# TeMA

Journal of
Land Use, Mobility and Environment

This special issue collects a selection of peer-review papers presented at the 8th International Conference INPUT 2014 titled "Smart City: planning for energy, transportation and sustainability of urban systems", held on 4-6 June in Naples, Italy. The issue includes recent developments on the theme of relationship between innovation and city management and planning.

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

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## Smart City

### planning for energy, transportation and sustainability of the urban system

Special issue, June 2014

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TeMA Journal of Land Use, Mobility and Environment

# SMART CITY

## PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

## Special Issue, June 2014

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# TeMA

Journal of
Land Use, Mobility and
Environment

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

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Journal of
Land Use, Mobility and
Environment

This special issue of TeMA collects the papers presented at the 8th International Conference INPUT 2014 which will take place in Naples from 4th to 6th June. The Conference focuses on one of the central topics within the urban studies debate and combines, in a new perspective, researches concerning the relationship between innovation and management of city changing.

TeMA Journal of Land Use, Mobility and Environment

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# EIGHTH INTERNATIONAL CONFERENCE INPUT 2014

## SMART CITY. PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

This special issue of TeMA collects the papers presented at the Eighth International Conference INPUT, 2014, titled "Smart City. Planning for energy, transportation and sustainability of the urban system" that takes place in Naples from 4 to 6 of June 2014.

INPUT (Innovation in Urban Planning and Territorial) consists of an informal group/network of academic researchers Italians and foreigners working in several areas related to urban and territorial planning. Starting from the first conference, held in Venice in 1999, INPUT has represented an opportunity to reflect on the use of Information and Communication Technologies (ICTs) as key planning support tools. The theme of the eighth conference focuses on one of the most topical debate of urban studies that combines , in a new perspective, researches concerning the relationship between innovation (technological, methodological, of process etc..) and the management of the changes of the city. The Smart City is also currently the most investigated subject by TeMA that with this number is intended to provide a broad overview of the research activities currently in place in Italy and a number of European countries. Naples, with its tradition of studies in this particular research field, represents the best place to review progress on what is being done and try to identify some structural elements of a planning approach.

Furthermore the conference has represented the ideal space of mind comparison and ideas exchanging about a number of topics like: planning support systems, models to geo-design, qualitative cognitive models and formal ontologies, smart mobility and urban transport, Visualization and spatial perception in urban planning innovative processes for urban regeneration, smart city and smart citizen, the Smart Energy Master project, urban entropy and evaluation in urban planning, etc..

The conference INPUT Naples 2014 were sent 84 papers, through a computerized procedure using the website www.input2014.it . The papers were subjected to a series of monitoring and control operations. The first fundamental phase saw the submission of the papers to reviewers. To enable a blind procedure the papers have been checked in advance, in order to eliminate any reference to the authors. The review was carried out on a form set up by the local scientific committee. The review forms received were sent to the authors who have adapted the papers, in a more or less extensive way, on the base of the received comments. At this point (third stage), the new version of the paper was subjected to control for to standardize the content to the layout required for the publication within TeMA. In parallel, the Local Scientific Committee, along with the Editorial Board of the magazine, has provided to the technical operation on the site TeMA (insertion of data for the indexing and insertion of pdf version of the papers). In the light of the time's shortness and of the high number of contributions the Local Scientific Committee decided to publish the papers by applying some simplifies compared with the normal procedures used by TeMA. Specifically:

- Each paper was equipped with cover, TeMA Editorial Advisory Board, INPUT Scientific Committee, introductory page of INPUT 2014 and summary;
- Summary and sorting of the papers are in alphabetical order, based on the surname of the first author;
- Each paper is indexed with own DOI codex which can be found in the electronic version on TeMA website (www.tema.unina.it). The codex is not present on the pdf version of the papers.

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# PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM
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SPECIAL ISSUE

Eighth International Conference INPUT
Smart City - Planning for Energy, Transportation and Sustainability of the Urban System

*Naples, 4-6 June 2014*

# URBAN PLANNING AND CLIMATE CHANGE:

## ADAPTATION AND MITIGATION STRATEGIES

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**ABSTRACT**

Climate change is a current phenomenon: the temperatures rise, rainfall patterns are changing, glaciers melt and the average global sea level is rising. It is expected that these changes will continue and that the extreme weather events, such as floods and droughts, will become more frequent and intense. The impact and vulnerability factors for nature, for the economy and for our health are different, depending on the territorial, social and economic aspects.

The current scientific debate is focused on the need to formulate effective policies for adaptation and mitigation to climate change.

The city plays an important role in this issue: it emits the most greenhouse gas emissions (more than 60% of the world population currently lives in urban areas) and the city is more exposed and vulnerable to the impacts of climate change.

Urban planning and territorial governance play a crucial role in this context: the international debate on the sustainability of urban areas is increasing. It's necessary to adapt the tools of building regulations to increase the quality of energy - environment of the cities.

**KEYWORDS:**

Urban planning, Climate change, Mitigation strategies, Adaptation strategies

## 1 INTRODUCTION

As a result of climate change in urban areas, more and more frequently unpredictable and adverse consequences occur: devastating weather events, weather sealing of the rains, strong instability of soils, hot summers, falling water tables, changes in the quality of air, bubbles urban heat, reduced water supply, desertification, coastal erosion, etc.

Urban planning and territorial governance play an important role in preventing these effects. In Western countries, in recent decades, the degradation of the natural environment, air pollution, climate change have resulted in the demand for socio-economic models with a connotation of "green" and "sustainable." Many climate adaptation measures have been gradually implemented at different scales. However, some questions remain open: how to adapt the urban dynamics to make the city less vulnerable to climatic changes and generating less pollution and greenhouse gases? How to implement the coordination between mitigation and adaptation in a coherent and integrated approach? It is necessary first to identify the factors that determine the responsiveness of urban societies to global environmental risks such as those related to climate change.

The responsiveness also depends on the perception of the risks and their social acceptability. These elements vary in relation to stakeholders, the interests represented and the territorial scale of reference. It is necessary to formulate mitigation and adaptation strategies to increase urban resilience. Local policies for sustainable development that have managed to have the actual effects are very rare. Some cities have achieved good results, for example, reducing $CO_2$ emissions by more than 20% in ten years as Malmo, Heidelberg, Stockholm, Vaxjo, etc. These cities have built neighborhoods where the energy supply is made entirely by renewable energy. These experiences will respond to strong local policies, in the context of decentralization advanced, but most of the city defines only partial feeds because they cannot coordinate the multiple policies in the area. Sustainable policies tested in the city have focused on four main areas: climate strategies, eco-building, sustainable mobility and urban planning, which is the more complex target. The community that systematically adopt these four lines of action are rare. The initiatives will change depending on opportunities, and suffer from a great political fragmentation. The choices and mitigation measures are determined according to the circumstances of social, political and economic conditions of each city. these mitigation policies are guided by the importance given locally to issues related to climate change.

## 2 CITIES AND CLIMATE CHANGES

The Fifth Assessment Report (AR5), produced by the Intergovernmental Panel on Climate Change[1] in 2013, confirms the ongoing climate change, through observations, models, and research into the causes. "Since 1950 changes were observed in all segments of the Earth's climate system" (Cacciamani 2013), in fact:

- since the beginning of the global thermometer measurements (1850), the temperature of the thirty years from 1980 to 2010 is the highest ever recorded in the last 1400 years, including the last decade turned out to be the warmest ever;
- rainfall has increased since 1951, both in frequency and intensity
- has reported an increased frequency of extreme events in the 50s of the last century.
- the number of cold days and nights has decreased since 1950;

[1] The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental body under the auspices of the United Nations, set up at the request of member governments. It was first established in 1988 by two United Nations organizations, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), and later endorsed by the United Nations General Assembly. Currently 195 countries are members of the IPCC.

- the ocean surface temperature has increased in the last four decades;
- the extension of the cryosphere has been reduced across the planet, especially in recent years, the Northern Hemisphere snow cover has decreased by half of the last century;
- Global average sea level has risen by 0.19 m in the last century;
- CO2 emissions have increased by about 40% since 1750, mainly caused by burning fossil fuels and deforestation[2]

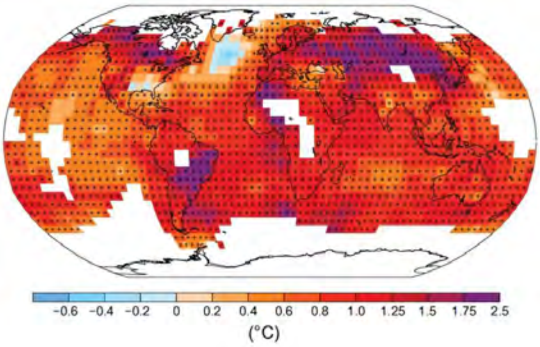


Fig. 1 Change of surface temperature from 1901 to 2012

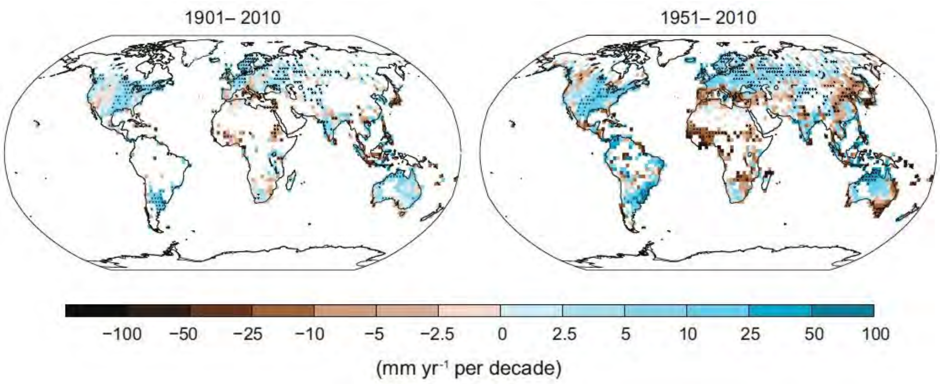


Fig. 2 Trend of annual rainfall

The climate changes have tangible effects in every part of the planet, but their effects vary greatly amplified in highly built areas due to human activity, which over the last few centuries has been concentrated in these territories located – often by changing the morphology and original conformation depending on your needs, not respecting the real nature of places and inevitably compromising the ability to respond to external stimuli. Recent estimates attest to the positive trend of growth of the world's urban population, of which approximately 10% live in megacities, but the largest share of the increase in urban settlements is being observed especially in medium and small sizes. The urban areas play a crucial role: they produce the majority of greenhouse gas emissions, and they themselves are more exposed and vulnerable to the impacts of climate change.

## 2.1 URBANIZATION AND URBAN HEAT ISLAND

Population growth and urbanization have resulted in a substantial transformation of the land by man. One of the main effects caused by this change is the change of the microclimate in the places where the

[2] Data taken from the Summary for Policymakers (SPM) published in October 2013 by the IPCC on all'AR5.

environment has suffered main transformations, ie urban areas. Despite the heat island[3] effect has been found for the first time by the British meteorologist Luke Howard in 1818, the term appears in the literature only in 1958 in an article by Gordon Manley in the Quarterly Journal of the Royal Meteorology Society.

The association of the term "island" to increasing temperature results from a similarity: air temperatures, being mapped through isotherms, make the city look like an island surrounded by the surrounding rural areas are characterized by lower temperatures, and urban areas characterized by greater intensity are those with an high building density. The extent of the problem varies greatly from city to city, and depending on the geographical location, the weather, the season and time of day. This alteration can be easily understood by considering: "the annual mean air temperature of a city with one million people or blackberries can be 1.8 to 5.4°F (1 to 3°C) warmer than the ITS surroundings and on a clear, calm night, this temperature difference can be as much as 22° F (12° C). Even smaller cities and towns will produce heat islands, though the effect Often decreases as city size decreases" (Oke 1997).

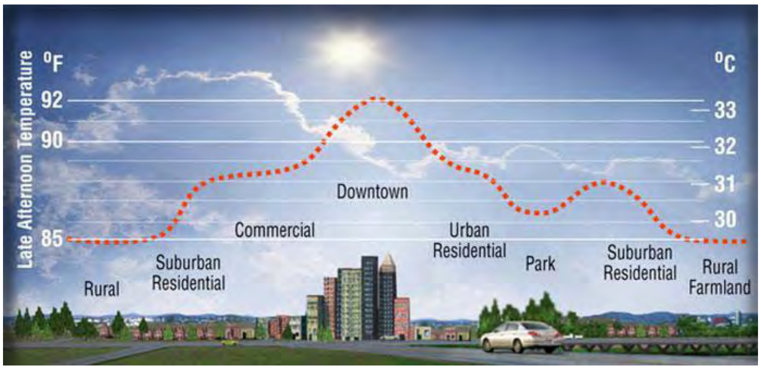


Fig. 3 Urban Heat Island

The growing urbanization of recent years and the resulting morphological structure of the city, have contributed significantly to the formation of heat island. Despite the elements that influence are obvious, their contribution to the UHI effect can not be defined uniquely, as the specific features of each city play a significant role.

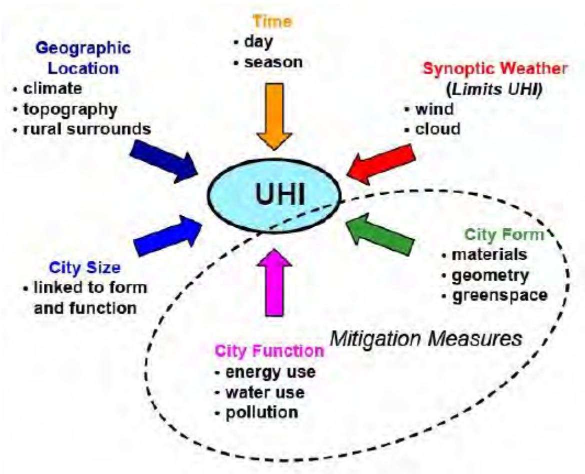


Fig. 4 Factors that influence the UHI effect

[3] An urban heat island (UHI) is a phenomenon where the temperatures in the urban space are higher than those of the suburban rural areas.

The origin of the effect UHI consists of altering by the man of the characteristics of the land, through the process of human settlement. The intensity of the phenomenon is influenced by the geographical location, the time horizon and the meteorological variables. These elements contribute to alter the environmental comfort. In particular, the wind speed and the cloudiness have the greatest impact on the intensity of the phenomenon, by modifying respectively the atmospheric turbulence and the solar irradiation.

In addition, it was found that the UHI effect is amplified at certain times of year and day: during the summer and at night. In addition to these uncontrollable variables, there are causes due to anthropogenic modification of the area: the use of materials that retain heat and do not allow the evaporation, the reduction of vegetation and green areas, the energy processes that satisfy the needs of the population and the urban and architectural geometry, the presence of so-called urban canyons and widespread overbuilding.

Fig. 5 Example of street canyon

Urban planning play an important role, because it affects directly the environment, often favoring the reduction of the agricultural areas resulting in increased anthropization places, pollution and alteration of the natural environment. The urban fabric, especially in metropolitan areas, is often made up of narrow streets than the height of the buildings facing on them, the street canyon differ from undeveloped surface because they capture a greater amount of solar radiation that remains trapped by the many reflections on the surfaces of buildings. This solar radiation and infrared residual is directly proportional to the height of the buildings, to equal the width of the road. The geometry of the urban context also affects the wind flow inside: buildings – especially impressive and close to each other – act as aerodynamic barriers, reducing heat dissipation compared to non-built area in which the wind speed grows with the logarithm of the height of the soil.

## 2.2 TERRITORIAL VULNERABILITY AND URBAN RESILIENCE

The effects of climate change cause considerably different consequences depending on the specificity of the context to which it refers, in this context fits the concept of vulnerability[4]. The degree of susceptibility is an intrinsic factor in human nature and in the community and it is a function of the sensitivity of the biophysical

[4] Vulnerability is 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. (IPCC 2007).

system against the effects of climate change and the social system, or the ability to absorb impacts and adapt to change. At the global level[5] has been evaluated, in order to better assess the current situation, the index of vulnerability to climate change, which considers, in general, three indicators:

- the level of exposure of the areas to extreme events,
- the degree of sensitivity of the population to external events,
- the regions' ability to adapt to climate change.

The parameters are closely related to social, economic, political and geographical. A careful study of the vulnerability of the area is of paramount importance to promote and develop effective intervention strategies, policies and actions for adaptation and mitigation of risks. "Cities are the places where most people in Europe will experience climate change impacts first, they accommodate around three quarters of the population, to share Which is expected to INCREASE further" (EEA 2012). The socio-economic factors, then, are a determining factor in the assessment of climate vulnerability of the territories, because they influence the degree of risk. In urban areas, the union of the conditions of heightened vulnerability associated with the effects of global warming can lead to very significant consequences in terms of human lives and economic costs. These impacts could be greatly reduced with proper prevention in terms of planning and management of the system and the consequent risks. The risk is directly proportional to the degree of vulnerability of the system under consideration. The climate vulnerability and the interventions aimed at increasing the capacity of adaptation, affect sectoral policies, defining the future trajectory of development of territories. The concept of vulnerability is so closely linked, in addition to the human factor and social, the micro cities, understood as the possibility of the urban fabric to respond to external stimuli.

Currently, a critical specification of urban areas is the rigidity of its structure. The city is often unable to readily adapt to abnormal stress, such as climate change. Moreover, some features of the city - for example, the low percentage of permeable surfaces or the morphology of the city, further inhibit its ability to react.

In this context, urban planning plays a fundamental role to guide the city towards a more sustainable and resilient way. “An adaptive and resilient community on disaster risks and climate change related hazards becomes a more progressive and productive community” (Golez 2012). In recent years the term resilience has expanded the paradigm of sustainable development, especially when applied to the sphere of urban planning. Resilience is a concept that involves different areas with a multiplicity of meanings: it refers to ecology, anthropology, the social sciences, and finally to urban planning. Resilience has two main definitions that involve different approaches related to the concept of stability. The most widely used definition has origins from engineering: the resilience is the property that enables a material to regain its original shape after a deformation. The second meaning – or eco – systemic resilience – is special, typical of complex systems, to combat the phenomena of stress, triggering solution strategies of adaptation in order to restore proper operation. The resilient systems, subjected to external impulses, respond renewing, preserving the functionality and recognition of the systems themselves. Resilience does not therefore imply the restoration of the status quo, but the reactivation of functionality through the change and adaptation. The decrease in resources for the renewal and functional diversity compromises the system, increasing the vulnerability. Throughout history, communities have always tried to adapt to climatic and historical changes. In some areas, the change has been so rapid and violent, forcing the man to abandon the settlements. Through slower processes, communities have been able, in some cases, adapt to change. A resilient city is an urban system that not only adapt to climate change, but it is also able to plan and manage a long-term strategy that will guarantee social stability through a shared governance, building conditions for a low-carbon

[5] Analysis performed by Maplecroft, specialists in risk analysis, which in 2008 published an index of vulnerability to climate changes.

civilization. The city needs to programmatic and operational instruments aimed at ensuring an adequate level of homeland security, managing risk prevention, through a multidisciplinary approach. We need to create an effective synergy of knowledge, capable of varying responses depending on the specific evidence and the needs of the territory, gaining thus a flexible adaptation strategy. The uncertainty of scientific knowledge can not be a valid reason for postponing action on mitigation and adaptation. When there is a risk of harm – although not quantified exactly – it is necessary to provide the appropriate countermeasures to prevent their effects. Scientific knowledge must, therefore, be on the basis of guidelines highlighting the vulnerability of the area to extreme events and indicating the path planning for a coherent, effective and efficient, and resilient. Knowing the risk areas it is possible to implement a series of measures of a structural nature, aiming to reduce the frequency and the severity of a hazard, through consolidation and maintenance actions, trying to reduce the impact, through the preparation of action plans to inform and assist the population in case of need.

## 3 ADAPTATION AND MITIGATION STRATEGIES FOR CITIES

The vulnerability of cities to climate change is determined by many factors (Red-Cross 2010). The location certainly affects risk exposure, but most accidents are those socio-economic factors and the ability of administrators to develop appropriate strategies for adaptation and mitigation. In recent years, the concepts of adaptation and mitigation have become the basis of climate policy, identifying several strategic options in order to manage these issues. First we have to define the meaning of the terms mitigation and adaptation: the first is a global business that requires the interest intervention of the State – which participates through international agreements – while adaptation is an activity mainly on a local scale, which, therefore, requires the commitment of local governments.

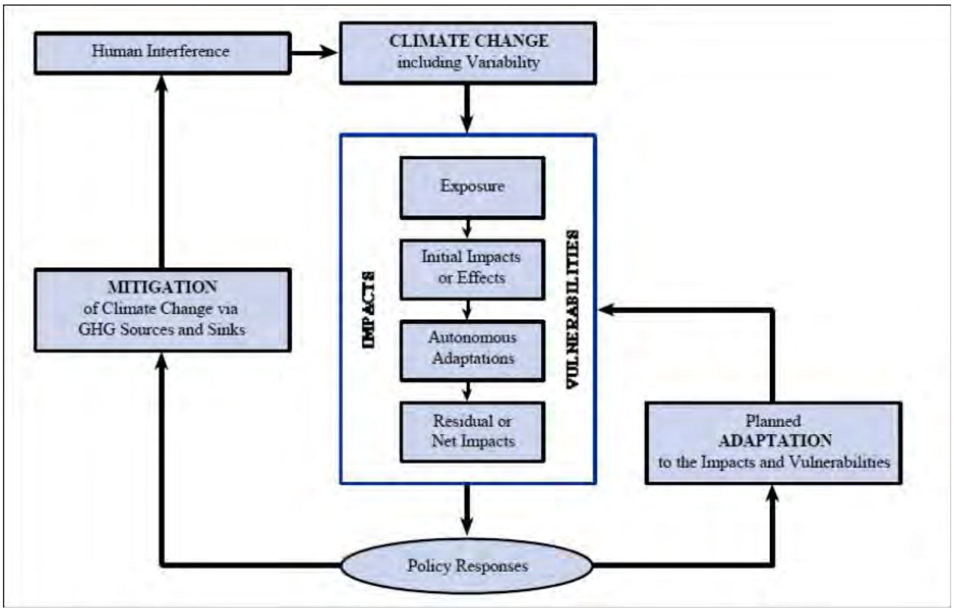


Fig. 6 Framework for the assessment of the effects of climate change

Furthermore, we must distinguish between adaptive measures and mitigative measures of the phenomenon (Solecki 2005). When we talk about adaptation we refer to those actions that tend to minimize the effects of climate change. Mitigation strategies are aimed instead to reduce the intensity of the phenomena. The adaptation seeks to manage the consequences of climate change. However, it is not intended to address the causes of the problems, but it tries to make it more tolerable coexistence with the phenomena, until subsequent deterioration require no further adjustments. In particular, these processes, which, on the one hand, seek to minimize the negative effects of the disturbance and on the other hand, tend to take advantage of the positive opportunities that this event can offer. The adaptability of the system are larger the greater its resilience – or the smaller is its vulnerability – and the lower the sensitivity of the system to the perturbation suffered or variations of pre-existing conditions.

As a consequence, increase the adaptation of the system means first reducing the vulnerability to climate change, increasing the risk threshold, reducing the potential negative impacts, increasing the positive ones, and promoting more sustainable development. The capacity to adapt varies considerably depending on the countries, regions and socio-economic groups. The ability to adapt is a function of different factors such as: economic power, technology, information, institutions and equity. Generally, the planning and development of adaptation strategies are considered necessary actions, complementary to mitigation.

### 3.1 COMFORT IN URBAN SPACES

It has been repeatedly demonstrated that the physical structure of the city affects the climate and weather, leading to various discomforts during certain times of the year. The conditions of well-being are therefore affected and often worsened because of physique and suspension geometry of the urban and architectural surfaces. In this sense the construction sector, accompanied and guided by a good city planning, plays a crucial role, as it has an inevitable impact on the environment, for example in terms of erosion of natural areas or agricultural, human settlement of places, pollution and degradation of the natural environment.

The complex urban structure of a city can be of fundamental importance for the mitigation of the phenomenon dell'UHI. This is the case of so-called urban canyons, ie narrow streets surrounded by buildings high. Unlike a flat surface undeveloped, urban canyons capture a greater amount of solar radiation that is trapped by multiple reflections. For this phenomenon (called the canyon effect) in some parts of the city heat island is preserved even at night. The cooling air that remains in the canyon is much slower than all other areas (eg rural areas), because the infrared energy radiated from the surfaces in the environment that surround the road corridor, rather than disperse freely in space, is largely captured and reflected several times on the part of the buildings that face on the opposite sides of the road. The trapping of solar and infrared radiation is much stronger than most buildings are taller than the width of the street. Another factor directly related to the geometry of the city is the wind profile within the urban context. The breezes and the wind in general are very important, especially at night, when the surfaces release the heat accumulated during the day and warm air stagnation causes discomfort for the citizens. The morphology of the city influence the wind profile: the buildings are in fact the aerodynamic obstacles that reduce the export of heat, especially if they are particularly large and close together. In the absence of an urban center (for example, in a rural area) in the surface layer wind speed increases approximately with the logarithm of the share. In the presence of an urban center, the structure of the boundary layer (called "urban boundary layer") will be unchanged. This layer is characterized by the presence of obstacles (buildings, trees, etc.) it is not common in rural areas. The role of cities within the mitigation strategies is crucial. Today more than ever necessary mitigation strategies to limit emissions of $CO_2$, produced by the city. Mitigation strategies can be seen as the best option for reducing the risk of disasters related to extreme weather events exacerbated by global climate change (Red-Cross 2010). The global $CO_2$ emissions come largely from human activity in cities and urbanization processes. The urban traffic, deforestation, industrial activities and energy consumption are among the main factors of greenhouse gas emissions in an urban setting. The role of urban planning is crucial in the challenge posed by climate change, both in terms of adaptation and mitigation.

In particular, the heat island phenomenon is developing more and more in different urban contexts, and especially in Italy, there are still few initiatives taken towards planning policies that can address the problem and mitigate the dangerous effect. Often the planning is developed on too many levels of decision and there is no interaction between them. It is necessary to make a good planning and a policy of control of environmental conditions, in order to define strategies and implement practical measures for the monitoring and mitigation of heat island. The current challenge for the city is to implement policies and projects aimed at both reducing emissions from urban areas to increase their resilience. The city will have to contribute to "mitigate" climate change and at the same time "adapt" to climate change. The most common strategies are:

- increase in areas with reflectivity (albedo);
- creation of green areas in the urban context;
- reduction of anthropogenic loads;
- use of specific materials.

The spread of surface reflectivity is very important. The albedo of a surface is the fraction of light, or more in general, of the incident radiation that is reflected back in all directions. Thus it indicates the reflecting power of a surface. Greater is the albedo and greater and the amount of radiation that urban surfaces reflect in space. Conversely objects that absorb solar energy have a low albedo value and contribute to the warming of the city. In urban areas it is very important to implement the ability of the surfaces to reflect solar radiation into space to avoid the storage of heat in the urban fabric, especially in the canyons, in cities with a high rate housing. For example the light surfaces reflect a greater percentage of solar radiation compared to conventional surfaces as they are characterized by a high albedo, and therefore entail a cooling of the surrounding air (Solecki 2005). Furthermore, it is very important to increase the green areas. Unfortunately, human activity in recent years is not developing in this direction: the vegetation of the urban environment is slowly disappearing because they are often made of low- density housing schemes that reduce the distinction between town and country.

The urban green has a value of albedo and thermal inertia different from other materials, and also has a large concentration of water. The presence of green is particularly important in the summer season, when the temperatures are higher due to evapotranspiration and the air temperature is lowered. Furthermore, the green, with its shading function, prevents the radiation directly affect artificial materials: these are less heated and consequently the energy re-emitted into the environment in the form of heat is reduced.

The green areas located in urban areas add quality to the urban landscape and the urban microclimate can be adjusted. The experimental data show that, thanks to the combined effect of the shadow and evapotranspiration, the presence of vegetation results in a significant reduction of the temperature (Robitu 2005). The functions of the green are emphasized in combination with the presence of elements of water because evaporation and evapotranspiration are always associated with the transfer of heat between water, vegetation and air (Robitu 2005). Another effective urban strategy is the reduction of anthropogenic loads. The city produces energy, with the loads generated by the traffic, from air conditioning or heating and industrial installations. Moreover, it is very important the choice of materials, which particularly affect the surface energy balance. The materials can be divided according to their intended use: flooring materials, building materials and structural materials. As for the roofs and pavements, we refer to cool roofs, green roofs and cool pavements. The roofs occupy about 20-25% of the urban area, therefore a reduction of the surface temperatures of roofs can bring direct benefits to individual buildings and indirect to the whole urban territory. To achieve this purpose materials are used in roofing and they reflect a greater proportion of radiation and high emissivity, eg cool roofs. A normal roof (black-roofs) can reach temperatures close to 85°

C and reflects only 5% of the radiation, the cool roof has a surface temperature lower than traditional materials, with high values of albedo and emissivity. A cool roof allows a lower heat transfer from the roof, then it has a more comfortable temperature inside the building, thus it limits the need for a cooling of the mechanical type. In those situations where the buildings are many and particularly close together and the realization of green areas is difficult, are used the green roofs. The best idea is to take advantage of the large area occupied by urban roofs for the realization of the so called green roofs, roofs covered by a layer of vegetation. The extensive use of green roofs leads to a reduction of the albedo and an increase of the processes of evapotranspiration that allow to limit the surface temperature of the roofs, reducing the flow of the incoming heat and heating the air.

Urban pavements can reach high surface temperatures, creating problems of microclimate and well-being.

The majority of the urban area is in fact made up of different types of flooring and the behavior is almost similar to other materials: during the day they absorb and store energy during the night, through the processes of radiative and convective cooling, dispose of the energy absorbed.

As for the roofs action can be taken on the properties of the floors to try to mitigate the heat island effect, unlike the budget shell (influenced by albedo and emissivity), the flooring is more complex: you have to consider factors such as the permeability, the thermal inertia and the convection.

All of these factors act on the surface temperature. To try to reduce this temperature may be used unconventional materials in order to reduce also the amount of heat stored. The cool pavements. reflect a greater proportion of the solar radiation and may be permeable. The cool pavements do not act on emissivity but on impermeability of the surfaces. This feature allows the descent of the water towards the ground, fundamental for the evaporative cooling. In contrast, porous pavements limit the transfer of heat to the subsurface because of their structure: the surface temperature will be greater but the advantage is that a lower thermal storage. Compared to the benefits produced by cool roofs and green roofs the benefits of cool pavements are indirect: for example with a good spread of permeable surfaces rainwater runoff may be reduced by up to 90% going to affect the costs of pumping.

## 4 CONCLUSIONS - THE ROLE OF URBAN PLANNING IN CLIMATE CHANGE

Planning is able to influence the way in which the density and the soil is used, but at the same time is able to connect the macro scale (cities and districts), at the micro (individual buildings) in a single perspective.

The planner often acts within the limits of political and economic factors, it is nevertheless an essential figure and plays a key role in the adoption of measures for improvement of the urban microclimate. In fact, the success of projects and mitigation plans also depends on the ability of the planner in developing awareness of the possible future changes in microclimate induced by modification of the urban fabric (De Schiller and Evans 1994). The planner must be able to understand and incorporate the principles and techniques that can be applied to achieve the objective of reducing the impact of the transformations of the territory urban climate. To facilitate this integration is a fundamental understanding of the two-way relationship between the built environment and the environmental thermal conditions: the planners change the environment through the building and on the other hand the buildings suffer from environmental changes around it. The future buildings should be designed in view of the reduction of impacts on environmental thermal conditions and at the same time control the negative effect of changes in these conditions over the users of urban spaces (De Schiller and Evans 1994). It is also necessary to evaluate the climatic variations at different scales: from the building, the neighborhood, to the city. It is necessary to concentrate their efforts on three areas with synergies between adaptation and mitigation: urban planning, building design and decentralized energy production. It follows the central role of local governments and local adaptation to climate change at the same time developing integrated strategies between mitigation and adaptation. Many actions have been taken in this direction. After the adoption of the European climate change package in 2008, the European Commission has proposed the "Covenant of Mayors" to support the efforts made by local authorities in the implementation of policies in the field of sustainable energy. To meet and exceed EU targets for energy and climate, the signatories of the "Covenant of Mayors" are committed to develop a Sustainable Energy Action Plan (SEAP). The SEAP is a document that defines the energy policies that administration must take to reach the EU target of reducing CO2 emissions by 2020. This objective is pursued through actions to reduce energy consumption in the city and to increase the production of energy from renewable sources. Many European cities have adopted their own Sustainable Energy Action Plan. Recently, the Institute for Environmental Protection and Research, ISPRA, has drawn up a strategy of local adaptation to reduce the risks caused by climate change, urging the development of the resilience of the community. The institute has set some Guidelines for Climate Change Adaptation Plans at Local level (PAL).

The aim of the Guidelines is not only to provide the basic theoretical concepts on the key issues of adaptation to climate change but also to propose a practical and operational support to local governments that are interested in starting a process of adaptation and to develop Climate Change Adaptation Plans at Local level (PAL). Furthermore, there are many opportunities for local governments to use the process of urban planning for the reduction of greenhouse gas emissions. A general urban consolidation and a more varied use of local centers of activity near public transport nodes help to reduce the amount of land used for construction and tend to reduce travel and emissions of transportation. However, the policy of adaptation to climate change require spaces inside and around buildings. An average density of settlements, along with a differentiated use and green areas, tends to lead to a reduction of greenhouse gases and contribute to adaptation. The integration of functions – residential, manufacturing, recreation, infrastructure – in urban areas causes additional benefits of adaptation. Innovative air-conditioning help to limit emissions. The orientation and organization of buildings and covered areas allow for the replacement of the conventional air conditioning system with solar and district heating. The planning of green areas around the buildings and green roofs to reduce the temperature leads to a substantial reduction in energy consumption. In conclusion, a sustainable territorial development must consider the impacts of climate change. A combination of mitigation and adaptation strategies can lead to optimal results in terms of resilience, environment and local economy. Such an approach needs to be developed consciously by government as a strategy of anticipation and opportunity that is based on the vision of a region resilient to climate change that takes the pulse to go down the route of a new model of development ”low carbon". The objective is to develop and prepare the implementation of strategies to address local and regional climate change in a comprehensive and integrated manner thereby broadening the effectiveness of climate policy through optimal combinations of measures, both short and long term, precautionary response and thereby establishing a kind of local planning and land that minimizes the risk for the development of the territory.

## REFERENCES

Berdahl, B., Bretz S.E. (1997), “Preliminary survey of the solar reflectance of cool roofing materials”, *Energy and Buildings*, 25.

Cacciamani, C. (2013), “È l'uomo a cambiare il clima, la scienza conferma”, *Ecoscienza*, 5, ARPA Emilia Romagna.

Chin, G., Desjarlais, M. (2008), *Reducing Urban Heat Islands: Compendium of Strategies. Cool Roofs,* Environmental Protection Agency.

De Schiller, S., Evans, J.M. (1994), “Training architects and planners to design with urban microclimates”, *Atmospheric Environment*.

EEA (2012), *Climate change, impacts and vulnerability in Europe 2012,* Report 12, EEA, Copenhagen.

Golez, R.B. (2013), “Resilient communities”, in *Congress report, Resilient Cities, IV Global Forum on urban resilience and adaptation,* Bonn, 31 may – 2 june 2013.

Haines, A., Kovats, R., Campbell-Lendrum, D. (2006), “Climate change and human health: impacts, vulnerability, and mitigation”, *The Lancet*, 367, Elsevier.

IPCC (2007), *Climate change 2007: The physical science basis*.

IPCC (2013), *Climate change 2013: The physical science basis.*

Oke, T. (1982), “The energetic basis of the urban heat island”, *Quarterly Journal of the Royal Meteorological Society*.

Oke, T. (1997), “Urban climates and global environmental change”, in Russell A.P., Thompson D. (eds.), *Applied Climatology: Principles & Practices,* Routledge, Londra.

Pinto, F. (2013), “Isola di calore e resilienza urbana: strategie di mitigazione e di adattamento della città ai cambiamenti climatici” in Sbetti F., Rossi F., Talia M., Trillo C. (eds,), *Il governo della città nella contemporaneità. La città come motore di sviluppo, Atti del XXVIII Congresso INU*, Urbanistica Dossier n. 4, INU Edizioni, Roma.

Red-Cross (2010), *World disaster report 2010,* International federation of Red Cross and Red Crescent Societies.

Robitu, M., Musy, M., Inard, C., Groleau, D. (2005), “Modeling the influence of vegetation and water pond on urban microclimate”, *Solar Energy*.

Solecki, W.D., Rosenzweig, C., Parshall, L., Pope, G., Clark, M., Jennifer Cox, M.W. (2005), Mitigation of urban heat island effect in urban New Jersey, *Environmental Hazards.*

Voogt, J. (2006), “Comparison of Four Methods to Estimate Urban Heat Storage”, *Journal of Applied Meteorology and Climatology*.

## IMAGES SOURCES

Figg. 1, 2: IPCC. (2013), *Climate change 2013: The physical science basis.*

Fig. 3: www.heatisland.lbl.gov

Fig. 4: Voogt, J. (2006), “Comparison of Four Methods to Estimate Urban Heat Storage”, in *Journal of Applied Meteorology and Climatology.*

Fig. 6: IPCC. (2007), *Climate change 2007: The physical science basis*.

## AUTHOR’S PROFILE

1986-1987: Graduated with honor at the Faculty of Architecture of Naples. 1988: she obtains qualification to practise the architect profession. 1989: beginning of teaching and research activity. 1998: PhD in Technical Urban Planning, at the Polytechnic of Milan. 1989-1999: Assistant Teacher at the University of Naples, Faculty of Engineering and at the Polytechnic of Milan, Faculty of Engineering. 1999-2002: Temporary professor in Urban Planning. Since 2002: Permanent Researcher in Urban Technique and Planning at the Dpt. of Architecture and Planning, Polytechnic of Milan. Currently she teaches at the Polytechnic of Milan, Faculty of Engineering: “Urban planning”, “Urban planning and transformation” and “Laboratory of Urban Technique”. She is author of many publications on the theme of relationship between urban planning and mobility system and on the theme of urban requalification. The results of these searches have been shown during various national and international conventions.