ERA NET URBAN/0001/2009 - *Potential impact of climate trends and weather extremes on outdoor thermal comfort in European cities - implications for sustainable urban design.*

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WP 5: Policy Making Strategies

Final Report

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1. INTRODUCTION

As planned in our research project the changing climate and the increasing concentration of population in urban centres will affect and bring many negative consequences to society, but it will also offer significant potential for innovative solutions. The aim of the work done in this final project step – WP5 - was establish the best ways to transfer the knowledge about the impact of climate trends and weather extremes on outdoor thermal comfort in European cities to key stakeholders and to develop innovative policies.

In this way we pretended to ensure that the several needs to mitigate the negative impacts of a changing climate is understood and addressed at the heart of city planning and management as well as by regional and national authorities.

Having demonstrated that the local urban 21st century scenarios (2045-2065 and 2080-2100), for the Goteborg, Porto and Kassel, will generate frequent discomfort outdoor environments with potential huge negative outcomes in public health, and having presented some possible mitigation measures exclusively anchored in urban design (i.e. increase greening areas), we started our task by examining and commenting/noting how the climatological concerns are included in European, national (Portuguese) and local (Porto) legislation. Then, we start a series of interviews and meetings with all local authorities in order to appreciate how this gap is considered and evaluated especially having in mind the Horizon 2020 strategy goals – a smart, inclusive and sustainable growth. Finally, we start an active, lively and dynamic participation in the 17 councils of Porto Metropolitan Area towards a strategic diagnosis and a priority investments list definition to achieve 2014-2020's targets and goals including the outcomes of this research project.

Our first participation was in the political proposal of the winner candidate of the 2nd most important city in the Porto Metropolitan Area – Vila Nova de Gaia. As Portugal had council elections last September 2013, we benefit from our discussions dialogue with several regional and local politicians and planning authorities to disseminate the framework of this project. The result was a formal invitation to make a chapter in a book of a candidate to establish a council environmental diagnosis and a proposal where we included the climatological concerns as an important tool to mitigate climate changing negative impacts. The proposal is now incorporated in the activities of the 4 years plan of the Vila Nova de Gaia town.

Furthermore, during October 2013, we accepted the invitation of the Porto Metropolitan Area to participate in the Porto Metropolitan Area's Horizon 2014-2020 Strategy Plan . In this on-going work we assume the *Sustainable Growth* coordination where we drop all the Urban Net outcomes and firmly introduce the importance of local climate knowledge as a urban planning tool to mitigate climate change, promote energy efficient economy and low carbon cities. We absolutely believe that our arguments and evidences were clear enough to expect that some of the strategic investments will be applied to create a better knowledge of local climate environment.

The city of Oporto[1], in particularly, can have a unique position in relation to the inclusion of climate on planning decisions, as long in most urbanized areas in countries like Germany, England or Sweden. Germany is still the benchmark of the benefits of inclusion of climatological knowledge in planning for humans and ecosystem are well reflected in various cities such as, Stuttgart, Düsseldorf, Frankfurt, Köln, Berlin, Freiburg, Karlsruhe or Kassel. In these cities, urban planning had, since the early twentieth century and especially after the war, as goals the achievement of the best possible human conviviality within its territory and air quality as well as brightness. And the results are now clearly visible in the quality of life, wellbeing and health of the citizens guaranteed by fitting harmonious form and function of each element in urban bio-geophysical support.

Now, the evidence of some undesirable manifestations of climate change, the rising cost of energy and the failure of a large number of solutions tested in urban environment whose main objective was to start, the promotion of sustainability and quality of life, has revealed with clarity, that the error is mainly from the perspective of analysis. By separating the urban form and function, the behavior of the global and zone climate from regional to local, and consider separately the weather subsystems indoor and outdoor urban-scale, was lost the ability to move towards with effective solutions to promote quality of life substantively without pinching the *modus operandi* of the climate system. Precisely what defended Marcus Vitruvius Polio in *De Architectura* published in 1500 BC or Albert Kratzer in *Stadtklima* published in 1937.

The successful inclusion of knowledge in climatology to optimize the distribution of people, shelters and functions in territory, has now come to be taken in various parts of the globe as the best solution to increase their resilience (Hebbert, 2011). Projects like *Buccaneer* in Birmingham, *Manchester. A Certain Future* or *UC-AnMap* in Hong Kong (Ng, 2008), seek to apply the knowledge of local climatic variables (albedo, exposure to solar radiation, temperature, relative humidity, wind speed and direction), the concrete actions and recommendations planning (shape and volume of buildings, building materials, orientation of streets, distribution of green spaces, water mosaics) in various time scales.

For this reason, to the city of Porto endeavour of including climatology in planning and for example in promoting health and preventing disease in human beings in particular, and in the ecosystem in general, would therefore deserve, for a long time to be pursued as a driver of development, qualification planning and welfare to humans because they are in fact very few places with such good conditions to fulfill an intention of this magnitude.

With the collection of climatological, social, economic and health data existing in the climatological station Porto-Serra do Pilar, located in the nearby town of Vila Nova de Gaia, there are all the conditions to support a development strategy in the short, medium and long term that, starting from a

[1] Total area – 41, 42 km^2; Total Population – 237,591 Inhabitants; Population density – 5736 Inhabitants per Km^2 (INE Censos 2011).

holistic and systemic point of view of the territory and people, contemplate another way of a more healthier life, less harmful to the ecosystem and also less costly in economic terms.

From the illustration of the relationship between urban form and function with the local climate and the degradation of air quality that manifests later in the health of people and places, it is possible to imagine a cascade of policies, plans, measures, actions and projects in the short, medium and long-term staying faithful to the idealized vision for the territory of the city of Porto, effectively leading to the construction of spaces where all the puzzle pieces can be pulled together harmoniously. After all, nothing more than Kratzer (1937), and his followers have been achieved in several cities with results that are currently cited as excellent testimonies of success as to how people and places can interact mitigating collision courses and enhancing opportunities.

The importance of climate for urban planning lies mainly in the strong motivation that, when associated with the health and well-being of people, may embody to make humans accept some changes in its paradigms of quality of life , well-being and comfort that we have had so far as certain. The mobilization of human beings to consent to substantial changes in their daily lives in the name of sustainability is, in most cases, very difficult. Especially, because they are seen as sacrifices and losses of welfare.

However, when is possible to demonstrate that certain combinations of urban form and function generate negative impacts on their health, humans are more likely to change behaviors that are to be taken as appropriate. Health is one of the few possessions they all have an interest in preserving and materializes undoubtedly the best motivation to welcome transformations encrusted habits, many years ago, in the minds of most people. As Thomas More said, indeed, in *Utopia,* in the sixteenth century, health is synonymous with happiness (Morus, 1516).

At the local scale, the climatic effects caused by the choices of urban form and function, are mechanically very well perceived (Monteiro, 1997, 2011, 2011 b and 2000) When it is possible to demonstrate that these changes lead to, for example, negative impacts on human health, then this trilogy becomes a good lever motivating the creation of other frameworks of reference for the location of people and activities in any territory (Fig 1).

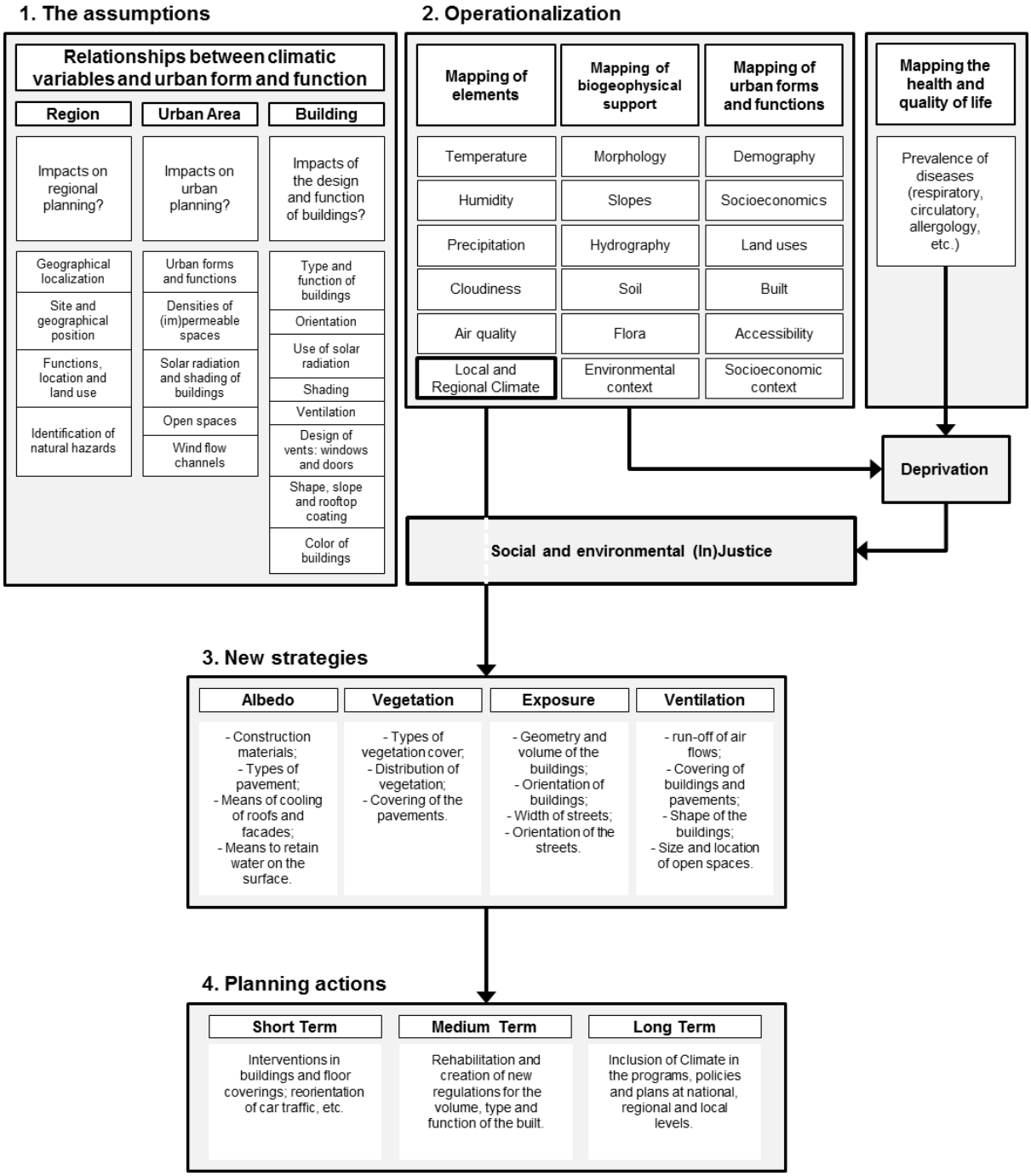


Fig. 1 - Organogram of development strategy from the knowledge of symptoms in climate and health (adapted and modified from Ren, 2011).

2. STRATEGIES, POLICIES AND MEASURES FOR ADAPTATION TO CLIMATE CHANGE

The impacts of climate change may affect all sectors of the economy and all segments of the population. In recent years, reducing vulnerability to climate change has become an important issue for all countries in general. The dependence of most countries demonstrates in relation to climatic conditions combined with their geographic location, whose impacts can cause huge damages in economic sectors (notably agriculture and fisheries sector and coastal ranges threatened by rising level of the sea) and in living conditions and health of urban populations, i.e. their vulnerability. Thus, adaptation to climate change should be at the forefront of any political agenda of any country.

Since the beginning of its history, the human being has been able to adapt to new conditions, including the natural variability of the climate itself over time. Adaptation is a "process by which individuals, communities and countries seek to cope with the consequences of climate change, including variability"(Burton et al., 2004). Knowledge about the weather / climate change and its negative impacts that manifest themselves through extremes of temperature, precipitation, among others, has been to develop and the results of the studies, although controversial, have shown that adaptation, from the perspective of prevention, it is necessary and perhaps more important and effective than mitigation.

The United Nations Development Programme – Global Environment Facility (UNDP-GEF), with support of the governments of Switzerland, Canada and Netherlands developed the Adaptation Policy Framework (APF) which aims to "support adaptation processes to protect and, if possible, to improve human well-being in the face of climate change, including variability" (Burton et al., 2004) and is structured around four key principles that can provide the basis for work from which adaptation actions can be developed to climate change (Fig 2).

• ***Adaptation to short-term climate variability and extreme events is included as a basis for reducing vulnerability to longer-term climate change.*** As users seek to prepare for near-, medium- and longer-term adaptation, the APF helps them to firmly ground their decisions in the priorities of the present.

• ***Adaptation policy and measures are assessed in a developmental context.*** By making policy the centrepiece of adaptation, the APF shifts the focus away from individual adaptation projects as a response to climate change and toward a fundamental integration of adaptation into key policy and planning processes.

• ***Adaptation occurs at different levels in society, including the local level.*** The APF combines national policymaking with a proactive “bottom-up” risk management approach. It enables the user to hone in on and respond to key adaptation priorities, whether at the national or village scale.

• ***Both the strategy and the process by which adaptation is implemented are equally important.*** The APF places a strong emphasis on the broad engagement of stakeholders. Stakeholders are seen as instrumental in driving each stage of the adaptation process.

Fig. 2 - Four fundamental principles of APF, adapted from Burton, Malone, and Huq (2004).

Using the synergies between institutions and areas of knowledge to enable informed policy-making and more informed and effective in a better adaptation measures, APF values what is already known and emphasizes that the starting point is the existing information on vulnerable systems, such as public health and risk management.

Some countries are already in the process for adaptation to the present climate conditions considering the different scales (national, regional and local scales) and different time horizons (short, medium and long term). Here planning occurs mainly in accordance with the guidelines of the policies of the governments. "When unplanned, adaptation tends to be triggered by unexpected changes in natural or human systems" (Burton et al., 2004).

To develop an adaptation strategy for future climate change are needed, according to the APF, a set of key objectives which must have their space in the development priorities of each country (e.g., improvement of outdoor thermal comfort and well-being of individuals living in cities). So, they are considered five important objectives (Fig 3).

- **Initiation** of a process to reverse trends that increase maladaptation and raise the risks for human populations and natural systems;
- **Reassessment** of current plans for increasing the robustness of infrastructure designs and long-term investments;
- **Improvement** of societal awareness and preparedness for future climate change, from policy-makers to local communities;
- **Increased** understanding of the factors that enhance or threaten the adaptability of vulnerable populations and natural systems; and
- A **new focus** on assessing the flexibility and resilience of social and managed natural systems.

Fig. 3 - Five objectives to develop an adaptation strategy principles, adapted from (Burton et al., 2004).

“Developing an adaptation strategy that can respond to these objectives requires a vision that balances the need to reduce climate change impacts with the constraints of national policymaking processes. Whatever adaptation options and measures emerge, packaging these decisions into an effective adaptation strategy will require increased policy coherence across economic sectors, societal levels and time frames” (Burton et al., 2004).

To address the impacts of climate change, new policies and measures can be added in development plans and sectorial plans, for example, at various scales and stages (including, assessment, development, implementation and monitoring). Once the proposed adaptation process (Fig 4) begins with the available information on vulnerable systems of countries (e.g., public health and risk management), it can contribute to changing how the risk (event X vulnerability) and the negative impacts of climate change are tolerate by the population.

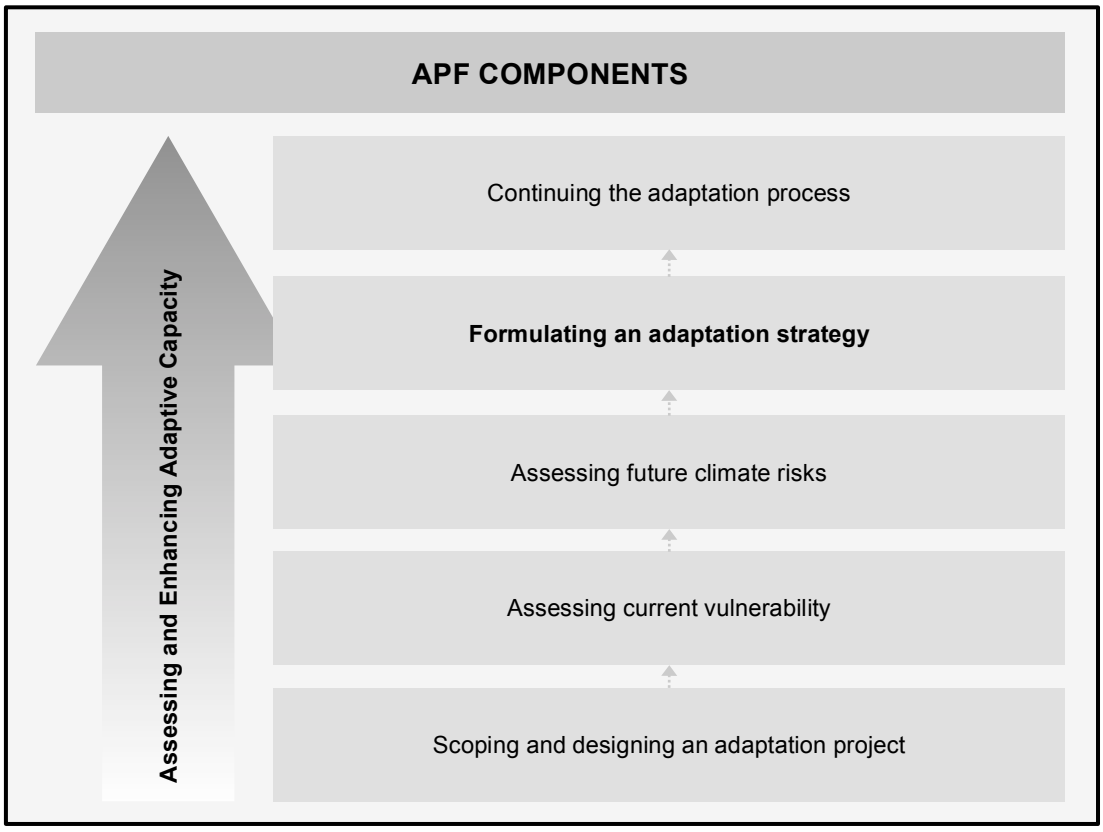


Fig. 4 - Outline of the Adaptation Policy Framework Process, adapted from Burton et al. (2004).

Once a process of adaptation, such as the APF, can be used in different ways it is important that could be identified and assessed the priorities, the expected results and the available resources. Should be taken into account, also, many aspects such as: the approach to be used (where they can be used several conceptual frameworks or approaches based on natural hazards, vulnerability, policies and adaptation capacity); the range (range may vary depending on a country strategy. For example, a case where can be included all geographic areas and sectors of activity considered most important in a long-term planning. Another case, could only be located in a city (e.g. Porto) and only address the public health sector and climate change (e.g. changing the urban design to enhance the outdoor thermal comfort of its inhabitants); methods and analysis tools (there are several methods and tools that can be used taking into account the complexity and scale of each of the chosen approaches); and components of the adaptation process (tasks that will be performed will depend largely on the APF components more suitable for a particular purpose, whatever the scale used. Whereas some countries already have evaluations about their vulnerability, other still has a long way to go). In conclusion, there exist a vast number of options. Thus, the implementation of the APF is characterized by:

- A careful application of the scoping process and the design process;
- A robust process for stakeholder involvement;
- An analysis of adaptation to deal with current and future climate change, and
- A program to monitor and evaluate the impact of adaptation (Burton et al., 2004).

2.1 Formulating an adaptation strategy, implementation of policies and measures

“Adaptation means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause, or taking advantage of opportunities that may arise. It has been shown that well planned, early adaptation action saves money and lives later” (EC, 2013).

For a process of implementation of policies and measures for adaptation to climate change to be successful it is necessary to overcome two major challenges. The main challenge is to convince policy makers that climate besides being seen as a resource of which can be drawn from numerous benefits, also have to be considered as a risk which dramatically affects the lives of the most vulnerable populations of any country. The second challenge is to accept that any process of adaptation is a long process and requires continued attention and that, according to Niang-Diop and Bosch (2004), “developing an adaptation strategy is not a simple “one-shot” deal; instead it is an iterative, continuous learning process”.

Figure 5 summarizes the five activities for the construction of an adaptation strategy. The first activity involves the collection, processing and synthesis of available information; second activity involves the creation of an adaptation strategy that considers the goals and the way of how to incorporate it in the national, regional and local plans of development; third activity focuses on the formulation of adaptation options (policies and measures); fourth activity involves the selection and prioritization of the choices made, and the fifth and last activity is the formulation of adaptation to implement strategy(Burton et al., 2004).

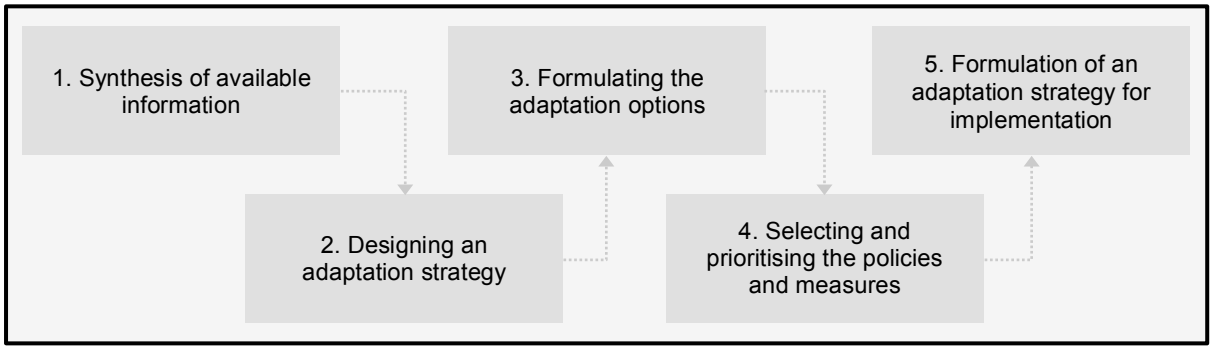


Fig. 5 - The five activities for the construction of an adaptation strategy.

2.2 Defining concepts: Adaptation strategies, policies and measures

An ***adaptation strategy*** for a country, region or city is a plan of action to combat the negative impacts of climate change (Fig 7). The strategy includes a range of policies and measures aimed to reduce the vulnerability of the territory and populations. “Depending on the circumstances, the strategy can be comprehensive at a national level, addressing adaptation across sectors, regions and vulnerable populations, or it can be more limited, focusing on just one or two sectors or regions” (Niang-Diop & Bosch, 2004). An adaptation strategy can contain several objectives (Fig 6).

Five generic objectives of adaptation to climate variability and change

1. Increasing robustness of infrastructure designs and long-term investments – e.g., by extending the range of temperature or precipitation a system can withstand without failure and changing the tolerance of loss or failure;

2. Increasing the flexibility of vulnerable managed systems – e.g., by allowing mid-term adjustments (including changes of activities or location) and/or reducing economic lifetimes (including increasing depreciation);

3. Enhancing the adaptability of vulnerable natural systems – e.g., by reducing other (non-climatic) stresses and removing barriers to migration (including establishing eco-corridors);

4. Reversing trends that increase vulnerability (also termed "maladaptation") – e.g., by introducing setback lines for development in vulnerable areas, such as floodplains and coastal zones;

5. Improving societal awareness and preparedness – e.g., by informing the public of the risks and possible consequences of climate change and setting up early-warning systems.

Source: Klein and Tol (1997) in Niang-Diop and Bosch (2004)

Fig. 6 - Five generic objectives of adaptation to climate variability and change.

The ***policies*** are the goals together with the means for its implementation (Fig 7). "In an adaptation context, a policy objective might be drawn from the overall policy goals of the country" (Niang-Diop & Bosch, 2004). An example:

a) Goal - to improve outdoor thermal comfort;

b) Means of implementation of this goal – population advice through the media and the healthcare sector, developing of research in urban climate questions, urban and building restructuring subsidies and incentives, etc.

"***Measures*** are focused actions aimed at specific issues (Fig 7). Measures can be individual interventions or they can consist of packages of related measures" (Niang-Diop & Bosch, 2004). The specific measures include actions that promote the policies, such as the creation of early warning systems and response targeted to the general population and vulnerable groups in particular (elderly, chronically ill and children), or provide financial incentives for a particular measure.

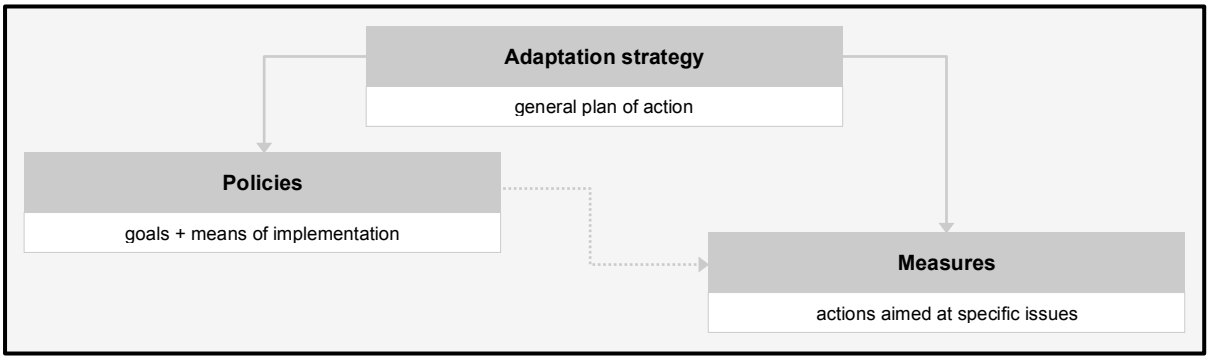


Fig. 7 – Schematic definition of the concept of an adaptation strategy, policies and measures.

When defining concepts that are related to each other, like wheels of a gear, it is normal that doubts arise about its true meaning. We present an example of how these concepts should be interpreted. For example, in the cities of Porto (Portugal), Frankfurt (Germany) and Gothenburg (Sweden) the ***strategy*** for adapting to global warming and improve outdoor thermal comfort of its inhabitants is put more vegetation in these cities. The inclusion in Municipal Plans of rules that aim to increase the permeable areas can be a ***policy*** for the implementation of strategy. One of the ***measures*** can be the creation of green areas (trees, green facades and green roofs).

After defining these concepts it is also necessary to establish timelines for each one (Fig. 8). Thus, in accordance with Niang-Diop and Bosch (2004), ***strategies*** would be long-term in nature, and ***policies*** targeted at the medium to long-term. ***Measures*** may have an implementation time of any length, but are expected to have sustained effects.

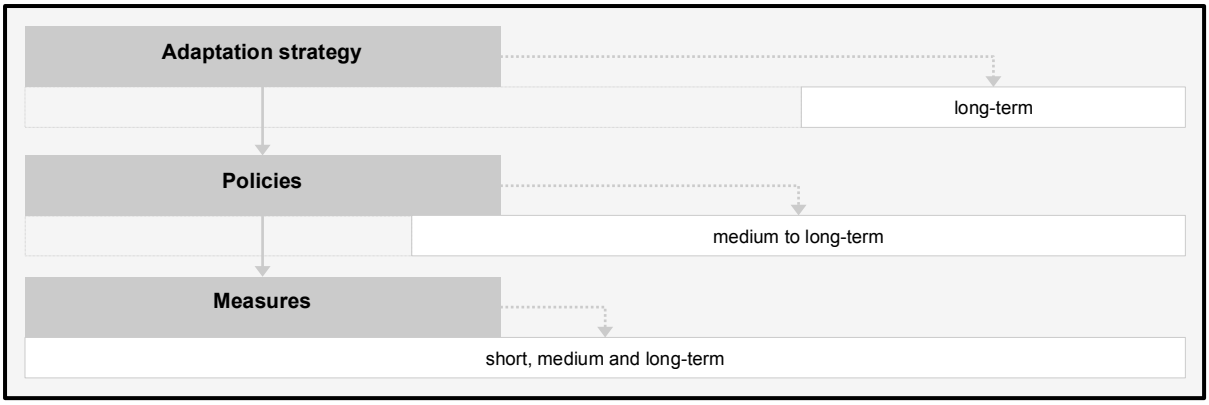


Fig. 8 - Definition of the timeline for an adaptation strategy, policies and measures.

An adaptation strategy is a comprehensive plan of action to be implemented through policies and measures in several timescales (short, medium and long-term). In relation to their goals, they can be directed to only one group or society or may be more comprehensive. But without effective support of a range of legal and financial instruments (Fig 9), the adaptation strategy may run the risk of not being executed. Thus, “a package of policies and measures should be designed to complement and reinforce each other” (Niang-Diop & Bosch, 2004).

Common types of policy instruments

• *Legislative, regulatory, and juridical instruments*.
Legal instruments set limits and provide sanctions, but can be difficult to enforce.
Examples are: laws, by-laws, regulations, standards, constitutional guarantees, and national agreements based on international conventions.

• *Financial and market instruments.*
Fiscal instruments can influence behaviour by sending price signals. They are a powerful set of instruments for raising revenue for environmental management, but tend to be difficult to implement politically.
Examples of market-based approaches are: property-rights based approaches (concessions, licenses, permits), price-based approaches (taxes, payments for amenities, user fees, tax credits for investment funds, performance bonds), perverse subsidy removal, and market-based measures (labelling, procurement policies, product certification, information disclosure requirements).

• *Education and informational instruments.*
Education instruments raise awareness, and over time, they change societal values.
Examples are: consumer information, public awareness campaigns, and professional development.

• *Institutional instruments.*
Private companies, corporations, and communities often adopt such policy instruments.
Examples are: environmental management systems, management policies and procedures for service contracts.

Fig. 9 - Common types of policy instruments (Niang-Diop & Bosch, 2004).

As mentioned earlier, it is important that new policies and adaptation measures are integrated in various sectors, and in the policies and measures that already exist. Specific measures that support the chosen policies according to the needs may also be developed. Also, as already mentioned, the adaptation options can be seen at various time horizons. The time factor can be decisive in how policies and measures are designed and then implemented in the adaptation strategy (Fig 10).

• **Long-term adaptations** that are responding to mean changes in climate (river basin planning, institutional changes for water allocation, education and research);
• **Tactical adaptations** concerned with mid-term considerations of climate variability (flood-proofing, water conservation measures);
• **Contingency adaptation** related to short-term extremes associated with climate variability (emergency drought management, flood forecasting);
• **Analytical adaptations** considering climate effects at all scales (data acquisition, water management modelling).

Fig. 10 – Types of adaptation by time horizons (Niang-Diop & Bosch, 2004).

"To ensure that the adaptations identified are suitable to the challenge, it is important to engage stakeholders that can provide perspective on the feasibility of proposed options" (Niang-Diop & Bosch, 2004). Figure 11 gives examples of adaptations.

Types of adaptation measures

Adaptation measures may be grouped according to whether they are **sectoral** (e.g., introduction of improved agricultural varieties), **multi-sectoral** (e.g., use of improved watershed and coastal zone management methods), or **cross-sectoral** (e.g., promotion of public awareness, climate research, and data collection).

• ***Sectoral measures*** relate to specific adaptations for sectors that could be affected by climate change. In agriculture, for example, reduced rainfall and higher evaporation may call for the extension of irrigation. For infrastructure, sea level rise may necessitate improved coastal protection or relocation of population and economic activities. In most cases, measures will mean a strengthening of existing policies, emphasizing the importance of basing climate change policies on existing coping mechanisms and the necessity of integrating them into national development plans.

• ***Multi-sectoral measures*** relate to the management of natural resources that span sectors – e.g., water management or river basin management. Integrated coastal zone management is also considered an appropriate framework to consider technical adaptation measures such as dike building, beach nourishment, etc. (Bernthal et al., 1990). The ecosystem approach to climate change adaptation involves the integrated management of land, water and other resources that promotes their conservation and sustainable use in an equitable way (Orlando and Klein, 2000).

• ***Cross-sectoral*** **measures** can span several sectors and include the following:
Education and training: Introduction of climate change issues at different levels of the educational system is an ongoing process that can help to build capacity among stakeholders to support adaptation in the future, and can help to develop appropriate research activities and a greater awareness among citizens.

Public awareness campaigns: Such campaigns can raise awareness and disseminate information in order to increase the concern and involvement of the broad array of stakeholders. These campaigns can also be an opportunity for adaptation decision makers to better understand the perception and views of the public on climate change and adaptation.

Strengthening/changes in the fiscal sector: Public policies may encourage and support adaptation of individuals and the private sector, particularly through the establishment of fiscal incentives or subsidies.

Risk/disaster management measures: These measures include the development of early warning systems, in particular for extreme events like cyclones (that can be predicted only a few hours before), and for droughts, floods, El Niño-Southern Oscillation (ENSO) (that can be predicted several months before). Emergency plans, extreme events relief and recovery measures also belong to this type of measure. Generally, the success of these measures depends upon good communication systems and a certain level of trust among users.

Science, research and development (R&D) and technological innovations: R&D and innovation are needed to enable responses to climate change in general, and to enable specific responses to climate change vulnerability, including economic valuation of adaptations, technological adaptations (development of drought- or salt-resistant crop varieties), and investigations of new sources of groundwater and better resource management. It may also be necessary to adapt existing technologies to fit with the adaptation demands – e.g., the development of more energy-efficient air conditioning systems, low-cost desalination plants, and new technologies to combat saltwater intrusion.

Monitoring, observation and communication systems: These systems may have to be created or strengthened, particularly for climate-related parameters, but also for other indicators of climate change and impacts (e.g., sea-level rise, changes in species composition of ecosystems, modification of piezometric levels, etc.). This monitoring will allow policy-makers to adjust the adaptation strategy based on confirmed changes in the climate.

Fig. 11 - Types of adaptation measures (Niang-Diop & Bosch, 2004)

In short, an adaptation strategy is a plan that includes the implementation of a set of appropriate policies and measures to a particular territory, and respective population in the most opportune time horizon. An implementation plan which policies and measures are characterized as follows (Fig 12) can also be developed.

1) How they are to be incorporated into existing sectoral strategies, national development plans, etc. (e.g., management plans, education and research programmes, laws to be developed or enforced).

2) Additional plans, policies, measures and/or projects that specifically address climate change that may be needed if gaps have been identified in the current policy framework. Some measures will likely require financing, either government or external, while others could be taken aboard within the regular national budget.

3) A further distinction could be made between urgent policies, measures and projects, and those that are somewhat less urgent. Some of the measures may be implemented right away, while others may require detailed feasibility studies

Fig. 12 - Example of a plan for implementing policies and adaptation measures (Niang-Diop & Bosch, 2004).

Throughout the process of formulation and adoption of policies and measures, it is important to include stakeholders at all levels (from national to local) in order to gain public acceptance of the strategy. “However, formulating a plan that is only motivated by climate change may be unrealistic, not only because adaptation involves different sectors, regions and populations that are vulnerable to climate change, but because climate change is often far from being the first concern of most of decision-makers” (Niang-Diop & Bosch, 2004).

3. GREENING THE CITY, TO FIGHT URBAN HEAT

A changing climate and an increase concentration of populations in urban centers will affect and bring many negative consequences to society, but it will also offer significant potential for innovative solutions. The aim of this working package is to transfer the knowledge about the impact of climate trends and weather extremes on outdoor thermal comfort in European cities to key stakeholders and to develop innovative policies. In this way we ensure that the need to mitigate through adaptation strategies, policies, measures and actions the negative impacts of a changing climate is understood and addressed to the heart of city planning and management. One of the innovative policies that we propose in this document is the greening of cities. The goal is to cool the urban environment, and thus provide a better outdoor thermal comfort and improve well-being and health of its inhabitants.

Today there is a severe disconnect between the weather and the conditions that shape the environment in which we live. For most individuals living in cities, it is very easy to take shelter in the heat (winter) or cool (in summer) from their homes, places of work and leisure, and probably the only contact they have with climatic elements happens when entering or leaving the car. And it must be so? Modern man has to live locked in a flat world? Of course not! There are certainly many reasons to encourage outdoor living, but ultimately it is about quality of life and well-being that we speak. It's all a matter of choices, individual priorities.

Beatley (2011), states that “Evidence suggests that the presence of green space (green neighborhoods) has broader and more widespread impacts on health than we sometimes imagine”. He mentions several studies that conclude that the presence of vegetation improves the physical and mental health conditions, and studies which confirm that proximity to parks and green spaces is associated with the decrease of stress and probably with the reduction of obesity.

The inclusion of vegetation in the urban context, as trees, green roofs and green facades serve also to address the phenomenon of urban heat island and to moderate and reduce urban heat, this has the effect to significantly reduce the stress and the aggravation of diseases related to heat in cities, something that should be the target of most concern in all cities where there is a significant increase in summer temperatures. There are, furthermore, benefits to air quality in cities for example, the urban vegetation, reduces significantly pollutants and particles and they are an important source for renovate oxygen.

The urban planning to include vegetation should be done, as suggests Beatley (2011), in four main scales: the region, the city, the neighborhood and the building. The author stresses that the type and the extent of natural resources are dependent on the scale (Fig 13).

SCALE	BIOPHILIC DESIGN ELEMENTS
Building	Green rooftops Sky gardens and green atria Rooftop garden Green walls Daylit interior spaces
Block	Green courtyards Clustered housing around green areas Native species yards and spaces
Street	Green streets Sidewalk gardens Urban trees Low-impact development Vegetated swales and skinny streets Edible landscaping High degree of permeability
Neighborhood	Stream daylightning, stream restoration Urban forests Ecology parks Community gardens Neighborhood parks and pocket parks Greening grayfields and brownfields
Community	Urban creeks and riparian areas Urban ecological networks Green schools City tree canopy Community forest and community orchards Greening utility corridors
Region	River systems and floodplains Riparian systems Regional greenspace systems Greening major transport corridors

Fig. 13 - Biophilic Urban Design Elements across Scales (Beatley, 2011).

3.1 Policy Making Strategy

Figure 14 presents the conceptual framework for the definition of policies and measures for urban design that meets the objective of reducing the negative impacts of global warming through the creation and rehabilitation of green structures in the cities, providing, hopefully, a better adaptation to climate of its inhabitants.

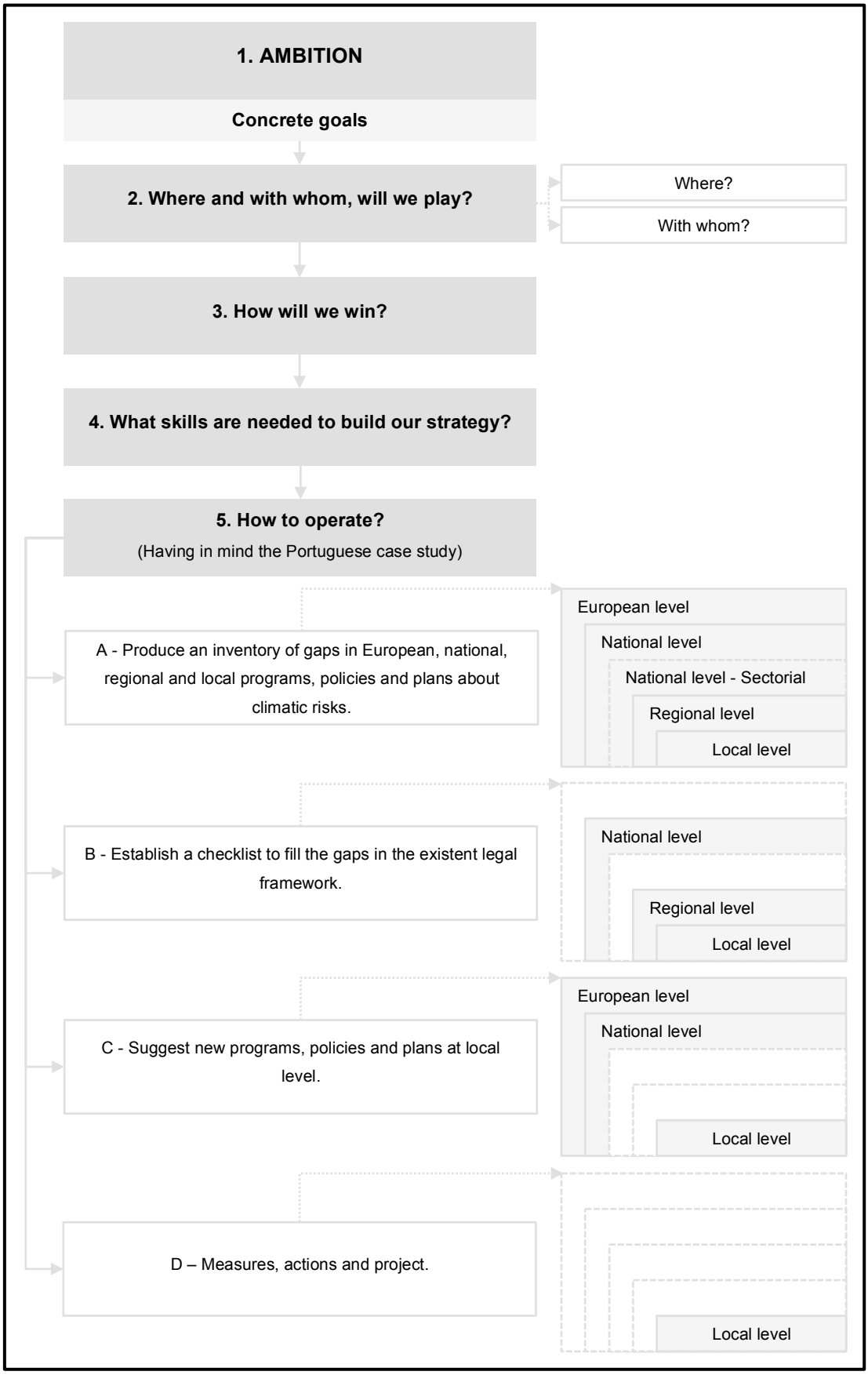


Fig. 14 - Conceptual framework for the definition of policies and measures.

1. Ambition

Our proposal for an adaptation strategy to climate change in the figure of the negative effects of extreme heat on people has as ambition "Improve human wellbeing in urban areas under a warming scenario". This desideratum is based on the following specific objectives:

i. Create a new paradigm of human well-being that includes all ecosystem components (air, water, soil, flora, fauna and human beings).

ii. Force a downscaling approach to promote sustainability.

iii. Demonstrate urban lifestyle-climate and health relationships at local level.

iv. Illustrate efficient measures to mitigate the adverse heat effects on human beings at the neighborhood scale level.

v. Implement policies and adaptation strategies to improve outdoor thermal comfort.

2. Where and with whom, will we play?

The second issue of our proposal relates to: i) where and ii) with whom we will work. That is, we define the scale and the time horizons for the adoption of new policies and measures for adaptation/mitigation of the adverse effects of climate and what are the stakeholders that we will address.

i) Where?

- At an early stage: at the chosen locations at local scale in the neighborhoods of the city of Porto (Manuel Laranjeira, Fernão Magalhães, Vitória, Bairro da Bouça and Serralves Gardens) and in the chosen neighborhoods of the cities of Frankfurt and Gothenburg);

- At a later stage: in all European cities with problems with extreme heat events.

ii) With whom?

- Political sector (Decision makers at European, National, Regional and Local level);

- Municipalities and Parish (Department of Planning);

- Health sector (Health Authorities);

- National weather services;

- Energy sector;

- Corporate sector;

- Construction sector;

- Education sector;

- Media sector;

- Environmental NGOs;

- Neighborhood associations;

- Locals;

3. How will we win?

In section three we present a list of measures which will improve the urban environment and thus the welfare conditions of city dwellers.

i) Assure better urban ecosystem balance.

ii) Prevent anthropic impacts in regional and global climate.

iii) Prevent and mitigate negative impacts of local climate.

iv) Improve citizens' quality of life, well being and health.

v) Increase carbon and other air pollutants sinks efficiency (cool roofs, cool pavements, vegetation, etc.).

vi) Create healthy cities.

vii) Increase buildings' energy efficiency.

viii) Reduce GHG emissions (KYOTO Protocol).

4. What skills are needed to build our strategy?

In this section we present a set of nine goals based on proper tools and arguments to introduce policies and measures for mitigation / adaptation to the adverse effects of episodes of extreme heat.

i) Improvement of applied bioclimatology research to urban areas (evidences of relationship climate-health-urban form and function).

ii) Create a widespread use of integrated GIS data of people and place features at local level.

iii) Produce detailed urban climate risk zones maps.

iv) Produce detailed deprivation areas maps (vulnerable to extreme heat events).

v) Attract innovative society players (actors, politicians and stakeholders).

vi) Find and gather useful financial resources

vii) Encourage close partnership between universities, corporate sector and society.

viii) Convince prepared and sensible media to communicate climate risks at a local scale.

ix) Motivate an open minded society attitude, sensible to have a systemic approach of climate-health relationship.

5. How to operate?

Keeping in mind the Portuguese case study, we divided the last point into four sections (Fig 15):

A - Produce an inventory of gaps in European, national, regional and local programs, policies and plans about climatic risks.

B - Establish a checklist to fill the gaps in the existent legal framework.

C - Suggest new programs, policies and plans at local level.

D – Measures, actions and project.

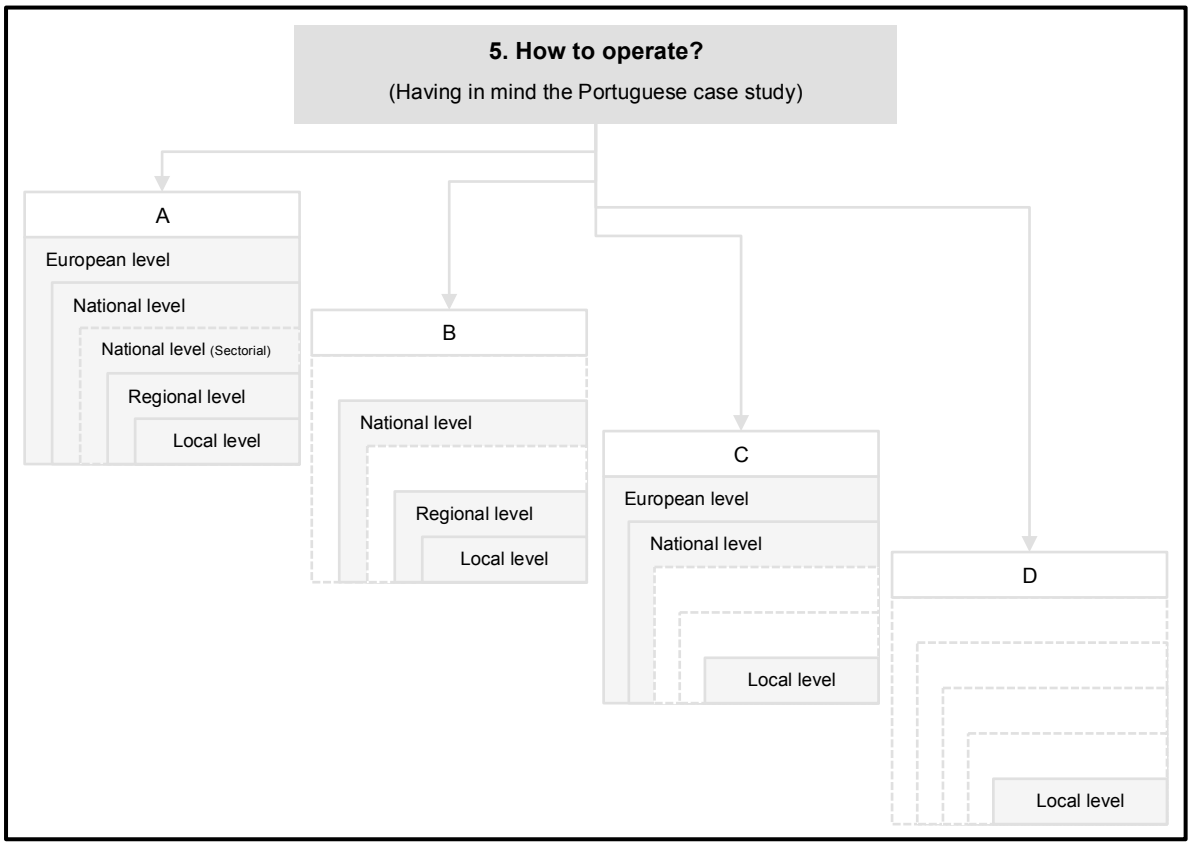


Fig. 15 - Scheme of Section 5: How to operate? (from European to Local level).

A - Produce an inventory of gaps in European, national, regional and local programs, policies and plans about climatic risks.

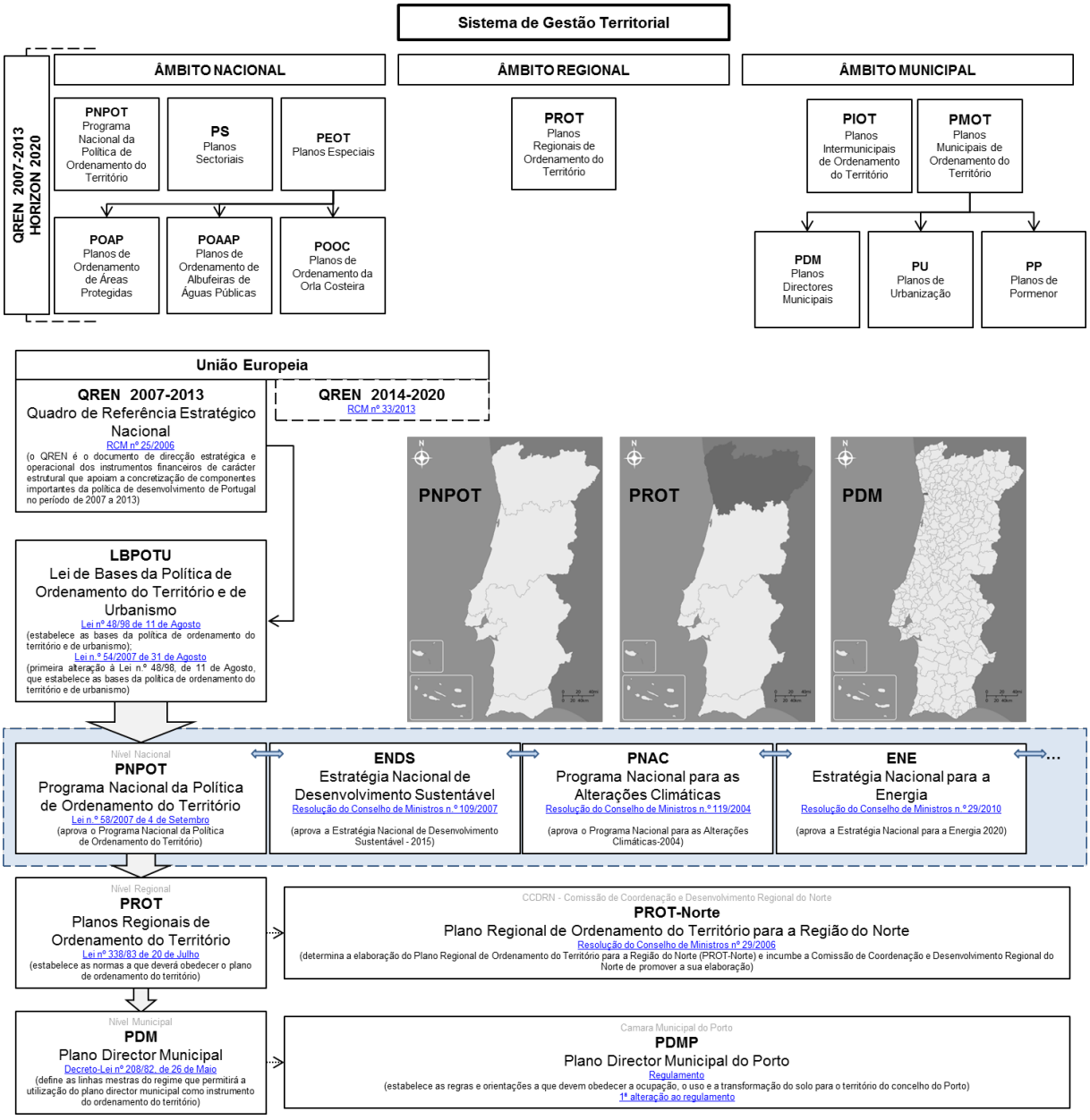


Fig. 16 - Portuguese Territorial Management System

European level

- Inventory of gaps in European level – QREN 2007-2013 and QEC 2014-2020. (ver)

- Ver sites:

Climate action http://ec.europa.eu/clima/index_en.htm

European Climate Adaptation Platform (Climate-ADAPT) http://climate-adapt.eea.europa.eu/web/guest/home

IPCC – V Ralatório Climate Change 2013: The Physical Science Basis http://www.ipcc.ch/

National level

- Portugal 2020.

- Inventory of gaps in PNPOT (Plano Nacional das Políticas de Ordenamento do Território).

National level - sectorial

- Inventory of gaps in ENDS (Estratégia Nacional de Desenvolvimento Sustentável).

- Inventory of gaps in PNAC (Plano Nacional para as Alterações Climáticas).

- Inventory of gaps in PNAAS (Plano Nacional de Acção Ambiente e Saúde).

- Inventory of gaps in ENE (Estratégia Nacional para a Energia).

- Inventory of gaps in ENCNB (Estratégia Nacional de Conservação da Natureza e da Biodiversidade).

- Inventory of gaps in PANCD (Programa de Acção Nacional de Combate à Desertificação).

Regional level

- Norte 2020

- Inventory of gaps in PROT (Plano Regional de Ordenamento do Território).

- Inventory of gaps in PCRTEA (Plano de Contingência Regional Temperaturas Extremas Adversas Norte).

Local level

- Inventory of gaps in PDM (Plano Director Municipal).

- Inventory of gaps in PMEC (Plano Municipal de Emergência de Protecção Civil).

- Inventory of gaps in ESCP (Estratégia para a Sustentabilidade da Cidade do Porto).

B - Establish a checklist to fill the gaps in the existent legal framework.

National level

At PNPOT, PNAC concern with climate is related to Climate Change and the only mitigation measure is GHG reduction.

At PNAAS concern with climate is related to: air quality and atmospheric pollutants; human health and comfort inside buildings; positive impacts of green areas to healthy life styles; extreme climate events and health.

At ENDS and ENCNB concern with risks are restricted to flooding, forest fire, coastal erosion and slope movements.

At ENE concern with climate is related to indoor comfort and artificial refrigeration or heating procedures.

At PANCD concern with climate is related to hydrological cycle and soil conservation.

Regional level

At PROT concern with climate is related to renewable energy, energy efficiency, flooding, forest fire, coastal erosion and slope movements.

At PCRTEA concern with extreme heat events is related to health negative outcomes, it consider a general warning procedure system whenever meteorological office deliver a warning of heat wave (recommendations like: drink water, protect yourself staying home, avoid sun exposure, use sunscreen protection, if you are old, disable or child find someone to be with you, if you are homeless, or you have diseases like mental health, diabetes, hypertension, obesity, etc. search health care help, etc.

Local level

At PDM concern with climate risk doesn't exists. There is no mention of climate adverse effects in the obligatory Constraint Map

At PMEC concern with climate risk is related to floodings, forest fires, urban and industry fires. The vulnerabilities considered to Porto are: forest, population density, 22 enterprises under SEVESO Directive, port and airport.

At ESCP concern with climate is related to urban rehabilitation but climate is mentioned as an advantage because it is "moderate without thermal amplitude and good solar exposure which facilitate comfort indoor without high energy consumptions" and to GHG reduction and to promotion of solar energy implementation.

4. FINAL REMARKS

4.1. *New Programs, Policies and Plans to mitigate* adverse extreme heat events at urban level

Having in mind all the outputs of the research already done it sounds reasonable propose some innovative actions, measures and projects at European, national and local level.

4.1.1. European Level

Lobbying to create a Directive with a set of tools focused on adverse impacts of heat in urban health citizens.

Strengthen the importance of urban climate research in the Framework Programme for Research and Innovation – HORIZON 2020 (FP2020).

Motivate *FP2020 extreme weather risk mitigation challenge* to tackle health negative outcomes of heat, in in aged society urban areas.

Suggest the importance of extreme weather events in FP2020 – EIPAHA (European Innovation Partnership on Active and Healthy Ageing).

4.1.2. National Level

Creation of a National Program for Adverse Weather Events in Urban Areas (NPAWEUA).

Promotion of new legal incentives like, tax credits, floor-area-ratio tax bonuses, grants, expedite permissions, to all climate sensitive initiatives (rebuilding, cool roofs, gardens, greening facades, insulation, draught proofing, etc.).

Force the introduction of negative health outcomes during extreme weather events in: PNPOT, PNAAS, PNAC, ENE, ENDS, ENCNB and PANCD.

4.1.3. Local Level

Creation of mandatory requirements, in Porto Land Use Plan (PDM), to assure climate comfort (outdoor/indoor).

Definition, in the Porto's PDM Constraints Map, of thermal outdoor and indoor risks.

Inclusion of climate concern in Porto's Sustainable Strategic Plan (rectify and review huge mistakes in the document about Porto's climate).

Setting up a task force devoted to prevent and mitigate negative health outcomes due to extreme weather events (multidisciplinary team including a town hall representative, climatologists, geographers, architects, primary public health authorities, civil protection, social services, media, etc.).

Establish a forum to share different experiences and perspectives of climate friendly cities.

Creation of an interactive and user friendly website to help citizens decisions having in mind indoor and outdoor climate comfort.

Production of extreme weather events risks identification and assessment map, in a GIS integrated basis.

Production of a Porto's health deprivation map under a warming scenario, in a GIS integrated basis.

Creation of legal incentives to all regeneration and rebuilding actions when climate sensitive measures are adopted (fee rebates, grants programs, tax bonuses, expedite permissions, etc.).

4.1.4. Measures, actions and projects.

Measures

Increase green areas (trees, green facades, green and blue roofs).

Increase cool and permeable pavements.

Facilitate the presence of water surfaces.

Reclaim all piped rivers into free flowing rivers.

Encourage ventilation increase and promote more adequate building geometries.

Raise the use building materials with conductivities and albedo adequate to Porto's microclimates.

Create local extreme weather early warning system (primary care health services and emergency services linked with climatologists and civil protection authorities).

Create pilot areas to develop innovative projects prepared to be extreme weather events adapted areas.

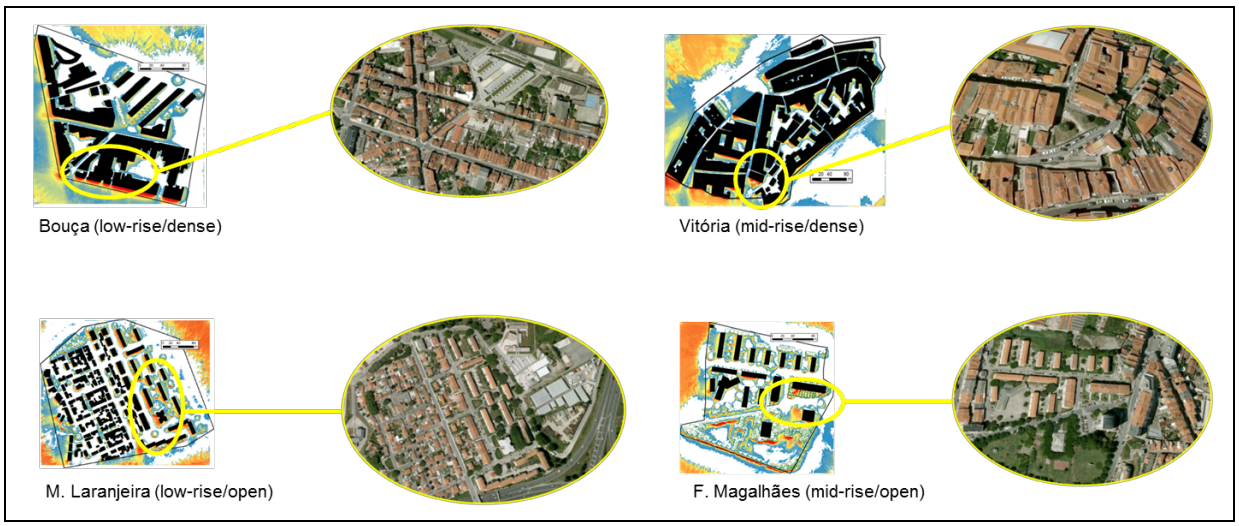
Identify and geocode vulnerable population (elderly, children, homeless, disable, sick people, etc.).

Develop campaigns and actions for education and sensitisation to extreme weather negative impacts on health targeted to different publics (elderly, children, homeless, disable, sick people, etc.).

Actions

Create a Porto's building codes zoning according to outdoor climate comfort risk (high, moderate and low).

Use the five pilot projects areas to set up innovative projects (Bouça, Vitória, F. Magalhaes, M. Laranjeira e Serralves).



Projects

Classify each pilot project area according to: green areas, open spaces, solar radiation income, roughness e porosity, evaporative cooling index, ventilation, sky view factor, building materials, buildings density and geometry, inhabitants health deprivation index.

Bouça and Manuel Laranjeira – High outdoor climate comfort risk	
Diagnosis:	- Tmrt show several day hotspots. Bouça mainly W exposure; Manuel Laranjeira mainly N exposure. - Medium and low families' income. Some housing estates. Medium/low literacy.
Actions:	- Promote the use of reflective paving materials with high emissivity. - Implement green and blue roofs and facades. - Promote shadow during warm season. - Facilitate ventilation. - Install free drinking fountains.

Vitória – Medium/high outdoor climate comfort risk	
Diagnosis:	- Tmrt show some day hotspots. Vitória mainly S and E exposure. - UNESCO heritage area. - Low income families. High density of elderly people. Low literacy. - Medieval urban plan (good in warm season but bad in cold season).
Actions:	- Green and blue roofs. - Evergreen shrubs and deciduous trees species in open spaces. - Improve pedestrian areas and constraint traffic. - Improve environmental friendly public transport. - Install free drinking fountains.
Fernão Magalhães – Low/medium outdoor climate comfort risk	
Diagnosis:	- Tmrt show few day hotspots. Fernão mainly W exposure. - Medium high income families. Adult and elder people. High/medium literacy.
Actions:	- Maintain all green areas. **- Install free drinking fountains.**

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