN: 0199282765

McGarigal, K., & Marks, B. J., 1995. FRAGSTATS: spatial pattern analysis program for quantifying landscape structure. USDA Forest Service General Technical Report PNW-351.

Mitrakis, N.E., Topalogou, C.A., Alexandridis, T.K., Theocharis, J.B., & Zalidis, G.C., (2008). A novel self-organising neuro-fuzzy multi layered classifier for land cover classification of a VHR image. International Journal of Remote Sensing, 29, 4061–4087

Molles, M., (2006). Ecology: Concepts and Applications, 4th ed. McGraw Hill, Boston, USA.

Pathan, S.K., Jothimani, P., Pendharkar, S.P. and Sampat Kumar, D., (1989). Urban land use mapping and zoning of Bombay Metropolitan Region using Remote Sensing data. J. Indian Soc. Remote Sensing, 17(3), 11-22.

Pathan, S.K., Shukla, V.K., Patel, R.G., Mehta, K, S., 1991. Urban land use mapping - A case study of Ahmedabad city and its environs. J Indian Soc Remote Sensing, 19(2), 95- 112.

Ramachandra, T.V., and Kumar, U., (2009). Geoinformatics for Urbanisation and Urban Sprawl pattern analysis, In Geoinformatics for natural resource management, Chapter 19, 235 – 272

Ramachandra, T.V., Bharath, A.H., & Durgappa, D.S., (2012a). Insights to urban dynamics through landscape spatial pattern analysis, Int. J Applied Earth Observation and Geoinformation, 18, 329-343

Ramachandra, T.V., Bharath, A.H., & Sreekantha, S., (2012b). Spatial Metrics based Landscape Structure and Dynamics Assessment for an emerging Indian Megalopolis, International Journal of Advanced Research in Artificial Intelligence, 1(1), 48-57.

Ramachandra, T.V., Bharath, H.A., & Vinay S., (2013). Comprehension of temporal land use dynamics in urbanising landscape., Proceedings of User Interaction Meet - 2013, Balanagar, Hyderabad, 21-22, February, 1-6.

Ramachandra, T.V., Bharath, H.A., (2012a). Spatio-Temporal Pattern of Landscape Dynamics in Shimoga, Tier II City, Karnataka State, India, International Journal of Emerging Technology and Advanced Engineering, 2(9), 563-570.

Ramachandra, T.V., Bharath, H.A., (2012d). Land Use Dynamics at Padubidri, Udupi District with the Implementation of Large Scale Thermal Power Project, International journal of Earth Sciences and Engineering, 5, 409-417.

Roth, M., Oke, T.R., & Emery, W.J., (1989). Satellite-derived Urban Heat Islands from Three Coastal Cities and the Utilization of Such Data in Urban Climatology, International Journal of Remote Sensing, 10(11), 1699 – 1720

Sudhira, H.S., Ramachandra, T.V., & Jagadish, K.S. (2003). Urban growth analysis using spatial and temporal data, Journal of the Indian Society of Remote Sensing, 31(4), 299 – 311

Sudhira, H.S., Ramachandra, T.V., & Jagadish, K.S., (2004). Urban sprawl: metrics, dynamics and modeling using GIS, International Journal of Applied Earth Observation and Geoinformation, 5(1), 29 – 39

Sutton, P.C., (2003). A scale adjusted measure of "Urban sprawl" using nighttime satellite imagery, Remote Sensing of Environment, 86(3), 353 - 369

Taubenbock, H., Wegmann, M., Roth, A., Mehl, H., & Dech, S., (2009). Urbanization in India: Spatiotemporal analysis using remote sensing data. Computers, Environment and Urban Systems, 33(3), 179–188.

Uuemaa, E., Antrop, M., Roosaare, J., Marja, R., Mander, U., (2009). Landscape metrics and indices: an overview of their use in landscape research. Landsc. Res. 3, 1–28

Verzosa, L.C.O. and Gonzalez, R.M. (2007). Remote sensing, geographic information systems and Shannon's entropy: measuring urban sprawl in a mountainous environment, In: Wagner W., Szekely, B. (eds.): ISPRS TC VII Symposium – 100 Years ISPRS, Vienna, Austria, July 5–7, 2010, IAPRS, Vol. XXXVIII, Part 7A. Available at http://www.isprs.org/proceedings/xxxviii/part7/a/pdf/269_XXXVIII-part7A.pdf. Accessed on 1st Aug 2013.

Vinay, S., Bharath, H.A., Ramachandra, T.V., (2012). Spatio-temporal dynamics of Raichur City, LAKE 2012: National Conference on Conservation and Management of Wetland Ecosystems, 6-9th November 2012, School of Environmental Sciences Mahatma Gandhi University, Kottayam, Kerala.

Voogt, J.A., & Oke, T.R., (2003). Thermal Remote Sensing of Urban Areas, Remote Sensing of the Environment, 86, 370 – 384

World Urbanization Prospects revised, 2011. United nation department of socioeconomic affairs. Available at http://esa.un.org/unup. Last accessed on 04th Aug 2013.

Xiao, J., Shen, Y., Ge, J., Tateishi, R., Tang, C., Liang, Y., & Huang, Z., (2006). Evaluating urban expansion and land use change in Shijiazhuang, China, by using GIS and remote sensing, Landscape and Urban Planning, 75(1), 69 – 80

Yang, L., Xian, G., Klaver, J.M., & Deal, B., (2003). Urban land-cover change detection through sub-pixel imperviousness mapping using remotely sensed data, Photogrammetric Engineering and Remote Sensing, 69(9), 1003-1010.

Yeh, A.G.O., & Li. X., (1999). Economic development and agricultural land loss in the Pearl River Delta, China, Habitat International, 23(3), 373 – 390.

Yeh, A.G.O., & Li. X., (2001). Measurement and monitoring of urban sprawl in a rapidly growing region using entropy, Photogrammetric Engineering and Remote Sensing, 67(1), 83-90

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THE EFFECTIVENESS OF PLANNING REGULATION TO CURB URBAN SPRAWL

THE CASE OF STRIANO (NA)

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ABSTRACT

Italy is facing an almost irreversible, extremely serious condition. A vital asset for humankind and the ecosystem, such as land, today suffers the negative effects of anthropogenic activities, first of all its uncontrolled and limitless consumption.
Such transformation of landscapes and environments, due to the misuse of land, not only affects the Italian country, but it spills over its borders: across Europe, urban sprawl is threatening agricultural productivity and biodiversity, increasing the risk of flooding, reducing water resources and contributing to global warming (ISPRA 2012).
The catastrophic impacts related to the spread of urban sprawl have made the identification of planning strategies capable of reducing the phenomenon essential. In Italy, many regions are trying to conform regulations and planning tools to control land use, and among them the Campania Region.
To date, only few studies have evaluated the effectiveness of these tools in curbing the phenomenon (Anthony 2004), to this end, the paper aims to assess the ability of Campania's Planning regulations and tools in checking urban sprawl.
The analysis was conducted in the town of Striano, within the complex urban conurbation of the Metropolitan Area of Naples, which can be considered an example of urban sprawl development pattern.
In particular, a hypothesis of Area Action Plan for Striano was developed on the basis of the measures imposed by Regional Law n. 16 of 2004 and the ones proposed by PTCP of Naples, then the potential outcomes achieved by the Plan were evaluated in terms of land use and density.
The case study results show a disconnection between the current legislation and the new planning tools which are pending approval, therefore, the paper suggests the need to update Campania's Planning legislation to the new guidelines, which are much more effective in terms of land protection.

KEYWORDS:
Urban sprawl, land consumption, soil sealing

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规划法规对遏制城市扩张的有效性

斯特里亚诺（STRIANO）案例

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摘要

意大利正面临着一个几乎不可逆转并且极为严重的状况。对于人类和生态系统至关重要的资产（如，土地），如今正遭受人类活动（首当其冲的是不受控制和无节制的消耗）的破坏。
这种因土地滥而用造成的地貌和环境的改变，不仅对意大利的国土产生影响，而且还跨越了国界：在整个欧洲，城市扩张正威胁着农业生产和生物多样性，同时增加洪灾的风险、减少水资源并导致全球变暖。
城市扩张的泛滥所带来的灾难性影响，已使人们意识到通过规划战略能够在根本上遏制这种状况。意大利的许多地区正在采用法规和规划工具来控制土地的使用，其中就包括坎帕尼亚大区（Campania Region）。
到目前为止，仅有少数几项研究对于这些工具遏制这种状况的有效性进行过评估，有鉴于此，本文旨在评估坎帕尼亚的规划法规和工具对城市扩张的遏制能力。
分析过程是针对斯特里亚诺（Striano）镇进行的，该镇位于那不勒斯大都会区的城市圈范围内，可将其视为城市扩张发展模式的一个样本。
尤其是，根据《地区法2004年第16号（Regional Law n. 16 of 2004）》的强制措施和那不勒斯PTCP提出的措施，制定出了“斯特里亚诺地区行动方案（Area Action Plan for Striano）”，然后根据土地利用和密度情况，对该方案能够实现的可能结果进行评估。
案例研究结果表明，当前立法和待审批的新规划工具之间存在脱节，因此，本文提出，需要将坎帕尼亚的规划立法更新至对土地保护更为有效的新的指导原则。

关键词
城市扩张；土地消耗；土壤板结

1 INTRODUCTION

Urban sprawl processes, born in the U.S. as a result of economic development after World War II, spread all over the world affecting urban and metropolitan areas, creating new ways of land use and damaging the environment and social relations.

Urban sprawl is now considered by the scientific community one of the most dangerous land transformation's processes involving Western cities: the uncontrolled use of land and the increasingly rapid expansion of cities, have weakened, if not eliminated, any kind of boundary between urban and natural space and, as Mumford stated in 1961, the shape of the metropolis is its shapelessness.

To stop urban sprawl, even European Commission decided to get involved, stating that after 2050 it won't be possible to build on free areas anymore (EU 2011).

In Italy, soil sealing related to urban sprawl is causing every day the transformation of over 100 ha of agricultural area in order to build housing, parking, commercial centers, quarries, etc.

Such change of landscapes and environments is threatening agricultural productivity and biodiversity, increasing the risk of flooding, reducing water resources and contributing to global warming (ISPRA 2012).

The Metropolitan Area of Naples can be considered a clear example of urban sprawl development pattern, for this reason the analysis has been conducted here.

The paper aims to verify if Campania's regulations and planning tools are able to curb urban sprawl and promote a sustainable use of land.

The concept of urban sprawl, its causes, its impacts as well as the planning policies adoptable to control the phenomenon are defined in the first part of the paper.

On the contrary, the definition of a hypothesis of Area Action Plan for the town of Striano is the core argument of the second part of the paper.

At the end, the study analyzes the impacts of the Area Action Plan in terms of land consumption and density and finds out that Campania's current planning regulations are not effective in curbing urban sprawl.

2 FROM CONCEPT OF SPRAWL TO THE POSSIBLE INTERVANTATION STRATEGIES TO STOP IT

The term urban sprawl was introduced in the U.S. in the beginning of '60, when the phenomenon was studied for the first time (Self 1961; Clawson 1962; Harvey and Clark 1965).

Over fifty years have gone by, the term has been used so widely that today it lacks of a precise meaning (Galster 2001).

Four types of urban sprawl definition can be found in scientific literature, each one of them focusing on a different feature: urban shape, land use, impacts and density (Chin 2002).

Regarding urban shape, sprawl is identified versus the ideal urban shape, such as the compact city: if the compact city is characterized by high density, by mixed used, by the presence of a central core and by the strong separation between city and countryside, it means that urban sprawl is the opposite.

When urban sprawl is defined by land use, it refers to the development of low-density residential areas with single-familiy houses and mixed use functions (Duany, Plater-Zyberk and Speck 2000).

An other type of definition of the phenomenon is that based on its effects on the environment: Ewing (1997) identifies some of the indicators of sprawl in the reduced accessibility and lack of available open spaces, which are both factors easy to measure.

Furthermore, you can define urban sprawl in term of density: several authors used density to define the phenomenon, but often without a clear measure of the parameter.

Recent studies tried to overcome the limits of preceding analysis by including within the definition of urban sprawl more than one feature:

(1) «Sprawl is a pattern of land use in an urbanized area that exhibits low levels of some combination of eight distinct dimensions: density, continuity, concentration, clustering, centrality, nuclearity, mixed uses and proximity» (Galster et al. 2001);

(2) «Urban sprawl is synonymous with unplanned incremental urban development, characterized by a low density mix of land uses on the urban fringe» (EEA 2006);

(3) «Sprawl is defined here as a process of uncoordinated change, an approach that broadens the analytical perspective to incorporate the role of spatial planning in steering the activity in the urban hinterland» (Chorianopoulos, Pagonis, Koukoulas and Drymoniti 2009);

(4) «Urban sprawl is known worldwide as the uncontrolled expansion of low-density, single-use suburban development, that in Italy is mainly shaped by settlements scattered around the countryside» (La Greca, Barbarossa, Ignaccolo, Inturri and Martinico 2011).

From these recent definitions of the phenomenon, the absence of planning polices and coordination emerges as one main characteristic of urban sprawl development. Hence, it is necessary to sustain a correct planning strategy that is able to contain the random growth of the city.

The numerous literature that investigated urban sprawl pointed out several factors which can be considered responsible of its proliferation.

From early studies, researches agree to consider innovations in transportation technology the main cause of the phenomenon (Mumford 1961; Holden & Turner 1997; Antrop 2004): train railways first, automobiles later, favoured access to the city centre, making it easy to reach from the suburbs (Antrop 2004).

The growing attractiveness of suburbs compared to the urban core can be considered responsible of starting sprawl too (Friedman and Miller 1965; Mumford 1961): exodus towards suburbs is the first reaction to the dramatic decline of post-industrial cities.

Technological innovation in telecommunications largely reduced the supremacy of the city centre making it possible to widen several activities, contributing to urban sprawl (Ewing 1997).

Also planning policies adopted from several governments to increase competitiveness can be added to the list of urban sprawl causes: public investments for building highways and street systems represent a necessary condition to the automobile becoming the first mean of transportation.

At last, zoning regulation contributes to the spread of the phenomenon because it forces the separation of the different urban functions favouring the rise of residential suburbs, which are typical of urban sprawl environments.

In 2006, the European Environmental Agency (EEA) conducted the research *Urban sprawl in Europe; the ignored challenge* identifying a great number of variables responsible of the phenomenon, amongst which the aforesaid elements are mentioned together with others that can be considered more current, such as globalization, availability of agriculture land at convenient prices and weak application of planning rules.

The wide range of causes responsible of urban sprawl shows the complexity of the phenomenon that quickly evolves because of social, cultural and technological changes and, at the same time, it has dangerous consequences, discordant with the sustainable development of the city.

The effects of urban sprawl can be grouped in three categories: environmental, economic and social.

The increase of air pollution due to the use of automobiles is one of the environmental effects (Ewing 1997; Arbury 2005; EEA 2006), in fact, in low-density urban areas there is a reduced attitude to use public transport, absolute absence of pedestrian movement, and vice versa, a great use of the automobile; even

the strict separation between the different city's functions, typical of urban sprawl, leads to a higher distance between urban areas which makes the automobile the only possible means of transportation.

Air pollution related to car's emissions represents only one of the environmental effects due to urban sprawl, to these we should add land consumption, typical of the phenomenon.

Land consumption causes the loss of a non-renewable resource of primary importance, in fact, soil acts as a carbon sink, additionally, the little distance between urban activities and natural space causes noise and pollution, which are dangerous for animals and plants as well as for the integrity of the remaining natural areas. Land fragmentation produces negative impacts on the environment too, because it disconnects natural habitats so that wildlife species are split (IUNC 1980; Harris 1984; Kautz 1993).

Nonetheless environmental effects have to be considered as well as the economic and social ones, which are utmost relevant. The phenomenon of urban sprawl is absolutely unsustainable from an economic point of view because of the huge expenses that it demands of local governments for the deliverance of services and infrastructures. As a matter of fact, the costs of public investment for sewerage and water supply in sprawl urban areas tend to be greater than those ones you'd have in the case of a compact setting, that is to say that single-family houses request much more expenses that the multi-family ones: Burchell e Mukherji (2003) state that in the U.S. you could save more than 12 billion of dollars only by a more compact development, without limiting the user's request.

The infrastructure development represents an other relevant item of the administration's financial statement and its costs depend on the distribution and on the users density so that sprawl has direct negative consequences: in such a greatly wide territory, with low-density, the expenditure for road construction will be higher than the one you'd need for a more compact urban setting. A similar analysis can be considered for other public services such as schools and hospitals.

Besides the direct costs of urban sprawl we just mentioned, we have to take into account the indirect ones, deriving from the environmental effects we described above: the costs due to pollution, amongst which those deriving from health, agriculture and buildings damage.

Altogether with the economic effects, urban sprawl has also social impacts of similar relevance even if they are more complex to measure and to monitor.

A compact urban setting with pedestrian paths, mixed use functions and public meeting spaces, favours the interaction between inhabitants and a sense of belonging to the community in a way which is different from the suburbs of sprawl areas, where inhabitants have to move about for any kind of requirement, where the automobile is a necessary need and where the sense of place is weak, if not completely absent.

Urban segregation is one of the social effects which are typical of sprawl, not surprisingly, most of the residents of suburbs belongs to the same social class, with similar income and type of family.

If in the U.S. families with children and high income represent the typical inhabitant of the suburb, generally coming to escape the city's congestion and pollution, in Europe we can observe the opposite situation, meaning that suburbs generally are the place where lower classes and immigrants live. In both cases, urban segregation is harmful, because it creates a separation, which is impossible to overcome, between the different classes, that loose any form of dialogue and interaction. The consequences of urban sprawl we just analysed show why the phenomenon has to be curbed and checked.

In the U.S., where urban sprawl has been a matter of interest for the first time, its harmfulness was soon recognized and the initial tools to limit it were found.

From the beginning, researchers all agree to consider that urban planning is the most powerful way to stop urban sprawl: "my answer to sprawl is active planning" (Ewing 1997).

The early policies to reduce sprawl have been engaged in the U.S. from the beginning of '60 and are known with the term *growth management*. The goal of this programs is to control urban development introducing limits to quantity, timing and geographical distribution of new urban settlements.

The first program of growth management was adopted in Hawaii (Land Use Law 1961), where urban growth was putting agriculture at risk; since then, more than twelve American states adopted similar policies to reduce urban sprawl.

From the early '90 the idea of smart growth became popular with the aim of building compact, mixed used and pedestrian friendly districts, to preserve natural resources and open spaces, and assimilate instead of separating residential units by characteristics and price.

Pretty often the terms *growth management* and *smart growth* are confused or used alike: some sustain that smart growth is just a more appealing definition to identify policies of growth management. If we accurately analyse both concepts, you can find instead some important differences regarding the goals they want to reach: the aim of the programs of growth management is above all that of limiting the quota of urban development, on the contrary, strategies of smart growth focus more on the shape and type of settlements rather than on their volume.

This renewed interest for urban shape is tied to New Urbanism, a movement born at the beginnings of '80 and led by the architect Andres Duany, who paid much attention to urban design promoting the transformation of the basic principles of zoning, which was considered a wrong planning technique, also responsible of the increasing growth of urban sprawl.

Similar statements to those promoted by the New Urbanism movement inspired a new revolutionary tool for urban government, known as Transit Oriented Development (TOD), which transfers to public transport system a central role in the process of urban transformation. The term TOD refers to a high-density urban district built in such a way that any single house unit has a maximum distance of 10 minutes on foot from a public transport stop (Fig. 1). Favouring the use of alternative to the automobile is the main way to improve the quality of life and reduce environmental risks. So far, in the U.S. we have more than a hundred examples of TOD and it is advisable that in the upcoming years this number will keep growing.

Urban policies that we described have been introduced in last few years and, although there is plenty of scientific literature regarding urban sprawl, very few papers assessed the efficacy of such tools in limiting and control the phenomenon (Anthony 2004), in fact, their impacts on ground, economy and environment are not yet measurable. Among the available studies, the analysis by Anthony compares the variation of urban density in 49 American states between 1982 and 1997 and it points out that, although growth-managed states generally experienced a lesser density decline than states without growth management, regression analysis revealed that state growth management programs did not have a statistically significant effect in checking sprawl (Anthony 2004). The mismatch between measures adopted at state level and those implemented at local level is a possible explanation of the result, according to the author who states that if local support lacks, the implementation of any central policy ends up being of little efficacy.

Moreover, Anthony concludes his analysis suggesting a modification of actual zoning regulations to make anti-sprawl American urban policies more effective. These rules, in fact, impose a maximum density value which was fixed when American urban settlements were congested, crowded, with few available infrastructures; nowadays, things are different, so it is necessary to update the rules and define a minimum density value instead of a maximum density one, in order to guarantee compact urban development, inspired to principles of sustainability and land preservation.

Anthony's analysis results provide the opportunity to verify if, in Italy, planning policies are effecting in curbing urban sprawl, or if they are weak as well as the American ones.

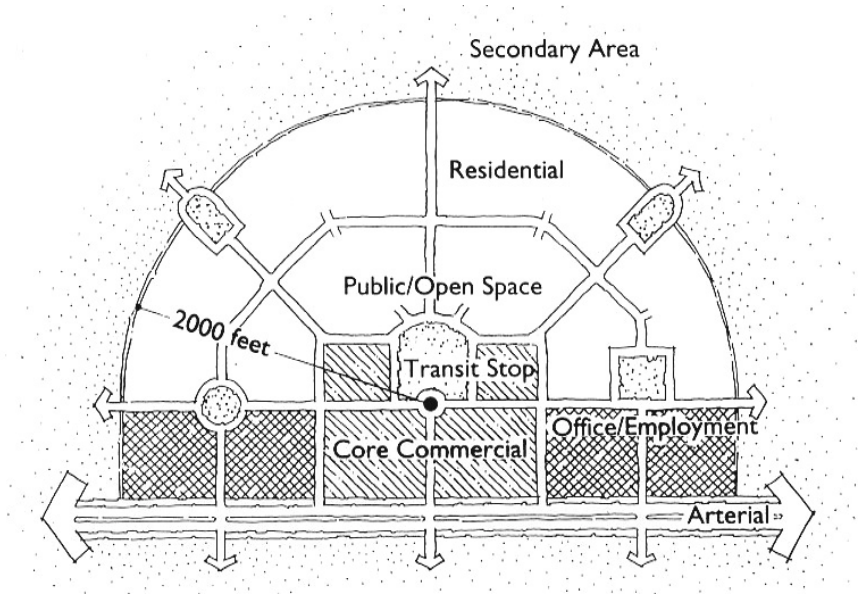

Fig. 1 TOD's model

3 STRIANO CASE STUDY

Inspired by Anthony's analysis, the paper aims to analyze the way planning regulations drive urban development in the Campania Region, now that urban sprawl represents one of the most dangerous phenomenon for the preservation of land.

Instead of comparing how urban density changed in a given period of time, the choice is to formulate a hypothesis of Area Action Plan so as to practically measure how much soil is necessary for the settlement of a given number of inhabitants in Campania, respecting the current legislation.

The town of Striano, which belongs to the Metropolitan Area of Naples, represents an interesting case study because it is identified by the proposal of Territorial Plan of Provincial Coordination (PTCP) of Naples as one of the few areas where increase in housing is allowed.

3.1 THE METROPOLITAN AREA OF NAPLES

In Italy, the metropolitan area notion was introduced with Law n. 142 of 1990 that, at art. 17, Section VI-*Aree Metropolitane*, states as follows: "We consider metropolitan areas those including the cities of Turin, Milan, Venice, Genoa, Bologna, Florence, Rome, Bari, Naples and other municipalities whose urban settlements maintain strict relations with them regarding economic activities, social life and culture, as well as territorial characteristics".

The institution of this new authority, the metropolitan city, which is similar to the Province but with greater powers, shows to which extent urban sprawl impacts Italian landscape: in fact, big isolated cities, as well as little towns, don't exist anymore, but territory is characterized by huge urban conurbations where relations between municipalities belonging to them, are so strong that they became part of a unique entity.

Law n. 142 gave Regions the task to draw the borders of single metropolitan areas within one year it became effective, but so far, in Campania, no official delimitation exists at all, but only several hypothesis.

One study regarding the trend of population on the Metropolitan Area of Naples (Mazzeo 2011) is interesting for our analysis. The paper identifies the boundaries of the Metropolitan Area of Naples based on «5 concentric bands, drifting far from the center», including a total of 142 municipalities belonging to the Province of Naples (92), Caserta (40) and Salerno (10). The analysis of the demographic variation between 1861 and 2009 allows to isolate two trends: the first regarding Naples, where population increases up to

1981 and then progressively decreases; and the second one regarding the other bands, from 2 to 4, in which population increases from 1981 to 2009, without any flection. «From data you can point out how decreasing of population in Naples was distributed in its surroundings and, in particular, in municipalities of band 2 and 3» (Mazzeo 2011).

Leaving Naples was generally due to the difficulty of reaching an acceptable level of quality of life in its center, and it favored the urbanization of surrounding areas and, as a consequence, the increasing consumption of land. The danger represented from excessive and uncontrolled consumption of land is nowadays, and more than ever, of great concern: several studies regard this topic (EEA 2011; Gerundo and Grimaldi 2011; FAI and WWF 2012; European Commission 2012; EEA 2012; ISPRA 2012) and focus attention on possible strategies to adopt to limit the phenomenon in the near future.

In the Campania Region, planning tools specifically redacted in order to contrast urban sprawl have been recently introduced. For example, one of the main goals of the Regional Territorial Plan (PRT), adopted in 2005, is to preserve and protect the natural environment by creating the Ecological Regional Network. Even the proposal of PTCP of Naples states and regulates the consumption of land focusing on the conservation of natural and rural spaces, promoting the improvement of density standards, because the densification of urbanized territory ensures a better use of land.

The town of Striano is within those territories that according to PTCP are to be densified and it is also chosen as a new node of the high-speed railway. For these reasons, Striano represents an interesting case study to apply those strategies we have already analyzed in order to limit urban sprawl and so evaluate the results in term of land consumption and density.

3.2 THE TOWN OF STRIANO

Striano lies in the Valley of Sarno located 38 km far from Naples.

Although it is not distant from the Vesuvio, it is not part of the eighteen municipalities belonging to the so called *red zone* (Fig. 2).

Its population amounts to 8.368 people (ISTAT 2011), distributed on 7.58 km^2.

The discovery of a IX sec. a.C. necropolis bears witness of an ancient village during the iron age. Several populations have followed in the territory: from the Opici, early inhabitants of the area, the Etruschi and Sanniti, up to the Romans. The entire population of Striano was forced to leave its land because of two natural catastrophes such as the earthquake of 62 d.C. and the Vesuvio's eruption of 79 d.C., and for these reasons the area surrounding the volcano stayed unpopulated until the beginnings of II sec. d.C., when the peasant community came back.

The agricultural vocation of Striano is still pretty dominant for its economy, even if from the beginning of '70 several industrial plants settled in the area.

Urban facilities are particularly scarce: two green areas, two sport centers with a soccer field and one school institution including one primary school and a secondary one, and a food market which was instituted in 1906 and a new market realized in Risorgimento Road.

Medical assistance is offered by an ambulatory located by the cemetery, in the eastern part of the city.

Striano's urban fabric looks complex and messy, so that it can be difficult to find an urban model that might represent its main structure. The plan's complexity disappears in buildings height: buildings, in fact, reach almost the same elevation; most of the buildings are under three floors and only few of them reach the fourth. Around the city center, characterized by the mix of ancient and new architecture together with few degraded buildings, there are some neighborhoods of more recent development, that were built without a precise urban project and so contribute to extend the disorder outside the city center.

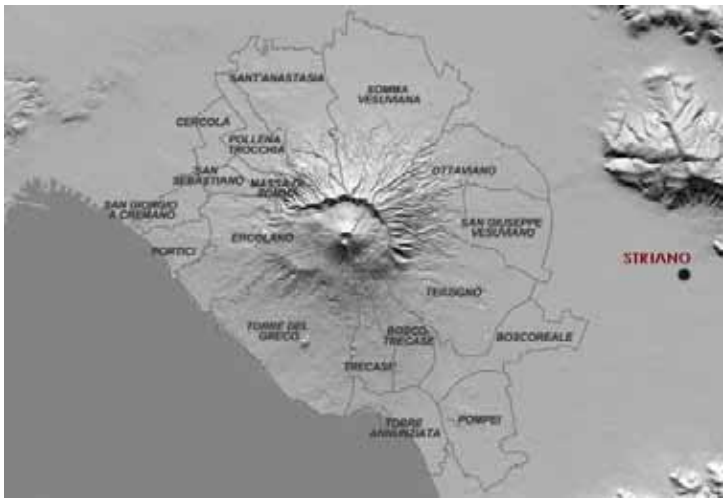

Fig. 2 the municipalities belonging to the *red-zone*

3.3 THE PROPOSAL OF PTCP OF NAPLES AND ITS MEASURES FOR STRIANO

The proposal of PTCP of Naples was made public in July 2006 with a Preliminary Document; in 2007, it was initially approved, but following the approval of PTR it was modified and integrated in conformity with PTR contents, and so newly approved in 2008.

After the administration election in 2009, the new provincial commission decided to extend the counselling phase before the final approval of PTCP, and for this reason, so far, PTCP remains a proposal.

One of the main goals of the Plan proposal is the preservation and the enhancement of the natural resources of the landscape, focusing attention on limiting land consumption.

The Plan isolates some area of *residential densification* to concentrate any intervention to increase housing supply, so that agricultural areas are preserved improving the use of building sites.

The area between Poggiomarino and Striano belongs to the *densification sites* where it is possible to make "interventions of requalification, densification and reinforcement of the existent settlements, towards the East, to move away from the high volcanic risk area" (Implementing Rules, PTCP of Naples).

According to the Table P.06.6. of PTCP, the area of Striano is classified in three different categories, relating to land use: historical area, urban area and agricultural area (Fig. 3).

The historical area lays in the central part of the town, confining with consolidated urban settlements that are surrounded by an area of urban integration.

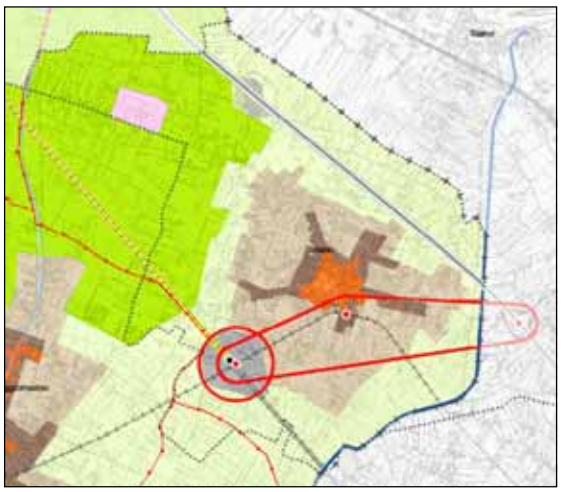

Fig. 3 Table P.06.6 of PTCP of Naples

Striano's rural areas are two, an ordinary agricultural area surrounding the area urban integration, and one of agronomic relevance in the East and Nord-Est part of the town, that the PTCP protects from future development. The first step to define the Area Action Plan is that of estimating the population housing needs, based on a ten year projection, using data from the National Institute of Statistics (ISTAT).

On this amount, a 15% of population rate has been added in order to supply the residential relocation needs, according to the forecasts of the execution rules of PTCP (art. 53)[1].

In the end, we have that the number of people to relocate in the project area corresponds to 3,908 inhabitants. Knowing the number of residents to relocate, it is possible to calculate the site area required, comprehensive of areas for building public facilities, called *Standards* (D.M. 1444/68) that include areas for schools, community facilities, green spaces and parking.

We chose to ensure an area for Standard destination of 20 m^2/person – greater than the minimum prescribed by the DM 1444/68 – as required by L.R. 14/82 for some types of municipalities[2]: the choice is justified by the expected significant increase in population that Striano will face in the future decade, in part due to the need for residential relocation of the communities of the close *red zone*.

The recently adopted L.R. 16/04 left in force the previous L.R. 14/82, which contains maximum residential density stipulations that restrict urban developments to 4 m^3/m^2; implementing such a measure, we obtain a site area of about 30 ha, corresponding to a population density of 127 persons for hectare (Tab. 1).

This result disagrees with the minimum population density value of 200 persons for hectare imposed by the proposal of PTCP for new residential developments[3].

Type of data	**Threshold**	**Value**	**Measure unit**
New population		3,908	
Residential Floor Area per person	35 m^2	136,780	m^2
Residential Building Volume (RBV) per person	105 m^3	410,340	m^3
Net Site Area (NSA)		170,975	m^2
Standard (DM 1444/68) per person	20 m^2	78,160	m^2
School	5 m^2	19,540	m^2
Community facilities	2.5 m^2	9,770	m^2
Green area	9.5 m^2	37,126	m^2
Parking	3 m^2	11,724	m^2
General Facilities per person	2.5 m^2	9,770	m^2
Residential Density (RBV / NSA)		2.40	m^3/m^2
Street Area	18%	46,603	m^2
Site Area		30.6	ha
Population Density		127	person/ha

Tab. 1 Area Action Plan for Striano

For this reason, a second hypothesis of Area Action Plan has to be formulated, respecting only PTCP's measures, in order to compare the two results. Calculating the site area for the second Area Action Plan based on a population density value of 200 persons for hectare means that 20 hectares of land are sufficient for the relocation of 3,908 people (Tab. 2).

1 PTCP of Naples, Article 53 (3): the allowable increase in residential development is that required to meet the existing needs of the resident population as well as a portion of what is required to meet the needs arising from the residential relocation, expressed in the strategy outlined by the PTCP. The aforementioned additional amount may not exceed 15% of the projected population for the decade of reference, determined in the manner set forth in Article 65. Interventions to increase residential development must be based on maximum savings in land consumption, providing new areas of residential urbanization only when the increase is not feasible through the reorganization of existent urban areas and the re-use of abandoned areas and buildings.

2 L.R. 14/82, Annex 1, Section 2 (1.4): the minimum allocation of areas for public facilities, established by art. 3 of the Ministerial Decree of 2 April 1968 n. 1444, of 18 m^2 per person, is increased to 20 m^2 per person in the Provincial capitals, in the municipalities with more than 50,000 inhabitants, and those with average rate of population increase in the last decade higher than 5%.

3 PTCP of Naples, Article 70: "General guidelines for the localization of new urban settlements".

Type of data	Threshold	Value	Measure unit
New population		3,908	
Population Density	200 person/ha		
Site Area		20	ha
Standard (DM 1444/68) per person	20 m^2	78,160	m^2
School	5 m^2	19,540	m^2
Community facilities	2.5 m^2	9,770	m^2
Green area	9.5 m^2	37,126	m^2
Parking	3 m^2	11,724	m^2
General Facilities per person	2.5 m^2	9,770	m^2
Street Area	18%	35,172	m^2
Net Site Area		72,298	m^2
Residential Building Volume per person	115 m^3	449,420	m^3
Residential Density		6.22	m^3/m^2

Tab. 2 Area Action Plan for Striano, second hypothesis

3.5 RESULTS

The hypothesis of Striano Area Action Plan based on the Campania Region's Law shows that for 3,908 inhabitants almost 30 ha of land are required, meaning a population density value of 127 persons per hectare. The second hypothesis of Action Plan, based only on PTCP prescriptions, indicates that 20 ha are enough for the relocation on 3,908 people, corresponding to a population density value of 200 persons per hectare. The Standard surface is the same in both hypotheses, because the number of people doesn't change, but in the second Plan this area is distributed on a smaller portion on land, thus confirming the greater settlement density of the new Plan. Hence, to make it easier to compare between the two hypotheses of Action Plans, the corresponding urban parameters have been summarized in the Table below.

	General data	Hypothesis 1	Hypothesis 2
Planning regulations and tools:			
L.R. 14/82		**Res. Density ≤ 4 m^3/m^2**	
PTCP Napoli			**Pop. Density ≥ 200 person/ha**
New population	3,908		
Residential Volume (m^3)		410,340	449,420
School Volume (m^3)	46,896		
Community facilities Volume (m^3)	23,448		
General Facilities Volume (m^3)	23,448		
Total Volume (m^3)		504,132	543,212
Site Area (m^2)		305,508	195,400
Street Area (m^2)		46,603	35,172
Standard (m^2)	78,160		
School (m^2)	19,540		
Community facilities (m^2)	9,770		
Green area (m^2)	37,126		
Parking (m^2)	11,724		
General Facilities (m^2)	9,770		
Population Density (person/ha)		127	200
Residential Density (m^3/m^2)		2.40	6.22

Tab. 3 Comparing the two hypothesis of Area Action Plan

4 CONCLUSIONS

The above analysis has attempted to evaluate the effectiveness of the Campania Region's planning regulation to stop urban sprawl by formulating a hypothesis of Area Action Plan for the town of Striano (NA) and measuring its impacts on land consumption and population density.

Basing the hypothesis of Striano Area Action Plan on the maximum residential density prescriptions imposed by the current Campania laws – LR 16/04 and LR 14/82 – implies allocating almost 30 ha of site area for 3,908 new inhabitants, instead, respecting the minimum population density limit required by the proposal of PTCP it is possible to save more than 10 ha of land, allocating 20 ha for the same population.

Therefore, the study as it was conducted indicates that the actual Campania Region's planning regulations are not efficient in limiting urban sprawl and end up being contradictory with the prescription contained in the proposal of PTCP to be approved. Thus, despite current Campania's planning Law 16/04 has been recently formulated, it needs to be updated because it maintained some preceding enacted laws (LR 14/82) created in a time when fast urban development was encouraged. On the contrary, new urban planning tools, such as the proposal of PTCP, contain all the necessary elements for a new approach to urban planning, based on the concepts of densification and sustainability.

More research is necessary to verify the possibility of extending the results of this analysis to the entire national territory, because the paper exclusively relates to Campania.

REFERENCES

Anthony J. (2004), Do State Growth Management Regulations reduce sprawl?, *Urban Affairs Review*, 39:3.

Antrop M. (2004), Landscape change and the urbanization process in Europe*, Landscape and Urban Planning* 67.

Arbury J. (2005), From Urban Sprawl to Compact Citiy – An analysis of urban growth management in Auckland*, Thesis for the Master of Arts in Geography and environmental Science,* University of Auckland.

Benevolo L. (2008), *La città nella storia d'Europa*, Editori Laterza, Bari.

Burchell R. W., Mukherji S. (2003), Conventional Vedelopment Versus Managed Growth: The Costs of Sprawl, *American Journal of Public Health*.

Calthorpe P. (1993), *The next American Metropolis*, Princton Architectural Press, New York.

Carruthers J., Ulfarsson G. (2003), Urban sprawl and the cost of public services, *Environment and Planning B: Planning and Design.*

Chin N. (2002), *Unearthing the roots of urban sprawl: a critical analysis of form, function and methodology*, Centre for advanced spatial analysis CASA, Working Paper Series, University College London.

Chorianopoulos I., Pagonis T., Koukoulas S., Drymoniti S. (2010), Planning, competitiveness and sprawl in the Mediterranean city: The case of Athens, *Cities*, 27, 249-259.

Clawson M. (1962), Urban Sprawl and Speculation in Suburban Land*, Land Economics* 38:2, 94-111.

Duany A., Plater-Zyberk E., Speck J. (2000), *Suburban Nation: the rise of sprawl and the decline of the American dream,* North Point Press, New York.

EEA (2012), *The State of Soil in Europe*, JRC Reference Report, Report EUR 25186 EN, European Union, Luxembourg.

EEA (2006), *Urban sprawl in Europe. The ignored challenge*, Technical Report 10, European Environment Agency, Copenhagen.

Ewing R. (1997), Is Los Angeles-style sprawl desirable?, *Journal of the American Planning Association*, 63:1, 107-126.

European Commission (2011), *Orientamenti in materia di buone pratiche per limitare, mitigare e compensare*

l'impermeabilizzazione del suolo, Europea Union, Belgium.

FAI, WWF (2012), *Terra Rubata. Viaggio nell'Italia che scompare.*

Friedman J., Miller J. (1965), The Urban Field*, Journal of the American Institute of Planners*, 31:4, 312-320.

Fulton W., Shigley P. (2005), *Guide to California Planning*, Solano Press Books, California.

Gerundo R., Grimaldi M. (2010), Consumo di suolo e scelte di pianificazione urbanistica, in Giuseppe Las Casas, Piergiuseppe Pontrandolfi, Beniamino Murgante (curr.), *Informatica e Pianificazione Urbana e Territoriale. Atti della Sesta Conferenza Nazionale INPUT 2010*, Libria Editore, Melfi.

Giammarco C., Isola A. (1993), *Disegnare le periferie*, Carocci Editore, Roma.

Galster G., Hanson R., Ratcliffe M.R., Wolman H., Coleman S., Freihage J. (2001), Wrestling Sprawl to the Ground: Defining and Measuring an Elusive Concept*, Housing Policy Debate*, 12:4.

Gordon C. V. (1950), The Urban Revolution, *Town Planning Review*, 21, 3-17.

Grgurevic O. (1981), *The evolution of urban sprawl and its reasons,* Center for Metropolitan Planning and Research: The Johns Hopkins University Baltimore, Maryland.

Harris L. (1984), *The Fragmented Forest – Island Biogeography Theory and the Preservation of Biotic Diversity,* University of Chicago Press.

Harvey R., Clark W. A. V. (1965), The nature and economics of sprawl*, Land Economics* 41:1, 1-9.

Hess G. (2001*),* Just what is sprawl, anyway?, *Carolina Planning*, University of North Carolina Department of City and Regional Planning, 26.

Holden R., Turner T. (1997), Western Europe, Current City Expansion and the Use of GIS*, Landscape and Urban Planning,* 36:4, 315-326.

ISPRA (2012), *Qualità dell'ambiente urbano* - VIII rapporto.

IUNC – International Union for the Conservation of Nature and Natural Resources (1980), *World Conservation Strategy: Living Resources Conservation for Sustainable Development,* Switzerland.

Kautz R. (1993), Trends in Florida's Wildlife Habitat 1936.1987*, Florida Scientist,* 56:1, 7-24.

La Greca P., Barbarossa L., Ignaccolo M., Inturri G., Martinico F. (2011), The density dilemma. A proposal for introducing smart growth principles in a sprawling settlement within Catania Metropolitan Area, *Cities*, 28, 527-535.

Le Goix R. (2005), Gated communities: sprawl and social segregation in southern California, *Housing Studies.*

Levy J. M. (2006), *Contemporary Urban Planning*, Pearson Prentice Hall, New Jersey.

Mazzeo G. (2011), *Città a meno del piano*, Franco Angeli, Milano.

Mazzeo G. (2009), Dall'area metropolitana allo sprawl urbano: la disarticolazione del territorio, *TeMA Journal of Land Use, Mobility and Environment,* 2:4, 7-20.

Mitchell J. (2001), *Urban sprawl*, National Geographic.

Mumford L. (1961), *La città nella storia*, Bompiani, Milano.

Papa R. (2009*), Il governo delle trasformazioni urbane e territoriali*, Franco Angeli, Milano.

Phelps N. A. (2010), Suburbs for nations? Some interdisciplinary on the suburban economy, *Cities*, 27, 68-76.

Piguet P., Blunier P., Lepage M. (2011), A new energy and natural resources investigation method: Geneva case studies, *Cities*, 28, 567-575.

Provincia di Napoli (2007), *Piano Territoriale di Coordinamento, proposta di piano,* Napoli.

Regione Campania (1982), l.r. *n. 14/1982, Indirizzi programmatici e direttive fondamentali relative all'esercizio delle*

funzioni delegate in materia di urbanistica, ai sensi dell' art. 1 - II comma - della l.r. 1° settembre 1981, n. 65.

Regione Campania (2004), *Legge Regionale n° 16 del 22/12/2004, Norme sul governo del territorio*.

Rossi A. (2010), *L'architettura della città*, Città Studi Edizioni, Torino.

Sardena A. (2010), Mixite funzionale e morfologica dello spazio abitabile dei quartieri residenziali, in Giuseppe Las Casas, Piergiuseppe Pontrandolfi, Beniamino Murgante (curr.), *Informatica e Pianificazione Urbana e Territoriale. Atti della Sesta Conferenza Nazionale INPUT 2010*, Libria Editore, Melfi.

Secchi B. (2008), *La città del ventesimo secolo*, Editori Laterza, Bari.

Mehaffy M., Tachieva G., Qamar L., Vogel M. (2011), *The unbearable costs of sprawl*, http://www.theatlanticcities.com/, access: 10/02/2014.

Young D., Keil R. (2010), Reconnecting the disconnected: The politics of infrastructure in the in-between city, *Cities*, 27, 87-95.

IMAGE SOURCES

Fig. 1: Calthorpe P. (1993), The next American metropolis

Fig. 2: www.vesuvius.it

Fig. 3: PTCP of Naples

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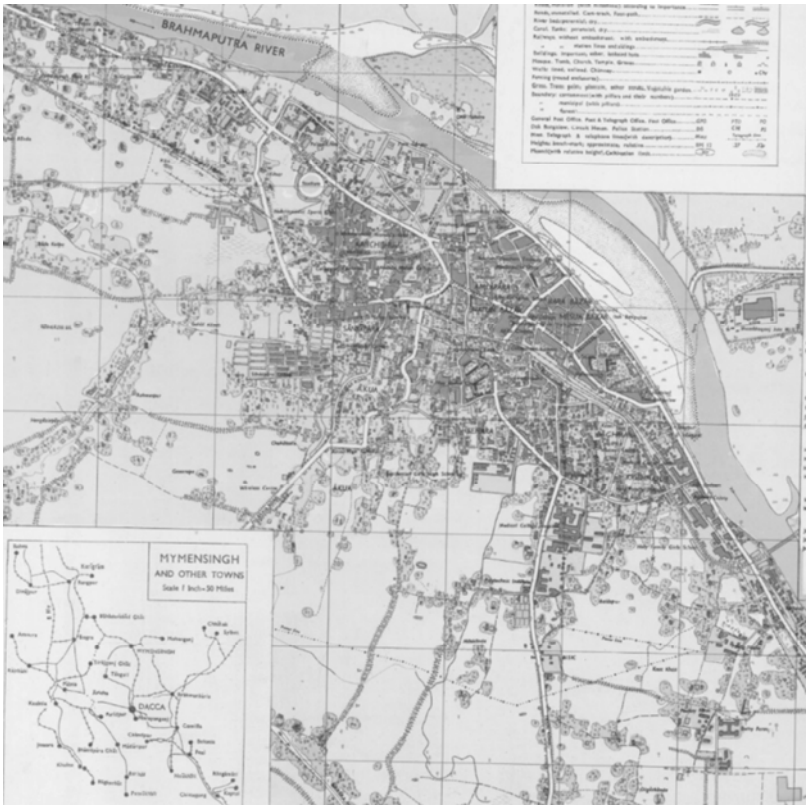

PREDICTION OF MYMENSINGH TOWN FUTURE EXPANSION

USING SPACE SYNTAX

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ABSTRACT

Urban space changes according to different space use with the passage of time, as seen in land use, location, and land value distribution. The paper intends to analyze the change of integration core related to the growth of commercial land use through different time periods. Two phases of Commercial land-use pattern is studied. The phases are i) 1974, ii) 2013.
The entire spatial structure of the commercial land use of Mymensingh reacts to the entire city system, particularly the road network pattern. In this context, this study aims to identify the influence spatial configuration exerts on the location of different types of commercial activity in terms of land use. The results of this study will help to interpret and predict the future commercial land use related to its road network. In this paper the process was conducted in the following steps: Step-01: A field survey was conducted to collect data regarding locations of commercial activity, Step-02: Land-use maps of two phases were collected to analyze the relation between commercial activity and road network, Step-03: Space syntax theory was applied to simulate the data to analyze the relationship and Step-04: Proposition.

KEYWORDS:
Integration-core, urban economy, spatial expansion, axial- analysis

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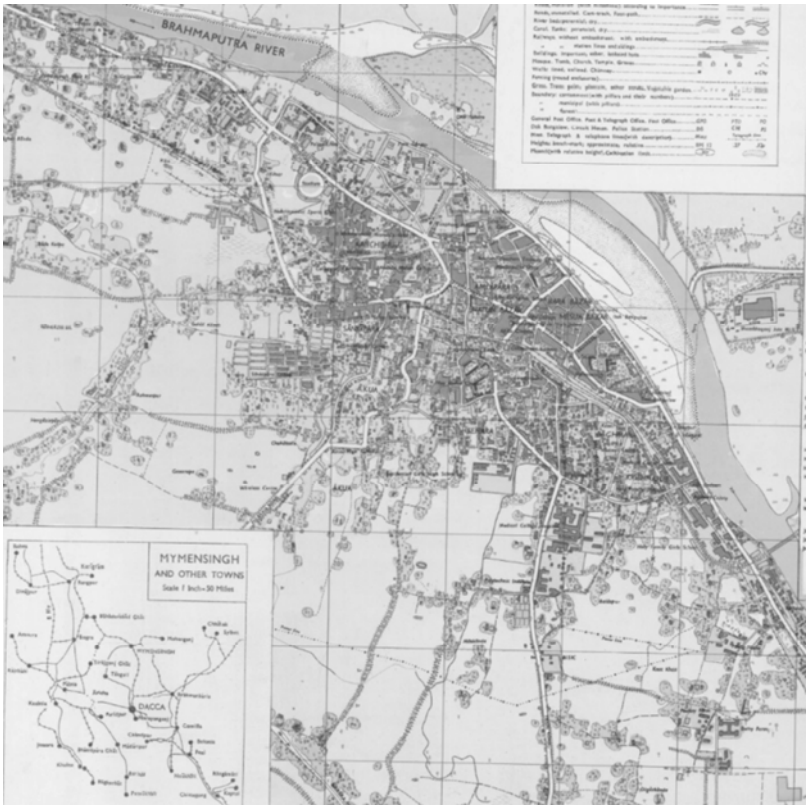

利用空间句法（SPACE SYNTAX）预测迈门辛县（MYMENSINGH TOWN）的未来扩张

SILVIA ALAM

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摘要

城市空间根据不同的空间利用并随着时间的推移而改变，这种变化表现在土地利用、选址以及土地价值分配等方面。本文旨在分析不同时期与商业用地增长有关的整合核心的变化，对商业土地利用范式的两个阶段进行研究：阶段一为 1974 年；阶段二为 2013 年。

迈门辛商业用地的整体结构是对整个城市系统，特别是道路网络格局的回应。在此背景下，此项研究的目的在于就土地利用而言，确定空间配置对不同类型商业活动选址的影响。此项研究的成果将有利于解释与道路网络有关的未来商业土地的利用，并据此做出预测。

本文的研究步骤如下：第一步，通过实地考查搜集有关商业活动选址的数据；第二步，搜集两个阶段的土地利用地图，分析商业活动和道路网路之间的关系；第三步，使用空间句法理论来模拟数据，分析两者的关系；第四步，提出建议。

关键词

整合核心；城市经济；空间扩张；轴向分析

1 INTRODUCTION

The economic progress of Mymensingh City completely depends on the commercial hub that consists of Shopping Centers, Banks, Local Bazaars etc. Since there is no industry or other business activity that exists in the city, the development of this commercial hub and its pattern of future expansion have a significant impact on the local economy. Hence this paper intends to study the formation and growth of the commercial hub of Mymensingh city over time and also analyze the possible direction for its future expansion. First, the commercial zones of the city were located through field survey and land-use data. Then the integration Core of Mymensingh city was identified by applying space-syntax theory. It was found that the formation of the Urban Core of the city (integration core) is codependent on the development of the Commercial Hub. Two of the city's economic phases (1974 and 2013) has been compared and analyzed for further results.

1.2 OBJECTIVES

- To find the relationship between the street patterns and the commercial land use patterns of a city on the basis of integrity of the roads
- To analyze the integration-core and the change of the most integrated route in relation to the economy of Mymensingh city.

2 METHODOLOGY

The methodology for the process of analysis and evaluation can be described in a structured way. The initial step is to acquire the basic information of the Mymensingh Paurashava, as such the historical background of the evolution of the city, the present dimension, the natural and geographical settings which influences the growth and expansion of the city.

The basic information of the land use patterns and street network is collected from the local authority of Mymensingh Paurashava. The land use maps include the different types of land use patterns and total areas. The depth map is used for simulation to generate the integration pattern of the streets of Mymensingh Paurashava. From this simulation the maximum and minimum integration of the streets can be generated and plotted through a map. Thus the maximum integrated part of the city or the urban core can be marked.

The comparison between the both simulated map and the land use map of 1974 and 2013 helps to understand the inner relationship of the different types of land uses and the integrity of the adjacent streets. It also helps to understand the reason of concentration and expansion of different parts of the city. The possibilities of future expansion of urban core and change of land use patterns can be assumed from the simulations and comparison of the land use pattern.

3 LITERATURE REVIEW

3.1 HISTORY OF MYMENSINGH CITY

Mymensingh (Bengali, pronounced *moy-mon-shing-haw*) is a city of Bangladesh situated on the river Brahmaputra. Since the 1980s the city has expanded with fast urbanization. Mymensingh city is clearly marked by the old Brahmaputra River flowing along its north. Shambhuganj is situated on the other side of the Brahmaputra, connected by the Shambhuganj Bridge. The other ends of the city are marked respectively by the beginning of the Agricultural University campus, the Medical College, Army cantonment and, finally, Sultanabad, a township built for the followers of Aga Khan. A railway line connecting Dhaka with northern districts, built between 1885 and 1899, passes through the city and divides it into two sides. The entire area between Durgabari Road, and Maharaja Road comprises the core commercial area. There are places like Ganginarpar, Boro Bazaar, Choto Bazaar, Mechua Bazaar within this area. There are spots like 'Jilapi Patty'

which is for making and selling 'jilapis'. The main road from Notunbazar to the railway station hosts a number of shops for manufactured products and clothing on the two sides.

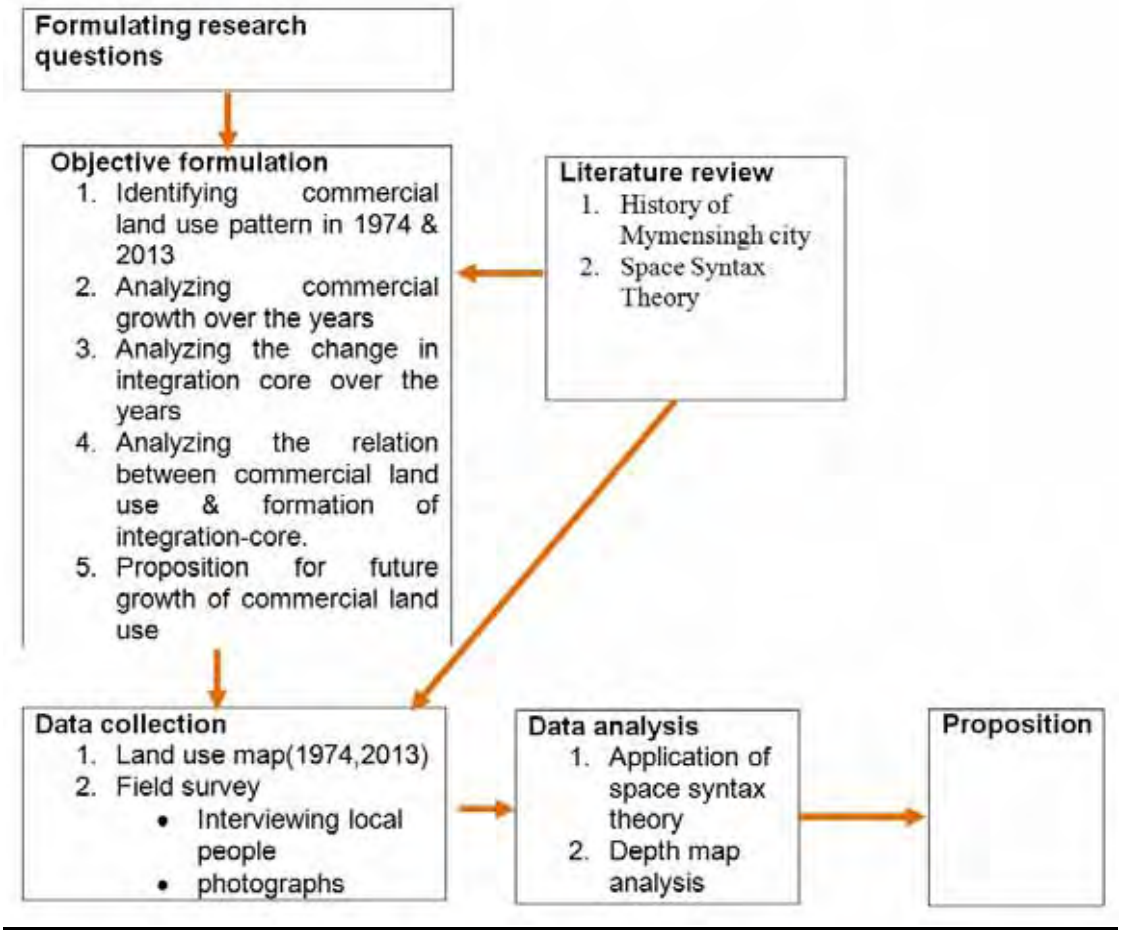

Fig. 1 Research methodology

3.2 SPACE SYNTAX THEORY

Space syntax is a methodology for measuring the relative accessibility of different locations in a spatial system by partitioning the spatial system into relatively independent but connected subspaces (Hillier and Hanson 1984, Batty and Rana 2004).

It adopts a configuration approach to study to what extent and in which conditions the social and spatial attributes are correlated. It analyzes the topological properties of the urban grid represented by urban street network, and compares that with the human movement including pedestrian and vehicle flow. Comprehensive mathematical models of the topology of urban street network, analyzed and supported by empirical data give deep insights into the functional patterns and settlements and cities (Hillier et al. 1993).

- Space syntax theory and technology were pioneered in 1970 by Prof. Bill Hillier and Colleagues at University of London.
- Built on quantitative analysis and geo-spatial computer technology, space syntax provides a set of evidence based techniques for the analysis of spatial configuration of all kinds, especially where spatial configuration seems to be a significant aspect for human affairs, as it is for buildings and urban areas.
- In this technique, the 'convex space' defined by polygons where no line is drawn between any two points in the space goes outside it. 'Axial line', defined as the longest and fewest straight lines of visibility and permeability that cover all the convex space represent the one dimensional organization of the spatial layout.

- In the context of a city, urban blocks or plots are considered as close spaces, while streets and squares as parts of the open spaces. Open space provides a unique vision in understanding the configuration of an urban system.
- There are ***four syntactic measures*** that can be calculated. These are used in quantitative representations of building and urban layouts:
- **Connectivity** measures the number of immediate neighbors that is directly connected to a space. This is a static local measure.
- **Integration** is a static global measure. It describes the average depth of a space to all other spaces in the system. The spaces of a system can be ranked from the most integrated to the most segregated.
- **Control value** is a dynamic local measure. It measures the degree to which a space controls access to its immediate neighbors, taking into account the number of alternative connections that each of these neighbors have.
- **Global choice** is a dynamic global measure of the 'flow' through a space. A space has a strong 'choice value' when many of the shortest paths, connecting all spaces to all spaces of a system, passes through it.

Integration

Among all the measures, the first and the most important measure of Syntactic analysis is integration. The integration of a space is a function of the mean number of lines and changes of direction that need to be taken to go to all other spaces in the system. Integration is therefore about syntactic and not about metric accessibility and the word depth rather than distance is used to determine how far a space lies. The integration value of a line is a mathematical way of expressing the depth of that line from all other lines in the system (Hiller & Hanson 1984). In integration, the relative depth and shallowness of any spatial system are seen from any Particular point within it. Integration is a global static measure in that, every axial line is assigned a value which is characteristic to its relation to all other lines in the and thus provides a global index of relative integration and segregation for that line relative to all others. These values that are well below 1 – out of the order of 0.4 to 0.6 – indicate more segregation, while the value ending to and above 1 show strong integration. The warmer color axial line has, high global or local integration value and vice versa. For example, the red line represents the highest integration value; the dark blue line represents the lowest integration value, in other words, the most segregation.

Integration Core

Once the integration of each space of the whole system has been calculated, the "integration core" which illustrates the important deep structure of a spatial system, can be identified. The integration core forms the pattern of 'the most integrated line' of an urban system. The nature of the integration core, its size, and space depends on the shape, connectivity, and geometry of the urban system and on its mode of growth.

4 DATA COLLECTION

Defining a methodology is imperative to directing any research work. In general, a method is the way of doing something and a methodology is a broad framework of systematically arranged various methods and techniques devised to conduct any research work or study (Jahan 2007). Here secondary data was collected. Like the Master plan on Land use zoning, Structure plan, Strategic plan, Spatial growth of Mymensingh town and Mymensingh town ward map, Road map of 1974 & 2013 from UDD and others demographic, geographical, economical, historical data from literature review.

4.1 LAND USE MAP 1974

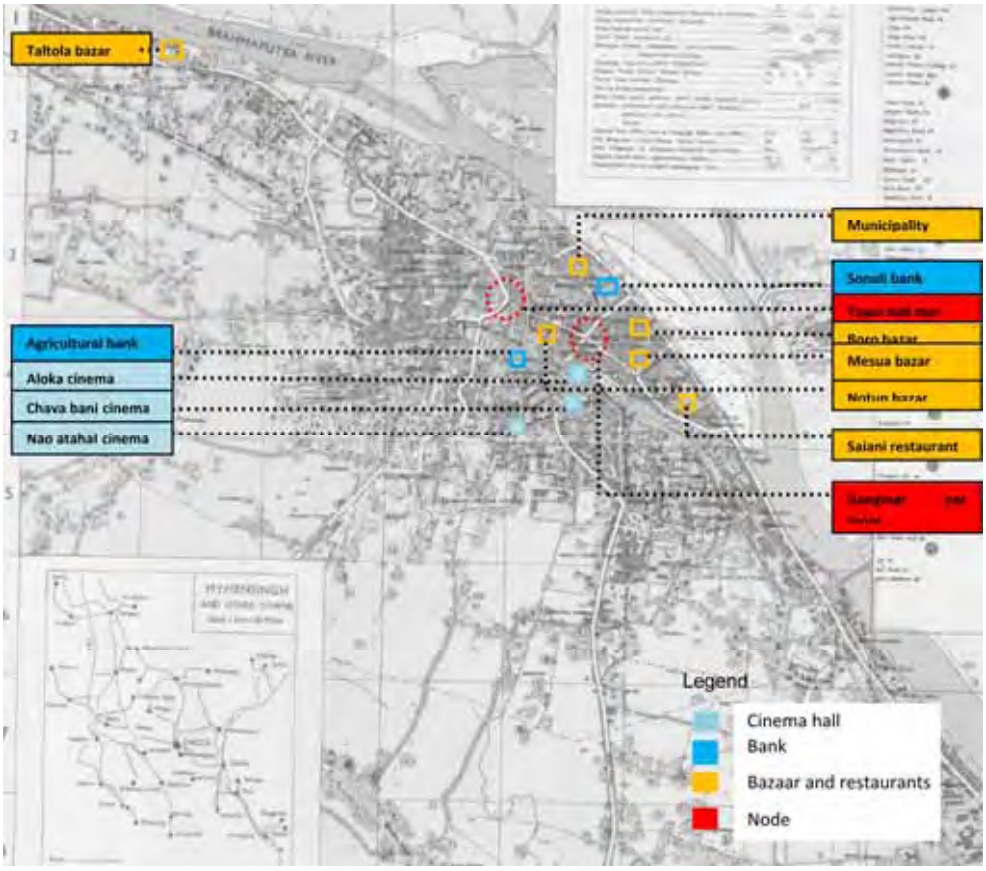

Fig. 2 Land use map of 1974

4.2 LAND USE MAP 2013

Fig. 3 Present name of the road and approximate locations of the selected commercial land use

4.3 LAND USE ZONING

According to the master plan, Mymensingh has attracted by the surrounding area which are treated as the hinterland and the development of Mymensingh adjacent with its near river "Bhrammaputra" and road. The **Ganginapar nodal point** and **Town Hall nodal point** is the main urban core that is connected with other roads and streets of the city. The movement from one part of the city to another part needed to pass these two nodes as the main road continues from east to west between these nodes and connected with Dhaka-Mymensingh highway (Mymensingh Master plan 2009-2013). The main commercial zone has been developed on both side of main road near the Ganginapar node after the establishment of Mymensingh Railway Station. The educational facilities have grown afterwards along the both side of main road near Town Hall node. The administrative facilities are established near the riverbank in an early period but the road connecting those buildings was not treated as main road of the city. The establishment of Agricultural University played an important role for expansion of the city on the east part though the development was slow comparing to southern part. At present the Dhaka Mymensingh highway is widened and the new commercial facilities are emerging along the connecting roads from Ganginapar node to Dhaka-Mymensingh highway.

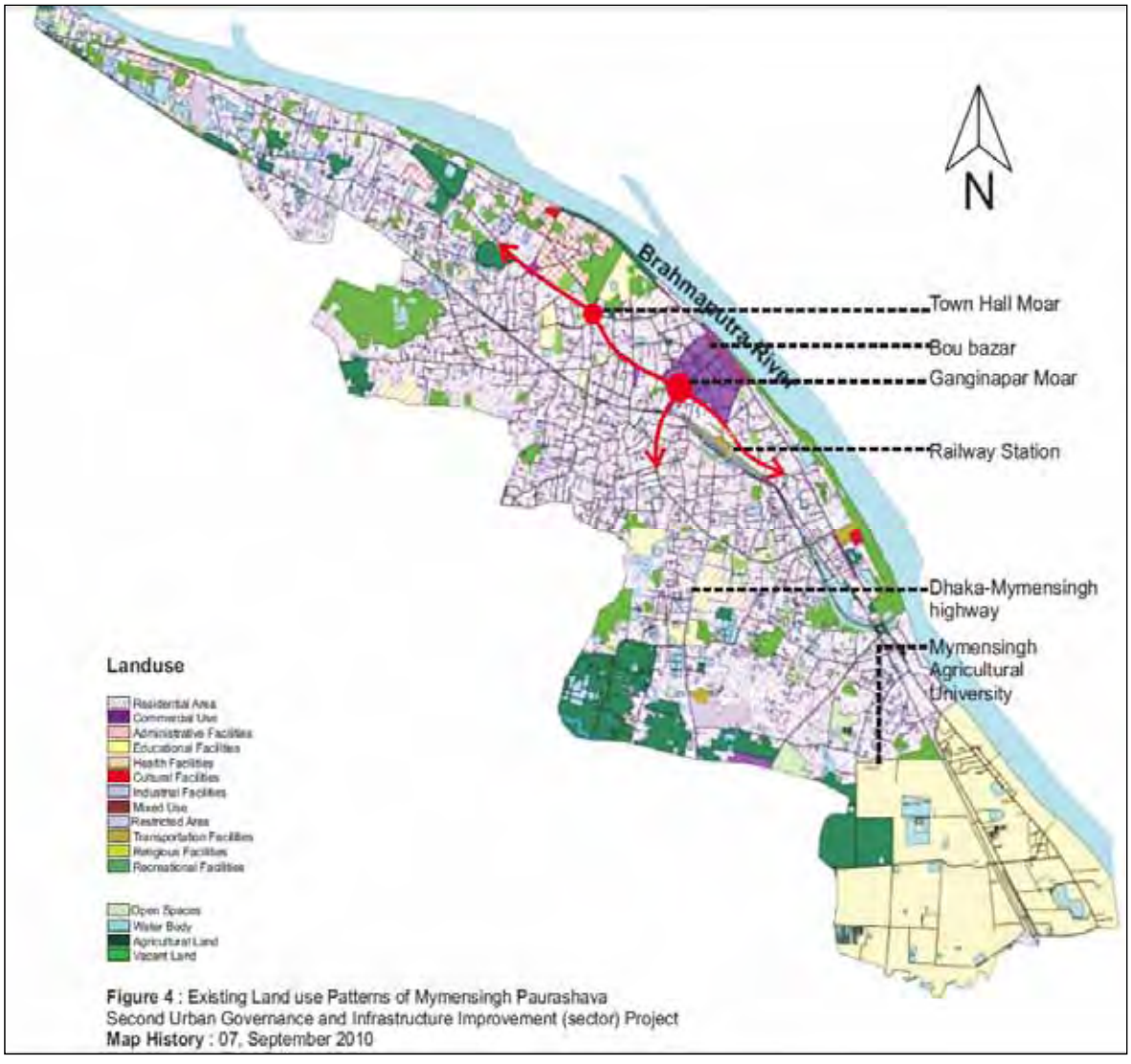

Fig. 4 Existing land use patterns of Mymensingh Paurashava, 07 Sept. 2010

Street Patterns

Mymensingh Paurashava is divided into 21 wards alongside the river of Brahmaputra. The main accessibility to the city center is from Dhaka-Mymensingh highway,Shamvuganj Bridge over the river Brahmaputra connecting Netrokona, Mymensingh-Tangail Road and from Fulbaria to Mymensingh road. The Ganginapar nodal point and Town nodal point are the main urban core that are connected with other roads and streets of the city. The movement from one part of the city to another needed to pass these two nodes as the main road continues from east to west between these nodes and connected with Dhaka-Mymensingh highway.

Town Hall Nodal Point

The major dynamic driving forces of the cities in developing countries are economic and social forces to change the urban system with the growing demand of population and urbanization. Of course all the urban problems are different and unique to a particular city based on the city growth pattern, economic and social character. The centre of economic hub of the city is “boro bazaar” and “notun bazaar” area. The changing city form gave “Boro Bazaar” the shape of mixed use zone rather solely commercial or business zone. As a central economic hubs in the city centre, Boro Bazaar needs to be more dynamic to response to the city economy and its growth pattern. For last one decade Boro Bazaar has faced compact unplanned haphazard development even along the riverside just to meet the demand of rapid urbanization process. Therefore it is now become an urban challenge to revitalize the Boro Bazaar area to make more effective response to the rapid economic growth and to ensure better urban environment for the residents, businessmen and the employers.

Ganginar Par Nodal Point

As a new economic hub, “Ganginar par” node has a great importance. At this node all kinds of mixed commercial business are running. All kinds of luxuries office and private Bank, insurance, show room has established. So, it has its own importance. The maximum traffic congestion occurs in some areas in different time period of the day. From morning 7 am to 9 am and 12 to 2 pm the traffic congestion can be seen in between Town Hall node to Ganginapar node as School and colleges are alongside the roads. The office vehicular flow for office going people is responsible for traffic congestion during 8 to 10 am and 6 to 8 pm. The main market and bazaar zone is along with the Station node and the connecting road towards Ganginapar node. The traffic congestion occurs here during 12 pm to 1 pm and 6-to 8 pm at the evening. The maximum pressure on the roads occurs at Ganginapar nodal point at all the rush hours because this point is passed by all types of vehicular flows for different purposes like educational, administrative and commercial. So it is clear that, the growth pattern of road runs with the city economy of Mymensingh. “Space syntax” has show; the transformation of the integrated core. This can be explained with the economic activities of the city.

4.4 FIELD SURVEY

Fig. 5 Bari plaza

Fig. 6 Notun bazaar node

Fig. 7 Ganginar par node

Fig. 8 Station node

Fig. 9 Charpara node

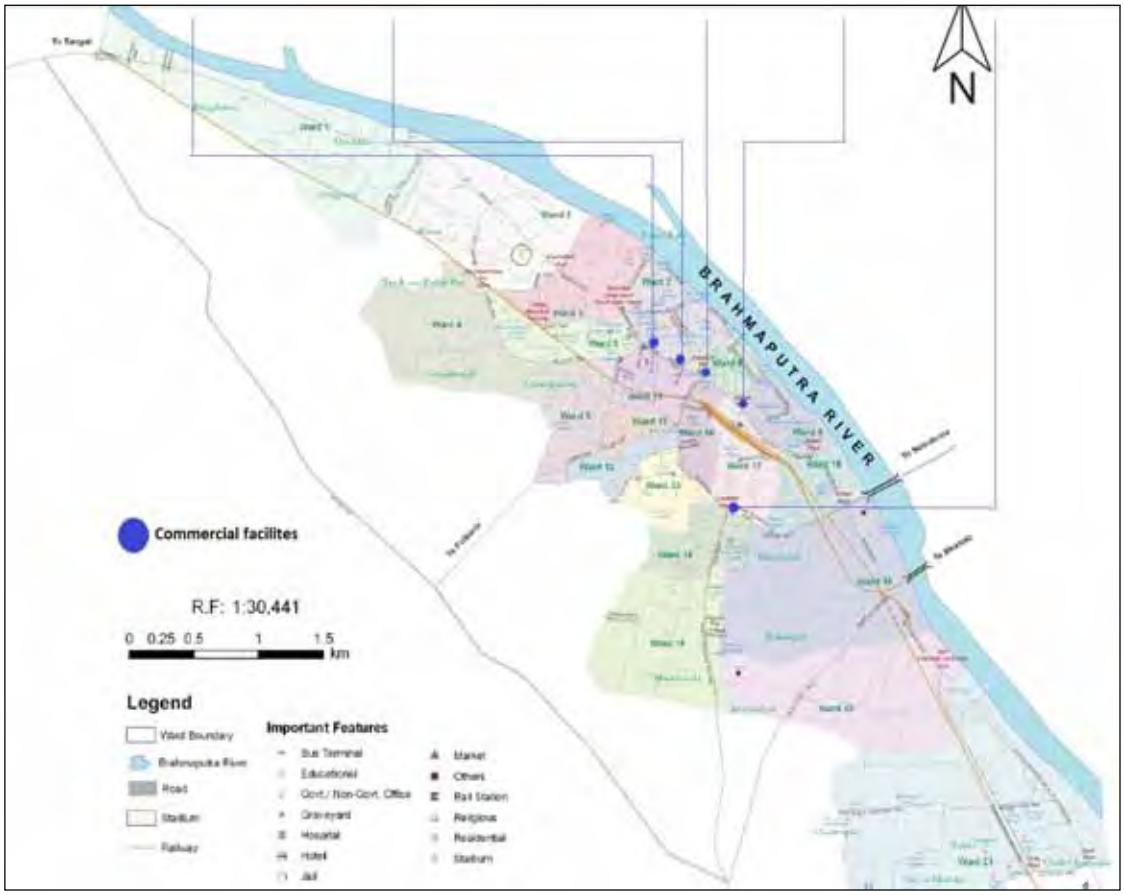

Fig. 10 Location map of Mymensingh town, 07 Sept. 2010

4.5 GENERATING AXIAL MAP

Fig. 11 1974 Road network layout drawn as convex space

Fig. 12 2013 Road network layout drawn as convex space

5 SIMULATION

5.1 IDENTIFYING INTEGRATION CORE

The space syntax simulation of the Mymensingh town is done with the help of depth map to create an axial map of the existing street patterns. The axial map is created by axial spaces or axial lines which are straight lines ("sight line"), possible to follow on foot. From the axial map the integration values of the streets are generated. The integration of a space is a function of the mean number of lines and changes of direction that need to be taken to go to all other space in the system. Integration is therefore about syntactic not about metric accessibility and the word depth rather than distance is used how far a space is lies.

The integration value of a line is a mathematical way of expressing the depth of that line from all other line in the system (Hiller & Hanson 1984). In integration, the relative depth and shallowness of any spatial system are seen from any particular point within it. This analysis has considered on the basis of Global theme (R= n).

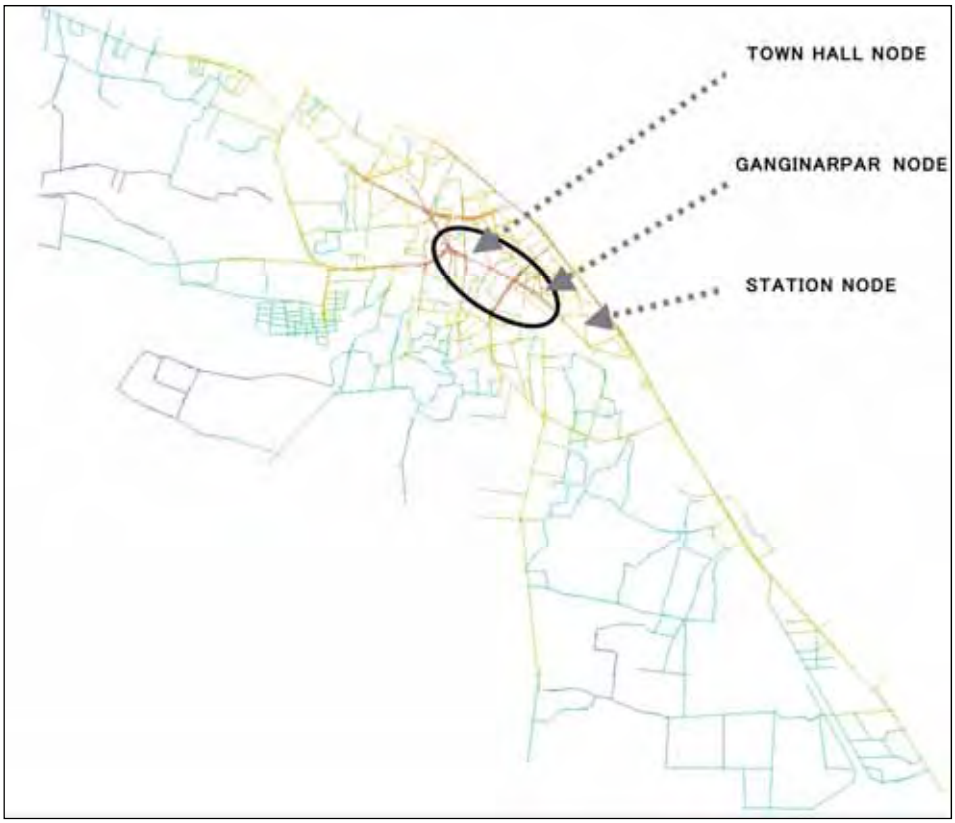

Fig. 13 1974 Axial map with global integration R=n

From Pouroshobha map of 1974 and 2013, it shows that each of the selected commercial zones is connected to a main road through a secondary access road. Global Integration, Connectivity of access road of commercial zone of 1974 & 2013 are given below.

From Tab. 1 it can be seen that Ganginarpar and Shemacharan roads were mostly integrated roads with the value of 1.38358 in the town and their connectivity were highest which is 34. Jubilee road was the second highest integrated road of the town as Borobazar and Chotobazar road were partially connected with it (Fig. 2). Chorpara road had the connectivity of 13 which had commercial buildings like Aloka cinema hall, Anondolok cinema hall and agricultural bank (Fig. 2) which was low down integrated road than Ganginarpar and Shemacharan roads.

Fig. 14 2013 Axial map with global integration R=n

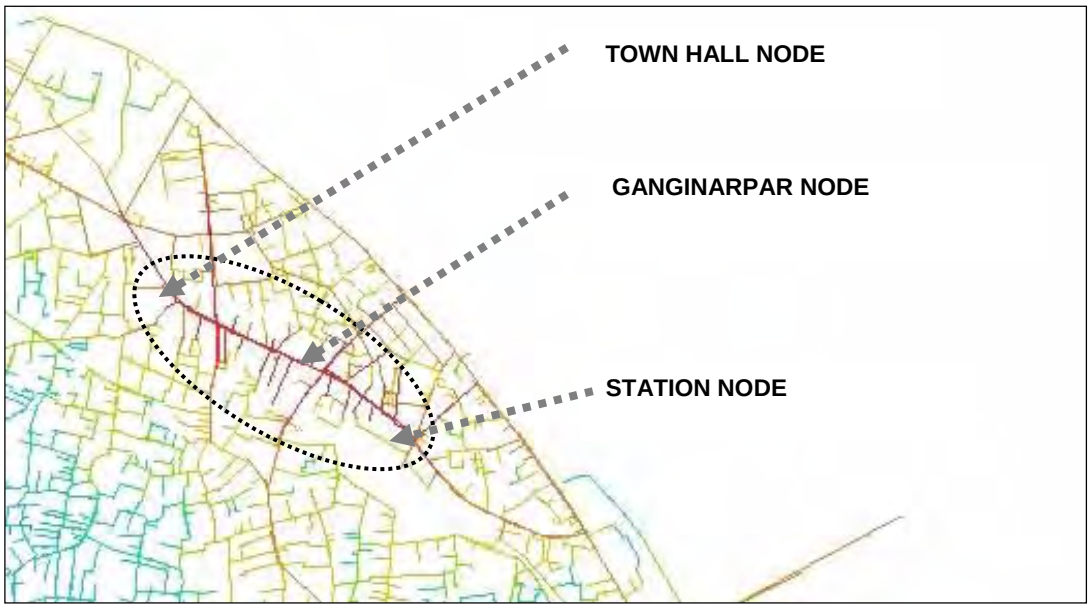

Fig. 15 Blow up of 2013 axial map with global integration R=n

5.2 ANALYSING AXIAL MAP OF 1974 & 2013

SL No	NAME OF THE BUILDING	ADJACENT MAIN ROAD	REFF NO.	INTEGRATION (HH)	CONNECTIVITY
1	Boro bazar	Borobazar Road	232	1.11073	6
2	Choto bazar	Choto bazar Road	231	1.0304	5
3	Mesua bazaar	Ganginar par Road	279	1.38358	34
4	Notun bazar	Shemacharan Road	279	1.38358	34
5	sonali bank	Jubilee road	295	1.21658	16
6	Anonda lok cinema, aloka cinema, agricultural bank	Chorpara road	272	1.07143	13

Tab. 1 Global integration, connectivity of access road of commercial zone of 1974

SLNo	NAME OF THE BUILDING	ADJACENT MAIN ROAD	REFF NO.	INTEGRATION (HH)	CONNECTIVITY
1	Boro bazar	Borobazar Road	1394	.745529	6
2	Choto bazar	Choto bazar Road	1523	.729942	5
3	Mesua bazaar, uttara shopping mall, harun tower	Ganginar par Road	1514	.818697	30
4	Notun bazar	Ram babu Road	1919	.843409	25
5	Municipality market, sonali bank	Jubilee road	1733	.768198	8
6	Nursery	Shemacharan road	2574	.810389	13
7	Chorpara kacha bazaar, janata bank	Chorpara road	1601	.797153	22

Tab. 2 Global integration, connectivity of access road of commercial zone of 2013

From Tab. 2 it can be seen that in 2013 the Rambabu road is mostly integrated road with connectivity of 28 roads because of their land use pattern are converted from residence into commercially used buildings. The commercial mall like, Uttara shopping mall, Harun tower, Bari plaza, Banks, Restaurants, Mesuabazar, other companies outlets, retail stores are developing alongside of Ganginarpar road which leads towards station node (Fig. 3). The Chorpara road which is connected from Ganginarpar node at south east side is third highest integrated road with the connectivity of 22 roads. Janata bank, Hotel al Rifat, Panch Tara hotel, Chorpara bazaar were developed in this road.

5.3 OBSERVATIONS

- Initially with the formation of the city the main commercial zone was located around town hall node during 1888 to 1889.
- The 1974 map shows that the business activity has shifted around Ganginar par node.

- At present time Ganginar par node is still important for its business potentiality. But at the same time this core has south ward pull to station node.
- Ganginar par node has become the integrated core.
- "Chorpara road" has gotten its importance which is connects towards Dhaka Mymensingh highway.

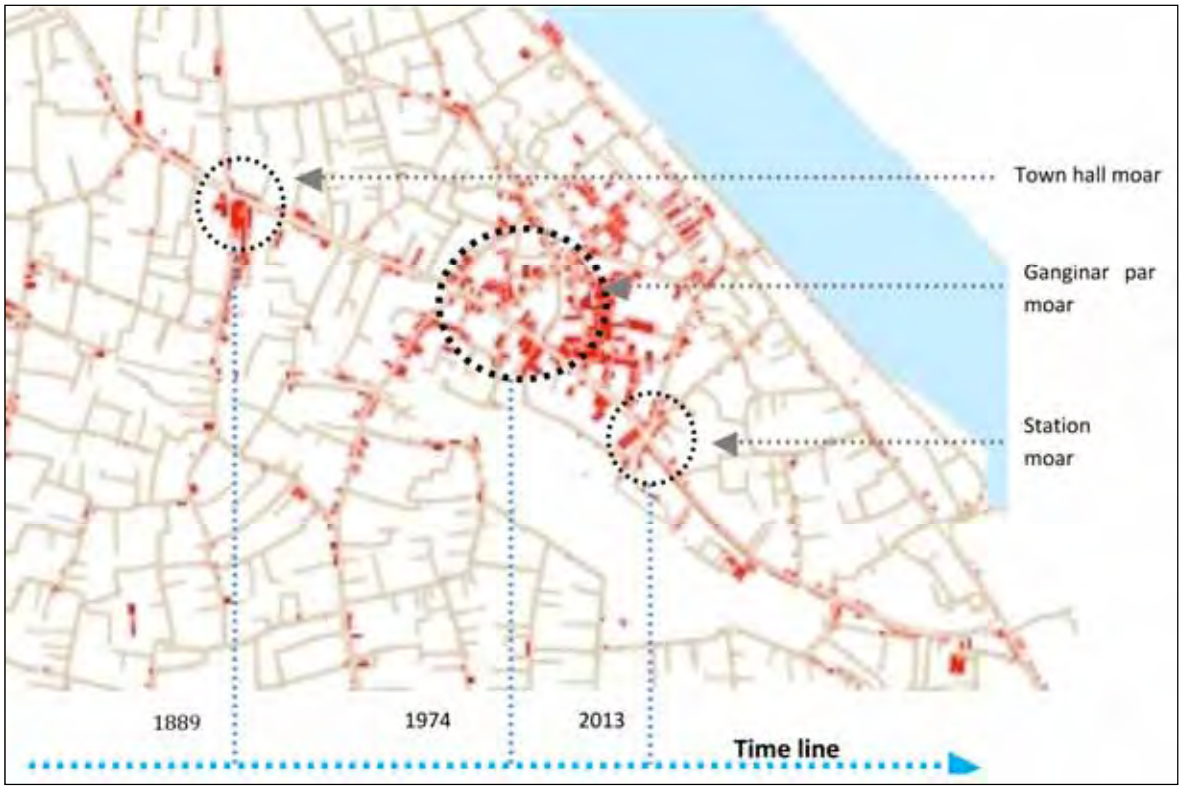

Fig. 16 Progression of commercial zone through time

6 PROPOSITION

A number of proposition can be illustrated from the analysis that are given below:

- The Axial Line Analysis explore that, the city integrated core has extended from north east to south west (Fig. 16).
- The shifting of the integration core can be assumed either towards i) the Dhaka-Mymensingh highway or ii) along Brahmaputra River through Station nodal point.
- Hence the possible future growth of commercial zone of Mymensingh city may take place towards Dhaka City or along with Brahmaputra River.

7 CONCLUSION

The objective of the paper was to analyze the relationship between the road network along with the commercial land use and its growth pattern in different time periods through space syntax. Two phases of axial maps are analyzed and it can be said that it has a strong relationship between commercial zones with mostly integrated cores. The survey data and the space syntax simulation help to represent this comparative analysis of the past with the present situation and possible future changes in the urban area. The future transformation and expansion of the city area in a logical and effective way can be plotted and necessary steps for city development can be assumed and suggested for the betterment of total urban area.

Fig. 17 Possible future expansion

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REFERENCES

Hillier B. (1996), *Space is the machine*, Cambridge University Press, Cambridge, UK. ISBN 052156039X

Hillier B. and Hanson J. (1984), *The Social Logic of Space Cambridge*, Cambridge University Press.

Batty M. and Rana S. (2004), "The automatic definition and generation of axial lines and axial maps", *Environment and Planning,* B,31, forthcoming.

Jahan M. A. R. A. S. (2007), *Spatial and Temporal Pattern of Urbanization of Bangladesh*, Bangladesh Institute of Planners, Bangladesh.

Hillier B., Penn A., Hanson J., Grajewski T., Xu J. (1993), "Natural Movement or, configuration and attraction in urban pedestrian movement", *Environment & Planning (B): Planning & Design*, 20:1, 29-66.

Peponis J. (1990), *Space Syntax* - Ph.D. thesis.

Hoque K. S., Najneen F., Mahmood S. M. S., Rahman S., Shamim M. M. (2010), "Change of the Integration Core with Urban Economy (A Study on Khulna City)", *Bangladesh Res. Pub. J*, 4:2, 133-141.

Structure Plan, Master Plan and Detailed Area Plan for Mymensingh town (2013), *Urban development directorate (U.D.D),* Ministry of Housing and Public Works.

Bangladesh District Gazetters Mymensingh

WEBSITES

Space syntax laboratory web page, www. Space syntax.org

Mymensingh information - http://www.triposo.com/loc/Mymensingh

History of Mymensingh - http://en.wikipedia.org/wiki/History_of_Mymensingh

http://www.casa.ucl.ac.uk/working_papers/paper58.pdf

http://timstonor.wordpress.com/space-syntax-2/

http://www.bdresearchpublications.com/admin/journal/upload/09161/09161.pdf

http://www.banglapedia.org/

IMAGE SOURCE

Fig. 10: Field Survey, 2010

AUTHOR'S PROFILE

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TeMA Journal of Land Use, Mobility and Environment

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REVIEWS PAGES

SMART CITIES CHALLENGES: SMART ENVIRONMENT FOR SUSTAINABLE RESOURCE MANAGEMENT

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.

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

author: FLORIANA ZUCARO
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The Law section proposes a critical synthesis of the normative aspect of the issue theme.

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TeMA 有关土地使用、交通和环境的杂志

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评述页（REVIEW PAGES）：

适用于可持续资源管理的智能环境

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开，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。因此，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
The web report offers the readers web pages which are directly connected with the issue theme.

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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: laurarusso88@hotmail.it

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01

SMART CITIES CHALLENGES: SMART ENVIRONMENT FOR SUSTAINABLE RESOURCE MANAGEMENT

REVIEW PAGES: WEB RESOURCES

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In this number
ICTs FOR A SMART AND SUSTAINABLE ENVIRONMENT

Already a quarter of the world's population is connected to the Internet, which can be considered the defining technological invention of our era. Information and communication technologies (ICTs) affect the way we work, live, and communicate, enabling the development, production, exchange and delivery of goods and services. Almost every aspect of our life has been touched by this digital revolution, which is having huge impacts on culture, business, politics and the environment: today, building a sustainable environment is easier thanks to the contribution of ICTs, which allow the global spread of information.

The first web resource analyzed in this number is the website of the International Telecommunication Union (ITU), which is the specialized agency of the United Nation for ICTs. As more and more people get connected, ITU drives innovation by allocating global radio spectrum and satellite orbits, setting technical standards, which all improve access to ICTs.

The other two web resources presented in this number refer to specific sectors affected by information and communication technologies: agriculture and waste disposal.

The application of ICTs in agriculture is increasingly important, but unfortunately, all over the world, many farmers still don't have access to the Internet and ICTs, or sometimes, they are not able to use them; for this reason, during the World Summit on the Information Society in 2005 it was decided to establish the e-Agriculture community of practices, with the goal of sharing knowledge and information about the role of ICTs in building a sustainable agriculture. E-Agriculture website is described below.

In the end, a focus on the use of ICTs in the waste management industry concludes this number: the Waste Management World website represents a point of reference for the stakeholders involved in the sector because it gathers information, news, article and much more about the latest innovation for the waste disposal, many of which involve the use of ICTs.

The aforesaid web resources clearly bear out that ICTs are fundamental for the development of a sustainable and smart environment.

INTERNATIONAL TELECOMMUNICATION UNION - ITU

http://www.itu.int/en

The International Telecommunication Union (ITU) is the United Nation specialized agency for information and communication technologies (ICTs), whose goal is to preserve people's right to communicate by improving access to ICTs.

Although ITU was born in 1865 as the International Telegraph Union, in 1934 it took its current name and it now covers the entire ICT sector and not only the telegraph as when it was founded.

ITU has three main areas of activity: Radiocommunications, Standardization and Development.

- Radiocommunication means space services such as satellites and radio-frequency, that today play a fundamental role in our everyday lives: phone calls and TV programmes are possible thanks to satellites, while wireless communications need radio-frequency spectrum to provide broadband services. ITU's Radiocommunications Sector coordinates these radiocommunication services and organizes meetings and study groups in order inform and to keep up-to-date those who are involved in the sector.
- Standardization can be considered one of the most relevant activities carried out by ITU, because without ITU's *Recommendations* things as simple as a phone calls or surfing the Internet would not be possible, in fact, every year, ITU generally produces over 100 standards that allow systems to work efficiently.
- The Development Sector's goal is to increase access to ICT worldwide. In order to achieve this target, ITU promotes a wide number of different initiatives, such as ITU Connect events, and it also publishes statistics and indicators, which are an important tool to support deployment of ICT networks and services globally.

All the information relating to the three main areas of activities are available on ITU's website, together with a variety of other material on the Agency and the ICT world.

Articles, latest news and events about ITC are available on the Home page of ITU's website, which also includes direct link to *Join ITU,* to *Get Involved* with its work and to access the *Video Corner,* which gathers all videos published by ITU on YouTube with interviews, debates, conference speeches, etc.

Furthermore, one section of ITU's website is dedicated to ITU Telecom World, a knowledge-sharing platform that involves public and private stakeholders belonging to the ICT sector; the platform aims to stimulate dialogue and debate, encouraging connections and collaboration among experts in the field. High level events allow to extend the virtual conversation offered on ITU Telecom platform and offer interactive discussion with renowned speakers. ITU counts over 700 members and represents the leading world forum for the development of the ICT industry.

E-AGRICULTURE

https://www.e-agriculture.org

E-Agriculture counts over 11.000 members from all over the world; the goal of the community is sharing knowledge and experiences related to the use of information and communication technologies (ICT) for

agriculture. Different professional profiles are part of the e-Agriculture community of practice, such as researches, farmers, politicians, entrepreneurs and volunteers, all of which interested in rural development. Such heterogeneity of figures allows for a greater exchange of information, encouraging constructive dialogue between different disciplines.

E-agriculture was officially born in 2007, but the idea was already clear after the World Summit on the Information Society in 2003 and 2005, when problems related to the weakness of communication in the rural context became evident. Nowadays, the community is still growing and one of its most popular activities is the e-Agriculture Forum, available for registered members only on e-Agriculture website.

The Forum is just a small part of what the website offers to visitors, in fact, it collects over 2.000 news, 500 events and discussions. The Home includes a section gathering a wide range of international Blogs and, yearly, a countdown of the ten most popular blogs of the year is arranged on twitter; for example, the blog "Current Scenario of India Farmers" by Rakshit Agrawal was read 730 times and won the first position in the list of the Top 10 blogs of 2013.

The numerous posts published by the community are organized into four main sections: *Agricultural Value Chains and ICT; Gender, ICTs and Rural Livelihoods; Mobile telephony in Rural Areas; Public Private Partnerships (PPP).*

In the section *Agricultural Value Chains and ICT*, there are several materials looking at key opportunities and challenges of ICT interventions in the agricultural value chain with a special focus on the most beneficial actions in rural areas.

The section *Gender, ICTs and Rural Livelihoods* is dedicated to the critical role of women in agriculture, and the positive benefits that ICTs can have in the livelihoods of rural women.

Furthermore, posts about mobile phones and their contribution in creating economic benefits and in improving communication are included in the section *Mobile telephony in Rural Areas.*

In the end, the section *Public Private Partnerships (PPP)* offers a great variety of posts regarding how PPPs can facilitate the generation and delivery of relevant and timely contents, particularly to reach the most isolated farmers.

In order to facilitate dialogue and connection between the members of the global network, it is possible, for registered members only, to see member's profile and easily connect with them; different colored badges identify different type of members: current members of the e-Agriculture team have an orange badge on their profiles, previous members of the e-Agriculture team have a gold one, and featured members have a green one.

For those who are interested in staying up to date with the latest information about the Community, you can follow its profile on Twitter, Facebook, LinkedIn, YouTube and Delicious.

WASTE MANAGEMENT WORLD
www.waste-management-world.com

Waste Management World (WMW) is an open access digital journal entirely dedicated to the industry of waste management. The bimonthly magazine collects information about the industry main news, innovative technologies, products and services with special focus on recycling and sustainability.

Each volume is dedicated to a specific theme but it also includes a regular section with the editorial, comments, product news and information on the International Solid Waste Association.

In compliance with the idea to support the free global exchange of knowledge, all the magazine's contents can be easily accessed on line at the WMW website, which is a rich source of information for the industry.

WMW website is organized into eight sections, each of which including articles, videos, news and events on a given topic; the eight main topics are: collection/transport, recycling, landfill, biological treatment, waste to energy, markets & policy, video and products.
Proving the strong relationship between Waste Management World and the International Solid Waste Association (ISWA), WMW website gives users the opportunity to download the full *State-of-the-art Report* of ISWA on Waste-to-Energy plants, which offers technical information and data on the plants in U.S. and 18 European countries. Moreover, the section on Opinions collects a significant number of interviews with leading figures of the industry, explaining their point of view on specific issues and contributing to widen the debate on the topic. For example, one of the latest interviews is that made to the managing director of a waste management machinery manufacturer, who explains why the waste and recycling industry should be more proactive in communicating its achievements to encourage an inflow of investment and talent.
The managing editor of the magazine daily updates the website with detailed articles on the latest news about waste management, gathering information from all over the world in order to provide the industry a useful tool to keen up to date; he is also the conductor of the *WMW Weekly Newscast,* that together with a wide range of video with different contents, constitutes an attractive video library easily accessible to everyone. The video library includes video about ongoing waste management projects as well as a mini collection of short film aiming to raise public awareness of the benefits of recycling beverage cans.
In order to better exploit the potential of the internet, Waste Management World does not limit itself having only the website, in fact, it uses several different social networks to expand its diffusion, such as Facebook, You Tube, Twitter, Linkedin and Google Plus, showing a great number of subscriptions. This success proves the strong interest for this type of industry, especially by insiders who want to be informed and updated on the latest news and technological innovation.

IMAGE SOURCES

The images are from: http://deeptech.org/four-conversations-on-greening-ict/; http://wmw.hotims.com/r5/search.asp?action=search&return_by_category=y; http://it.appszoom.com/android_applications/business/wmw-magazine_ijzpr.html; http://groups.itu.int/stocktaking/About/e-AgricultureCommunity.aspx; http://www.rle.mit.edu/eems/research/completed-projects/.

02

SMART CITIES CHALLENGES: SMART ENVIRONMENT FOR SUSTAINABLE RESOURCE MANAGEMENT

REVIEW PAGES: BOOKS

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In this number

ICT ROLE IN THE CURRENT ENERGY AND ENVIRONMENTAL CHALLENGES

In the late 1980s and early 1990s, the publication of the Brundtland Report Our Common Future and the first Earth Summit held in Rio de Janeiro, focused the world's attention on sustainable development. The world has been changing more and more since then and the sustainable growth, such as the wide use of information and communication technology (ICT), represent the two main issues in the worldwide and current debate about a low-carbon development. Sustainability is a critical challenge that must be overcome, while ICT is seen as both an opportunity and a strategic way to reach environmentally sustainable forms of economic and social growth, within an important historic context of growing world population, without requiring an end to growth.

More and more studies have been dealing with the role of ICT (broadband, mobile communications) in energy efficiency and climate change solutions, including the effects on the productivity of the economy and the role in monitoring and environmental management (Fuhr *et al.* 2007; Laitner 2008; ITU 2008). In regard to climate change, ICT can contribute to mitigate its effects especially in developing countries where emissions have been steadily got worse due to the necessity of developing faster and faster.

World poor countries are more vulnerable to climate change than the more developed ones, because low incomes and limited resources make the ability to cope with climate change impacts weak. Furthermore most of world poor people live in rural areas, which are highly dependent on natural resources and engaged in climate-sensitive livelihoods. These countries also use high carbon footprint technologies in energy applications and transport, as well high-carbon fossil fuels are used intensively. In order to create a low-carbon society where a strategic role has to be played by local communities, considering that most energy is consumed in urban areas, authorities should know how ICT-based energy efficiency solutions can be implemented.

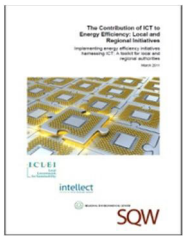
According to these brief considerations, this section proposes three documents related to three main opportunities of ICT application: the first one concerns how new technologies can be used for improving climate change adaptation capacity of developing countries; the second one focuses on local initiatives to promote energy efficiency through ICT; the third one describes how emission reduction and energy saving in the ICT sector itself can be reached.

Title: Africa transformation-ready: the strategic application of information and communication technologies to climate change adaptation in Africa
Author/ editor: AA VV
Publisher: n.d
Download: :http://siteresources.worldbank.org/
Publication year: 2010
ISBN code: n.d.

The International Institute for Sustainable Development (IISD) has been commissioned by the African Development Bank and the World Bank Group to study constraints, opportunities, implementation risks and challenges related to the use of ICT for adaptation to climate change. This report represents the up-to-date account of what has been done (chapters 1 and 2), what can be done (chapters 3 and 4), and what should be done (chapter 5) in order to contribute to building Africa adaptation capacities through ICT. Africa countries are highly vulnerable to climate change: the temperatures are increasing faster and faster compared to the global average, the dominant economic sectors (such as agriculture or fishing) are very climate-sensitive and stress factors (such as disease or land degradation) limit the adaptive capacity of communities more and more. All African governments are working collaboratively through intergovernmental bodies both preparing national adaptation strategies and identifying several priority areas in which ICT can be used in order to reduce the vulnerability:

- managing and communicating information about the risks resulting from climate change, and extreme climate events, as well as preparing for their effects on food security and water supply;
- improving an information system within the food sector that is better able to reflect household access to food and food consumption;
- developing early warning and hazard risk information systems to deal with the additional fire hazards associated with climate change and to enable integrated fire management;
- mapping vulnerable areas and provide spatial representations of climate change impacts.

Three case studies are described within the report so as to show examples of ICT programs and applications that can be replicated elsewhere. In Uganda ICT has been applied to extend existing meteorological services to help farmers adapt to climate change, while in Senegal national and local authorities have been developing online platforms for the sharing of data, knowledge and information for adaption actions. In Malawi GIS tools are used by local communities in order to create a centrally located model that can be used to determine current and future water needs. Nevertheless these three positive examples, the implementation of new technology in the most recent adaptation plans and strategies is still weak, and there are few adaptation and mitigation projects in which ICTs are explicitly intended or expected to play a central role. According to these issues IISD provides Africa governments with some main recommendations: ICT initiatives should support social and economic development (instead focusing narrowly on a specific sector), in order to reduce dependence on current sources of income that are vulnerable to the impact of climate change; the adaptation planning processes should embed ICT developing long-term programs and actions and including private sector especially mobile phone companies and Internet Service Providers, because any ICT action needs to be permanent and supported by lasting financial resources; policy makers and planners need to be able to connect with and learn from one another and this knowledge exchange needs to be made by open data and crowd-sourcing tools to generate real-time data on impacts of climate change.



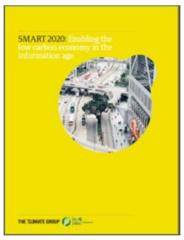
Title: The contribution of ICT to energy efficiency: local and regional initiatives
Author/ editor: AA VV
Publisher: ICLEI
Download: http:// ec.europa.eu/information_society
Publication year: 2011
ISBN code: n.d.

Thanks to the collaboration with the Committee of the Regions European Commission developed this research and dissemination project focusing on local and regional initiatives in order to promote energy efficiency through the direct and enabling roles of ICT. The product is a toolkit for local and regional authorities, including guidance and a series of case studies, articulated in two main parts: the first one (sections 2-9) is related to a broad range of energy efficiency and ICT initiatives realized at different scales; the second one (sections 10-13) describes specific kinds of initiatives, providing detailed information on the operational issues. The ICT energy efficiency actions analyzed are related to:

- ICT infrastructure and equipment;
- ICT enabled buildings and construction;
- ICT enabled transport sector;
- ICT enabled carbon/energy management and reporting.

At local level, in order to encourage and implement ICT energy efficiency measures, the first step is the setting-up of an energy agency that supplies several services based on the specific local energy needs. Both in Slovenia and in the Bretagne region the local energy agencies have allowed to reduce energy use in public buildings, municipal lighting and transport sector, through IT software. Transport demand management measures are one of the main application areas involving ICT solutions, especially the road user charging schemes, also known as road pricing and congestion charging schemes. London and Stockholm represent two success congestion charging schemes which have applied some of the main types of electronic technologies (Automatic Number Plate Recognition, Dedicated Short Range Communication, Global Navigation Satellite Systems) and have monitored and evaluated the scheme's performance through economic, social, environmental and ICT energy efficiency indicators.

In addition to urban mobility local authorities are improving the energetic and overall rehabilitation of buildings, both public and private ones, more and more through ICT systems: for instance, in Aalst (Belgium) a real time information system of the energy building management has been set up, such as in Maribor (Slovenia) for over one hundred public buildings. It is worth noting that in all the case studies related to "ICT-based building automation tool" the key element to bring these initiative to success has been the participation of the final users: local residents have to be always involved, establishing a good cooperation with them to help create sustainable behaviour. In fact, the use of new and efficient technology alone is not enough, without a radical change in the energy habits of the users to reach both carbon emission reduction and energy efficiency targets that EC has established. Awareness raising and adopting technologies, which are accessible to all, represent two important strategies to ensure that the technology selected can be easily used by the final users. The adoption of ICT has also pushed local administrations to learn managing ICT risk, such as financial, operational and technological risk. In order to minimize and control these risks successfully, a traditional project risk assessment (initiation, planning and design, execution, monitoring and control, closure) is recommended within the toolkit.



Title: SMART 2020: enabling the low carbon economy in the information age
Author/editor: AA.VV.
Publisher: The Climate Group and GeSI
Download: www.smart2020.org
Publication year: 2010
ISBN code: n.d.

The partnership between not-for-profit organisation The Climate Group and ICT sector group Global e-Sustainability Initiative (GeSI) has allowed to identify and quantify specific ICT impacts and opportunities, related to carbon emission savings and potential economic value. This report is aimed at giving a clear picture of the key role that the ICT industry plays in addressing climate change globally and supporting a low carbon development. In order to reply to three main questions, what is the direct carbon footprint of the ICT sector, what are the quantifiable emissions reductions that can be achieved by ICT applications in other economy sectors and what are the new market opportunities related to reaching these reductions, the study outlines five key actions to demonstrate the potential role the ICT sector supporting a SMART transformation: ICT can provide information about standard (S) forms on energy consumption and emissions, across different sectors; it can incorporate monitoring (M) information into the design and control for energy use; it can provide the capabilities and platforms to improve accountability (A) of energy and carbon emissions; this knowledge can be used to rethink (R) the current ways of learning, living and working; it can apply integrated approaches to energy management of systems and processes, transforming (T) all sectors of the economy. The report predicts that the ICT sector emissions will represent an estimated 2,8% of total global emissions by 2020 but, at the same time, ICT will be able to reduce these emissions by 7,8 $GtCO_2e$ by 2020 (remaining on a BAU trajectory), an amount five times larger than its own carbon footprint. In this perspective the report describes the four biggest opportunities for reducing emissions, and points up the role of ICT and the hindrances to be overcome. These four opportunities have been analysed associating them four case studies, selected because of the size of their abatement potential, the scale of the economic opportunity and the quality of data available.

- Smart logistics (Europe): ICT can improve the design of transport networks, allow the running of centralised distribution networks and run management systems that can facilitate flexible home delivery services, in order to save 1.5 $GtCO_2e$ in 2020;
- Smart motor systems (China): reducing electricity consumption in industry through optimised motors and automation could save almost 1 GtCO2e in 2020;
- Smart grids (India): improving the efficiency of electricity grids is the largest opportunity identified in the study, with a potential saving of 2 $GtCO_2e$;
- Smart buildings (North America): ICT-based monitoring, feedback and optimisation tools can be used to reduce both at every stage of a building's life cycle, from design and construction to use and demolition, saving 1.7 $GtCO_2$ in 2020;

In addition to these four opportunity sector dematerialization has been considered; by replacing physical objects and activities with electronic or "virtual" alternatives could save 500 Mt CO_2e in 2020, the equivalent of the total global footprint of the ICT industry in 2002. Many companies are still reluctant to adopt dematerialisation technology, because it requires both adopting new ways of working and significant cultural shifts.

REFERENCES

Fuhr J.P., Pociask S.B. (2007) Broadband Services: Economic and Environmental Benefits, The American Consumer Institute.

Laitner S. (2008) Information and Communication Technologies: The Power of Productivity, American Council for an Energy Efficient Economy.

ITU (2008) ICTs for e-Environment.

03

SMART CITIES CHALLENGES: SMART ENVIRONMENT FOR SUSTAINABLE RESOURCE MANAGEMENT

REVIEW PAGES: LAWS

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In this issue

EUROPEAN AND ITALIAN REGULATORY FRAMEWORK AGAINST FLOODING

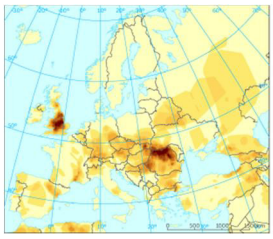
Between 1998 and 2004, Europe suffered over 100 major floods, causing some 700 fatalities, the displacement of about half a million people and insured economic losses totalling at least 25 billion (EU 2007). These phenomena is not related only to climatic factors and to the geology and geomorphology of the national territory, but also to human actions (clearing of forests, straightening of rivers, and extensive building in high-risk areas) that have increased uncontrolled during the last decades. Atmospheric phenomena of considerable intensity over short periods of time accompanied to an improper use of the land, lead to a considerable increasing of the number of people and goods affected by flood risk.

Also Italy is extremely exposed to flash floods and pluvial flooding as witnessed by the recent catastrophic events occurred in Modena in January 2014 and in Sardinia in November 2013.

To effectively respond to repeated emergencies related to hydrogeological risk, in recent years various parties responsible for water and soil conservation, both at Community and national level, responsible for water and soil conservation are trying to pursue the goal of sharing the importance of risk prevention and mitigation. A brief analysis of the relevant legislation indicates, in fact, the intention of the lawgiver to move from a logic of interventions "ex post", aimed at recovering the damages, to an approach finalized to the identification of risk conditions and to the adoption of measures to reduce significantly the potential impacts of the events.

On this basis, the laws section in this number examines the European and the Italian regulatory framework related to the prevention and mitigation of flood risk. The current regulations about flooding are represented by Directive 2007/60/EC on the assessment and management of flood risks transposed into Italian Legislative Decree of February 23, 2014 n . 49.

Both at national and Community level, the legislation related to flood risk hinges on the Plan instrument that, according to the latest regulations will evolve from the general hydrogeological management Plan to the specific flood risk management plan of which the characteristic aspects have been investigated in this issue.



DIRECTIVE 2007/60/EC: A FRAMEWORK FOR THE ASSESSMENT AND MANAGEMENT OF FLOOD RISKS

The European Directive n. 2007/60/EC of 23 October 2007 seeks to establish "a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community."(art. 1) and it is connected to the WFD 2000/60/EC, according to which the Water Management Plans have been drawn up. For the purposes of this Directive, Member States shall implement three phases of activity according to predetermined dates:

- set up a preliminary flood risk assessment and identify areas of potential flood risk by December 2011; this includes gathering information on the boundaries of river basins in the concerned district, on floods that have occurred in the past, on the likelihood of future floods and on the estimated consequences. On the basis of the assessment, Member States must categorize river basins according to whether or not they have a significant potential flood risk. This assessment and the resulting categories assigned to river basins must be published and reviewed by 22 December 2018 and every six years thereafter.
- draw up flood hazard maps and flood risk maps by December 2013; flood hazard maps shall cover the geographical areas which could be flooded according to the following scenarios: floods with a low probability, or extreme event scenarios; floods with a medium probability (likely return period ≥ 100 years); floods with a high probability. For each scenarios the flood risk maps shall show the potential adverse consequences such as the indicative number of inhabitants and the type of economic activities potentially affected, the indication of areas where floods with a high content of transported sediments and debris floods can occur, etc.;
- establish flood risk management plans to support measures for each river basin district by December 2015. Where the area concerned extends into several countries, the Member States must cooperate in preparing, as far as is possible, a single management plan. In preparing a management plan, appropriate levels of protection must be established for each river basin, sub-basin and stretch of coastline and measures must be drawn up to achieve those levels of protection. Management measures must focus on reducing the probability of flooding and the potential consequences of flooding.

  They must cover prevention (i.e. preventing damage caused by floods by avoiding construction of houses and industries in present and future flood-prone areas or by adapting future developments to the risk of flooding), protection (by taking measures to reduce the likelihood of floods and/or the impact of floods in a specific location such as restoring flood plains and wetlands) and preparedness (e.g. providing instructions to the public on what to do in the event of flooding) and must take account of relevant aspects, such as water management, soil management, spatial planning, land use and nature conservation. Each management plan must contain certain components, including the level of protection, the measures planned, flood risk maps, and, in subsequent management plans, an assessment of the progress made since the last management plan was implemented.

THE ASSESSMENT AND MANAGEMENT OF FLOOD RISKS IN ITALY: FROM THE ENVIRONMENTAL CODE TO THE LEGISLATIVE DECREE 49/2010

In Italy, the regulatory framework in the field of hydro-geological risk is represented by Legislative Decree of 3 April 2006, n. 152 named "Environmental Code". The third part of the code, entitled "Provisions relating to soil protection and combating desertification, waters protection against pollution and water management", is aimed at ensuring the protection and remediation of soil and subsoil, the hydrological restoration of the territory through the prevention of instability phenomena, the safety of the risk situations and combating desertification. Article 64 of the Code provides for the division of the whole country into eight river basin districts and the establishment, for each river basin district, of a River Basin Authority District.

The latter have to draw up the river basin Plans which represent the cognitive, regulatory, technical and operational tool through which actions and rules of use for the protection and the defense of the soil and the proper use of the waters, based on the physical and environmental characteristics of the area concerned, are planned and programmed. Pending approval of the river basin plans, the Basin Authority shall approve, in accordance with Article 67, provisional hydro-geological management Plans (PAI), which in particular contains the identification of hydro-geological risk areas, the perimeter of the areas to be safeguards, and the determination of those safeguards measures. These plans, drawn up by the River Basin Authority District, had the aim of identifying the hydrogeological risk areas and determine the protective measures to be implemented in the identified areas. These measures provide for both non-structural measures, aimed at regulating land use management as a preventive action, and protection interventions to reduce the existing risk. Within the PAI were highlighted areas of hydraulic hazard for events with different return periods and in some cases was also shown the level of risk associated with them.

However, reducing the risk of floods is not one of the main objectives of this Decree, nor does it take into account future changes in the risk of flooding due to climate change.

It is only with the legislative decree 49/2010 of 23 February 2010 that the assessment and management activities of flood risks are regulated, implementing the EU Directive 2007/60/EC. The implementation of the EU Floods Directive in Italy provides an opportunity to revise the model of flood risk governance and confront the shortcomings encountered during more than 20 years of organized flood risk management (Mysiak et al. 2013). Before the adoption of Directive 2007/60/EC, in Italy the flood risk management was implemented through the above more general "hydrogeological management Plans" (PAI). With the Legislative Decree n. 49 of 2010, there is a shift from the PAI to the Flood Risk Management Plans (FRMP). According to this decree, the River Basin Authorities have to:

– set up a preliminary flood risk assessment through the preparation of: thematic maps of the river basin district; the description of the floods that occurred in the past that had significant negative consequences for the human health, land, property, environment, cultural heritage and economic and social activities and that, with high probability, can still occur in the future; the evaluation of the potential adverse consequences of future flooding, taking into account factors such as topography, location of surface water bodies and their hydrological and geo-morphological characteristics, the effectiveness of existing man-made flood defense, location of populated areas and economic and social activities. Italian Government considered the existed "hydrogeological management Plans (PAI)", prepared in accordance with Law 183/89, sufficient and appropriate to provide the information required by the preliminary flood risk assessment. This situation has led to national decision not to conduct such

an assessment and then proceed directly to the elaboration of hazard and flood risk maps with the criteria laid down by the European Directive.

- identify areas prone to potentially significant flood risk through the drawn up of flood hazard maps and flood risk maps; specifically, flood hazard maps shall cover the geographical areas which could be flooded according to the following scenarios:
  a) rare floods of extreme intensity: return time up to 500 years after the event (low probability);
  b) floods infrequent return period between 100 and 200 years (mean probability);
  c) frequent floods: payback time of between 20 and 50 years (high probability).

  On the other hand, the flood risk maps show the potential adverse consequences associated with floods under the previous scenarios expressed in terms of:
  a) the indicative number of inhabitants potentially affected;
  b) infrastructure and strategic structures (highways, railways, hospitals, schools, etc.) ;
  c) environmental heritage, history and culture of considerable interest in the area potentially affected;
  d) the distribution and type of economic activities potentially affected ;
- develop the flood risk management plans coordinated at the river-basin level.

On the other side Regions, in coordination with each other and with the national Department of Civil Protection, are committed to prepare the management plans for the emergency alert system both at national and regional level. The time limits for the preparation of the flood hazard maps and flood risk maps (art. 6) and for publication of flood risk management plans (Article 7) are, respectively, June 22, 2013 and June 22, 2015.

In accordance with Annex I of the decree 49/2010, the FRMP must contain:

- a description of the objectives of the flood risk management;
- a summary of the measures and their prioritization for achieving the above objectives;
- the description of the prioritization and procedures for monitoring the status of implementation of the plan;
- the summary of the measures or actions taken to inform and consult the different actors involved;
- a list of the competent authorities.

REFERENCES

European Union (2007), *Flood management and evaluation*. Available at: europa.eu.

Misiak J, Testella F., Bonaiuto M., Carrus G., De Dominicis S., Ganucci Cancellieri U., Firus K., Grifoni P. (2013), Flood risk management in Italy: challenges and opportunities for the implementation of the EU Floods Directive (2007/60/EC), *Nat. Hazards Earth Syst. Sci.*, 13, 2883–2890.

IMAGE SOURCES

The image of page 142 is taken from: www.eea.europa.eu; the image of page 143: news.panorama.it;

04

SMART CITIES CHALLENGES: SMART ENVIRONMENT FOR SUSTAINABLE RESOURCE MANAGEMENT

REVIEW PAGES: URBAN PRACTICES

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In this number

ICTS AND CLIMATE CHANGE: THREE CASE STUDIES

According to the United Nations (UNFCCC, 1992), the climate change can be defined as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". Unlike this definition makes a distinction between "climate change" attributable to human activities altering the atmospheric composition, and "climate variability" attributable to natural causes, many researchers agree that the human activity is the dominant cause of observed changing since the mid-20th century (Stocker *et al.* 2013).

Climate change is a problem that is affecting people and the environment worldwide. Many places, especially in the southern and south-eastern regions of the world (already suffering from environmental or other changes) have seen changes in rainfall, resulting in more floods, droughts, or intense rain, as well as more frequent and severe heat waves (Loarie *et al.* 2009). As these and other changes become more pronounced in the coming decades, they will likely present challenges to our society and our environment.

The climate change is a long-term challenge. However, given the pace and the scale of its effects, innovative strategies are urgently required. In this contest, the Information and Communication Technologies (ICTs) has shown to provide a valuable tool to tackle the challenges imposed by the changing climate. An increasing number of ICT-based actions have been recently developed around the globe in the past two decades. In this paper, we present three relevant case studies:

– The Sri Lanka Disaster and Emergency Warning Network;
– The Indian e-Arik project;
– The Brazilian Deforestation Monitoring System.

The case studies aim to analyze the currently emerging opportunities offered by the Information and Telecommunication Technologies in addressing climate changes challenges and to identify common successful factors. In this regard, a strong collaboration between key players (i.e. local governments, public utilities, research centres and local communities) has emerged as important common conditions for the successful implementation of climate change related actions.

With different strategies and different solutions, the case studies analysed have shown how ICTs can be key factors to better mitigate, monitor and adapt to the impacts of the changing climate.

THE DISASTER AND EMERGENCY WARNING NETWORK (DEWN) INITIATIVE – SRI LANKA

On December 2004, the mega-tsunami unleashed by the earthquake of magnitude 9.1 in the Sumatra-Andaman subduction zone caused enormous loss of lives and damage to property in Sri Lanka and in several other countries bordering the Indian Ocean. In Sri Lanka, 13 of the 14 districts lying along the coastal belt were affected: the natural disaster caused nearly 40.000 victims with 15.000 injured and about 89.000 housing units either completely or partially damaged, leaving one million people homeless and causing massive disruption to livelihoods (Wijetunge 2006). When this natural disaster took place in 2004, there was no mechanism in place to alert the vulnerable communities. Of particular significance is the fact that there was ample time for the people leaving along the Southern and South-western cost of Sri Lanka to be warned and evacuated after the Tsunami strike on the Eastern coast (Wijesinghe *et al.* 2008).

This unprecedented tragedy clearly underscored the need to have a proper system in place for tsunami early warning as well as for quick evacuation of vulnerable coastal communities to safer areas.

After completing a successful pilot period, in January 2009 the Disaster Management Centre (the responsible agency of the island for all the disaster management issues), together with Dialog (the Sri Lanka's largest mobile telecommunications company) and other partners launched the Disaster Emergency Warning Network (DEWN) - Sri Lanka's first mass alert early warning system. The DEWN initiative is a multi-agency collaboration aimed to deliver a cost effective and multi-modal mass alert system which can be deployed for the purpose of warning key stakeholders in disaster management as well as the general public in advance of the occurrence of life threatening situations.

When information is received by the DMC, the information is verified, and customized alerts (with message text and recipients specified) are issued. Messages can be received by mobile phones or by the specially developed DEWN alarm devices. In a potential disaster scenario, DEWN will be used to first alert the emergency personnel on their individual phones. Public alerts will issued only when a threat is adequately verified.

The remote alarm is activated through SMS or Cell Broadcasting. Short Messaging Service (SMS) will be used for directed messages while Cell Broadcasting will be used for mass-alerts. Cell Broadcasting is also suitable for post-disaster operations since it is immune to network congestion.

The specially developed DEWN alarm devices are designed to be fixed indoors in public buildings such as places of worship, hospitals, markets, etc. They contains a loud siren, a flashing lamp, a LCD display to show the trilingual message, a radio and inbuilt call-back facility. The radio can be tuned to a Disaster Frequency if available. Special phones have been developed for Java/Symbian capable (smart) phones that causes the phone to rings continuously until acknowledged and displays the messages in all three local languages. DMC District Coordinators and other key contact members, being the first contact in each district, will be instrumented with such phones.

The cost and the benefits of the project are hard to estimate. However, with approximately half of the Sri Lankan population using GSM mobile phones, DEWN is in a good position to make use of this advantage to dispel emergency warnings. According to Wickramasinghe (2011), the benefits can be expected to much higher than the costs. There are also some more quantitative benefits, from greater feelings of security within communities that can access the warnings, to reputational and other benefits for the mobile operator.

THE E-ARIK PROJECT – INDIA

Agriculture is highly exposed to the climate change, as farming activities directly depend on climatic conditions. Continued changes in the frequency and intensity of precipitation, heat waves, and other extreme events have a strong impact on the agricultural production. Furthermore, compounded climate factors can decrease plant productivity, resulting in price increases for many important agricultural crops.
In this context, accessing to appropriate agricultural information is considered a key factor for rural farmers in order to increase crops' productivity and to provide opportunities for their self-development. Access to the appropriate agricultural information is a difficult task for the farmers of North-East India. Due to inadequate dissemination of advanced farm information and technologies, agriculture exhibits low productivity and creates food insecurity problems. Indeed, on one hand, the economic growth of the entire region depends, to a large extent, on the progress of agriculture sector. On the other hand, inadequate information on advanced farm technologies, market intelligence and rural development hinder the progress of the agricultural sector. To address these issues, a research study was initiated in August 2007. The project named e-Arik ("Arik" means "agriculture" in the tribal dialect of Arunachal Pradesh) aims to experiment the application of ICTs in agricultural extension services provision. The project is a collaborative effort that involves different key players such as the Indian Ministry of Science and Technology and a multi-disciplinary team of researchers from different Indian Universities. Presently, 500 farmers from 12 remote tribal villages of the North-East India are registered under the e-Arik system.
The main objective of the project is to provide the farmers with better information about climate-smart agriculture in order to raise awareness and adoption of practices that are sustainable. The aim of such practices is to increase productivity and resilience, to mitigate greenhouse gas emissions and to enhance food security and development. The focus of the project is on two crops: paddy rice and Khasi mandarin oranges. In the early stage of the project, a survey was conducted in selected villages during 2007, to understand the current situation and future needs of information exchange on agriculture. The results indicated that only 4 per cent of farmers had regular access to agricultural information. A majority of tribal farmers who were growing paddy, expressed a strong need for information on pest and disease management. The survey also looked into the access and use of communication tools by local communities. While very few farmers possessed cellular phones, none of them owned a computer nor was there internet facility in the surrounding three villages. In fact, more than half of the households had no power supply. To tackle this problem, a Village Knowledge Centre with computer, internet, printer was established at Yagrung village. Farmers are assisted through agricultural professionals, a computer instructor and farmer-facilitators. Additionally a project portal was created which provides information on agricultural practices, responsible governmental departments, markets and weather forecasts. Information is adjusted by project staff who visit fields and diagnose problems and document these issues using ICTs in the field. Another approach to disseminate information is by supporting the establishment of local self-help groups and farmer-to-farmer communication. The project has originate significant progress in terms of crops productivity that, in turns, has determinate a growth in the income level of the farmers. It is estimated that the e-Arik approach is 3.6 times cheaper than a conventional agricultural extension system and that farmers can access information 16 times faster. Giving the success of this initiative, a scale-up phase of the project is planned with further government funding. The goal is to replicate the project in the other seven north-east states of India.

THE BRAZILDEFORESTATION MONITORING SYSTEM

The forest of Amazonia is home of the most diverse and numerous arrays of species in the world and represents a major component of the Earth system (Soares-Filho *et al.* 2012).

The majority of the forest (about 60 percent) is contained within Brazil. In the last few decades the Brazilian Amazon forest has faced the dual threats of deforestation and stress from climate change. Between May 2000 and August 2006, Brazil lost nearly 150,000 square kilometers of forest – an area larger than Greece – and since 1970, over 600,000 square kilometers of Amazon rainforest have been destroyed (Butler 2008).

The Brazilian rainforest plays a major role in the world's climate system by storing large stocks of carbon and by regulating energy and water fluxes.

The release of this carbon to the atmosphere through deforestation and forest degradation is the second largest source of greenhouse gas emissions. Indeed, about 70 percent of Brazil's emissions come from the destruction of its forests, making it one of the world's top greenhouse gas emitters (Greenpeace 2011).

In one of the greatest environmental conservation challenges in history, Brazil has established a target for reducing Amazon deforestation by 80% below the historical baseline of 19,500 km^2 year by 2020.

Monitoring systems based on advanced ICT play a key role in tackling climate change by allowing policy makers and other policy stakeholders to make informed choices about strategies to curb greenhouse emissions.

Since the early nineteen, Brazil set in motion a plan to develop a satellite-based system for tracking changes in forest cover. Today Brazil has two major systems for tracking deforestation: PRODES (Program to Calculate Deforestation in the Amazon) and DETER (Real-time Detection of Deforestation), which allow it to rapidly identify where deforestation is occurring. PRODES, which has a sensitivity of 6.5 hectares, provides Brazil's annual deforestation estimates (measured each August), while DETER, which has a coarser resolution of 25 hectares, is a year-round alert system that updates Brazil's environmental protection agency (IBAMA) every two weeks.

This gives authorities the technical capacity — although not necessarily the political will — to combat deforestation as it occurs. In particular DETER is used for supporting the law enforcement actions, since data is provided rapidly.

PRODES is used for carbon accounting and year to year comparison. Both this two project have been developed by Brazil's National Institute for Space Research (INPE). PRODES and DETER detect deforestation based on satellite images captured through the US Landsat, which are then processed by computer algorithms developed by INPE and interpreted by a local team of technicians and scientists.

Following this process, it is possible to generate a georeferenced map for the whole Amazon with individual polygons indicating the location of deforestation.

Furthermore, since 2003 this estimates are available to the world through the INPE website, making transparency in the dissemination of Amazon deforestation data.

PRODES is the largest forest monitor project in the world, based on orbital remote sensing. It has become recognized as the standard-bearer for deforestation tracking and reporting worldwide. Data provided by these two projects has become the main baseline for discussing policies in the Amazon.

The wide acceptance of this systems in policy making in the Amazon and the related reduction in deforestation represent the main results of these projects.

REFERENCES

Butler R. (2009), *Deforestation in the Amazon*. Available at www.mongabay.com/brazil.html.

Greenpeace (2011), *Deforestation and climate change*. Available at www.greenpeace.org.uk/forests/climate-change.

Loarie S.R., Duffy P.B., Hamilton H., Asner G.P., Field C.B., Ackerly D.D. (2009), The velocity of climate change, *Nature*, 462:7276, 1052-1055.

Rajão R. (2012), *ICT-based monitoring of climate change related deforestation: The case of INPE in the Brazilian Amazon*, Report prepared for NICCD. Available at www.niccd.org.

Saravanan R. (2011), *e-Arik: Using ICTs to facilitate "Climate-Smart Agriculture" among tribal farmers of North-East India*. Report prepared for NICCD, available at www.niccd.org.

Soares-Filho B., Moutinho P., Nepstad D., Anderson A., Rodrigues H., Garcia R., Maretti C. (2010), Role of Brazilian Amazon protected areas in climate change mitigation, *Proceedings of the National Academy of Sciences*, 107:24, 10821-10826.

Stocker T.F., Dahe Q., Plattner G.K. (2013), *Climate Change 2013: The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Summary for Policymakers*, IPCC.

United Nations Framework Convention on Climate Change (1992), *United Nations Framework Convention on Climate Change: Text*. World Meteorological Organization and United Nations Environment Program, Geneva.

Wijetunge J.J. (2006), Tsunami on 26 December 2004: spatial distribution of tsunami height and the extent of inundation in Sri Lanka, *Science of tsunami hazards*, 24:3, 225-239.

Wickramasinghe K. (2009), *Role of ICTs in early warning of climate-related disasters: A Sri Lankan case study*. Report prepared for NICCD, available at www.niccd.org.

Wijesinghe L., Siriwardena P., Shanmugarajah S., Wijeratne S., Wijesinghe R., de Soyza M., Dias D. (2008), DEWN II: A trilingual disaster and emergency warning network, *9th International Information Technology Conference (IITC)*, 28-29 October 2008, Colombo, Sri Lanka.

WEB SITES

http://www.niccd.org

http://www.earik.in

http://www.dialok.lk

http://www.dmc.gov.lk

http://www.inpe.br

IMAGE SOURCES

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05

SMART CITIES CHALLENGES: SMART ENVIRONMENT FOR SUSTAINABLE RESOURCE MANAGEMENT

REVIEW PAGES: NEWS AND EVENTS

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In this number
SMART ENVIRONMENT

In recent years it has been increasing the interest by the private investors, organizations and governments in the development of new solutions and strategies that have as target the reduction of energy consumption. To promote this, the authorities of the EU member states have defined the Community strategies, not only through a new definition of regulatory guidance, but also by financing numerous infrastructure projects and research that will significantly reduce energy consumption. Not only in Europe, but also in most countries of the world, it is starting numerous programs to encourage the development of energy efficiency solutions. One of the nations in the world where there are more investments in this sector is America, which with the American Recovery and Reinvestment Act of 2009 has planned to invest about seventy billion dollars in the energy sector. In particular, the federal funds allocated for scientific research in this area are about eight billion dollars.

In America, the interest in respect of this topic has grown thanks to the diffusion of the citizens, the professionals and the administrators of the need to make major changes to the energy sector. For the definition of the different needs and the individuation of new effective solutions is fundamental the organization of meeting moments between the various actors that have the task of initiating the improvement of this sector. In the 2007, a lot of leaders and international delegates took part in the Energy Efficiency Global Forum (EE Global), which in recent years has become the most important world conference for the energy efficiency.

In the last six years, EE Global was held in different places in the world and has gained an international following of experts and leaders. In the 2014, a lot of executives and politicians from all sectors that deal with energy efficiency will gather in Washington, DC from 20 to 21 May with the aim to present and develop new effective policies and practices for energy efficiency. EE Global 2014, hosted by the Alliance to Save Energy a non-profit organization that brings together businesses, government agencies, environmental groups and consumers. The Alliance to Save Energy, founded in 1977, promotes energy efficiency worldwide to achieve a correct economy, a cleaner environment, and improved energy security. To achieve this mission, the Alliance:

– leads worldwide energy efficiency initiatives in policy advocacy, research, education, technology deployment and communications that impact all sectors of the economy;
– provides vision and activism which includes active and engaged members of Congress, leaders from business, the public interest sector and academia;

– initiates and participates in public-private partnerships, collaborative efforts and strategic alliances to optimize resources and expand its sphere of influence;
– executes its mission through a team of recognized energy efficiency experts and professionals.

The initiatives organized by the Alliance to Save Energy, are structured according to different sectors, and ranging from energy recovery of the buildings to improve energy efficiency in the manufacturing sector.

In the 2012, the Alliance to Save Energy took part to the National Commission on Energy Efficiency Policy, this committee that includes federal and local politicians, energy experts and productive organizations working to promote the implementation of strategies that promote energy saving. This committee has worked for a year to identify the most incisive energy policy most widely shared. This work brought to the definition of the Energy Action Plan 2030, which urges policy makers at all levels of government – local and federal – to act in three main lines of action:

– invest in energy productivity in all sectors of the economy;
– modernize of U.S. infrastructure, buildings, transportation, and equipment;
– educate consumers, business leaders and policymakers to encourage smarter energy use.

In summary the goal of the Alliance is to work with all levels of Government and with the private sector to successfully implement the Commission recommendations, in order to double the productivity of the nation's energy by 2030 and reduce dramatically the consumption energy.

Recently, the knowledge of the negative effects of the current methods of waste disposal has led to greater accountability of those involved in the effective management of the waste cycle.

As regard to the situation in Europe, every year are produced about two billion tons of waste (Eurostat 2010). A part of these are also particularly dangerous in constantly increasing.

Now there is knowledge that the availability of landfills or other waste storage sites isn't a sustainable solution, their destruction is an optimal solution due to the pollutant emissions and waste resulting from their highly polluting incineration. The best solution is to intervention at the source of the waste cycle, so start of a concrete reduce of the production of waste and must be used when there are sustainable solutions ecologically and economically, so as to recycle the various components of the products. Due to the increasing of the volume and complexity of household and industrial waste and his management is a major problem in modern society. To achieve these objectives it is necessary to encourage the search for new methods or solutions to facilitate disposal of waste in a more sustainable way.

Every two years, the Wessex Institute of Technology (WIT) organizes the International Conference on Waste Management and the Environment. It's sponsored by WIT Transactions on Ecology and the Environment, and the International Journal of Sustainable Development and Planning. This year the conference begins from 14 to 15 May in the city of Ancona in Italy, now it's seventh edition, provides an opportunity for professionals, researchers and governments to initiate a constructive exchange of scientific information and discuss the current situation and the possible future developments in waste management.

For the energy efficient sector, it is giving particular importance to the implementation of programs and solutions that want promote to improve energy behaviour of the users. The importance of the behaviours revealed by a study conducted by a leading American companies working in the field of energy behaviours that showed that only with the use of adequate energy behaviours can reduce the energy consumption of the United States of approximately 18 MWh per year. This amounts to a reduction of CO_2 emissions by about 10 million tons in a year and a consequent saving of $ 2.2 billion for American consumers every year.

To promote the achievement of this objective Behave The Energy Conference is dedicated to the theme of reducing energy consumption through the change individual behaviour. The conference will be held 3 and 4 September at the Said Business School in Oxford, UK.

The title chosen for this conference "Behave Energy" is to emphasize that a important aspect for the correct use of energy efficiency solutions and to start a change in the habits of life of citizens. The main topics that will be covered in this conference, with the contribution of numerous participants, are:

– reduction of energy through the use of feedback;
– programs for Community Energy: consumption, procurement and production;
– transport and mobility;
– moving in time the demand for energy;
– the consumption of energy in organizations;
– reduce energy consumption in buildings;
– social practices and energy consumption;
– gamification and social media.

Recently another sector that is evolving much is that of the Intelligent Environments (IEs) that use computer technologies to create networked environments, sensitive and responsive to the presence of people. These systems are built using a mix of innovative software and hardware systems, structured so as to promote the efficiency of the operations and activities, facilitate the presence and participation, improve the user experience and allow to better or change styles of life or methods of production. The IEs are spaces in which computation is seamlessly used to enhance ordinary activity. One of the driving forces behind the emerging interest in highly interactive environments is to make computers, not only genuine user-friendly but also essentially invisible to the user (Steventon, Wright, 2006). The development of this new information technologies and their application require the combined use of numerous disciplinary skills, ranging from science, engineering, architecture, sociology, education and the economy. The need to reconcile all these skills in order to enable the development of technical solutions that are able to cope with the demands of the market related IEs. It is therefore essential the organization of moments that will enable constructive dialogue on these issues. The 10th Intelligent Environments conference is organized by the Departments of Computer Science & Engineering with the Department of Department of Automation of Shanghai Jiao Tong University (SJTU). The Conference will take place in Shanghai, China from 2 to 4 July. Another collateral event at the conference, to be held forever in Shanghai from 30 June to 1 July, with the organization of eleven different workshops dedicated to specific sectors that deal with the implementation of solutions that involve the use of Intelligent Environments (IEs).

The workshops are organized to allow the participants to showcase their research and to discuss in a constructive way with the wider scientific community present at the conference.

In relation to the development of solutions IEs, one of the research areas in recent years has been attracting great interest of private investors both scientific research institutions is that of Wearable technology. This sector covers all technologies, portable and wearable, modelled around the body of the people, that are used as natural support for their operation. The main goal of the use of these new technologies is to enable the detection and monitoring of exogenous and endogenous signals of the human body, also of an emotional nature, allow these technologies to become a valuable assistant to solve the user's needs broadening also sensory abilities. The possible applications of these new technologies are varied and range from the simple use during sports and recreation, their use as tools for decision support for the planning of special services such as education, mobility, tourism, etc. (Tirri, 2013) or for use in the medical industry for prevention or monitoring of health conditions of patients (Signorini et al., 2014). The need for further actions on behaviours to reduce energy consumption has been highlighted recently by some studies in which it was verified that the incorrect behaviour of the energy could also undo all the positive effects resulting from the introduction of new technological solutions.

THE 7TH INTERNATIONAL CONFERENCE ON WASTE MANAGEMENT AND THE ENVIRONMENT
Where: Ancona – Italy
When: 12 - 14 May 2014

ENERGY EFFICENT GLOBAL FORUM
Where: Washington, D.C. - USA
When: 20 - 21 May 2014

THE 10TH INTERNATIONAL CONFERENCE ON INTELLIGENT ENVIRONMENTS
Where: Shangai – China
When: 2 - 4 July 2014

BEHAVE ENERGY CONFERENCE 2014
Where: Oxford – United Kingdom
When: 3 - 4 September 2014

REFERENCES

Signorini M.G., Fanelli A., Magenes G. (2014), Monitoring Fetal Heart Rate during Pregnancy: Contributions from Advanced Signal Processing and Wearable Technology. *Computational and Mathematical Methods in Medicine*.

Steventon A., Wright S. (2006), *Intelligent Spaces: The Application of Pervasive ICT*, Springer-Verlag, Berlin.

Tirri H. (2013), Indexing the real world: sensing, big data and mobility. In *Proceedings of the 19th annual international conference on Mobile computing & networking*, 415-416.

WEB SITES

http://epp.eurostat.ec.europa.eu/

http://www.behaveconference.com/

http://www.intenv.org/

http://www.wessex.ac.uk/14-conferences/waste-management-2014.html

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