ID 1566 | THE URBAN RISK ASSESSMENT: A METHODOLOGICAL PROPOSAL

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1 CITY PLANNING AND CLIMATE CHANGE

The risks for cities and natural environment coming from the climate change seems to give back substance to the considerations on urban sustainability, a word rich in promises, but poor in applicative content.

The Global Risks Report 2016 considers all the possible potential impacts on global scale, measured in a Cartesian system. In the diagram, the x-axis defines the probability of occurrence, and the yaxis shows the impact degree on economies, population and environment. The highest position, caused by a high probability and a devastating impact on world scale represents a failure of adaptation and mitigation policies. Then the migration caused by wars and environment disasters follows, and the third position is assigned to water scarcity (both attributable to the climate change consequences).

Today the challenge of climate change represents one of the most complex scientific and political questions of the 21th century. International institutions like IPCC, OCSE, FAO, UNDP, just to mention a few, identify climate externalities like extreme rainfalls, heat and drought waves as scenarios of high environmental impact for the next 100 years. The worst-case scenarios in economic and human life terms will occur above all in the cities (Betsill, Bulkeley, 2005; Biesbroek, Swart, van der Knaap, 2009; Van der Veen, Spaans, Putters, Janssen-Jansen 2010).

The climate change topic enters local political agendas, pushed by the urgency perceived on an international level, though finding difficulties in application.

The climate proof approaches seem to require a substantial modification in the urban planning, both by reducing the climate-change emissions (mitigation), and by making the urban systems more resilient to possible climate changes (adaptation) (Musco, 2015).

These two paradigms, mitigation and alteration, even if both oriented to climate aspects, differ in action scale and application models: the international level deals with mitigation policies (expressed in targets), whereas the local level becomes the place where adaptation challenges will take place, there where the action is oriented to reduce local vulnerabilities (physical, social and economic) in relation to the possible impacts of the climate change (fig. 1).

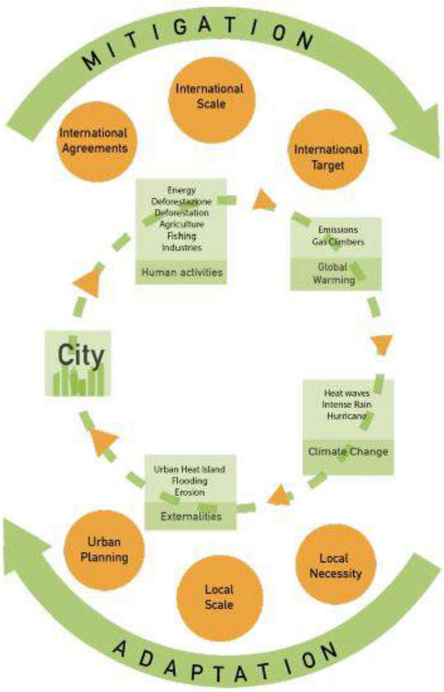

Figure 1 - Diagram of mitigation and adaptation approaches from environmental perspective (personal processing).

Adapting a territory entails mainly the modification of the consolidated fabric, vulnerable to climate impacts. In these terms, to plan a territory transformation, increasing its resilience to climate change, means to generate new rationalities in the territory planning to identify the possible impacts, measure their risk, and evaluate between the various adaptation options.

The analysis scenarios supporting an evaluation of the urban risk of climate change, require not ordinary urban knowledge frameworks (recalling the ordinary knowledge frameworks produced within the present mandatory planning practice). But details and informative types of local institutions prove to be not adequate to vulnerability and risk evaluations.

The implementation of territorial knowledge frameworks and information in general, finds in the new technologies an useful and efficient tool to produce, manage and make use of spatial information. The new technologies (ICT in particular), are more and more active in managing the spatial information. This work originates from this considerations, and investigates the possible modalities to structure an adaptation process on local scale (from analysis to identification of adaptation options), wondering about the role of technological and spatial information setup according to the territorial government activities.

2 ADAPTATION AND NEW TECHNOLOGIES OF INFORMATION

In defined urban contexts, risk perception and management can change in a substantial way. Local administrations try to contribute to mitigation strategies (through the voluntary instrument PAES, Sustainable Energy Action Plan), but above all, in the future, they should try to adapt by integrating multi-scalar policies of risk management into territorial planning and management processes. The new knowledge fostered by the NT allows the arrangement of effective knowledge frameworks as a support in the analysis and assembly phases, and it favours the understanding and the production of risk scenarios of short, medium and long term. The new technologies, if systematically applied in the planning process, can support the different phases, and allow the Plan to be less linear, granting more cyclicality in the work. The cyclicality in planning operations, made possible by the technological implication in the process, releases the planning from the rigidity of the horizontal process (Cecchini A., 1999), and allows continuous reviews and monitoring phases.

The local planning commitment to foreseen adaptation measures today, based on uncertain future scenarios, has to be supported by: a well defined work process, an integrated territorial information system and city planning instruments that take into consideration the possibility of continuous inspections. In this way, even if it means working with uncertainty, the goal of an effective planning is achieved. Therefore the interventions of adaptation will have to be considered through a comparison between the different urban situations, where the risk (or the vulnerability) doesn't refer to the city in general, but to specific urban areas of the city. In this way the risk mapping assumes different values on the territory, by indicating which areas are more vulnerable. They allow to better understand which possible measures can increase the resiliency of the area in relation to the considered expected impact.

The impacts attributable to the climate change considered in this work, which the proposed analysis process is organized on, are: heat waves and urban flooding.

Both the impacts are two of the most common in urban settings, because they both derive from dense urbanization and scarce permeability. These two features make many cities vulnerable, and endanger population, economic activities and infrastructures.

The work goal is therefore to identify an approach able to evaluate the impacts effects in the different urban transepts of the city, with the aim of supporting the planning phases with new investigation instruments, that can return the city as classified for risk and vulnerability. The classifications, besides suggesting the priority areas, are a guide in choosing the possible solution for that kind of city.

3 CONTROL CLIMATE CHANGE IMPACT THROUGH CITY PLANNING

The 5th IPCC report (Ar5, 2014), figure 2, defines a new approach to vulnerability evaluation in which it deeply modifies the terminology used in AR4 of 2007, and moves the analysis process close to the one produced by UNISDR for the disaster risk reduction (DRR).

The UNISDR DRR approach is defined as application of policies, strategies and practices to reduce a disaster vulnerability and risk, in the larger context of the sustainable development (UNISDR, 2004). The DRR is rooted in the school of thought founded in 1970 (Torry, 1978, 1979, Hewitt 1983, 2007; Lewis, 1999 et al), that considered the social, economic and environmental aspects as elements strongly exposed to risks. This was in stark contrast with the previous disaster recovery approach that looked at the natural events as inevitable, and the attention was addressed more to post-disaster aspects (Mercer, 2010). We can say that the UNISDR approach in disaster risk reduction anticipated, and perhaps laid the bases to build the paradigm of climate changes adaptation. The DRR recognizes the importance of understanding the different environmental stresses referred to a risk in general, by introducing the evaluation of danger, vulnerability, and adaptation capacity, to identify the best solution to reduce the risk in the most sensitive areas (Wisner et al., 2004). A DRR successful application aims to create a resilient community without limiting its development, or reducing its services (UNISDR, 2004).

The new approach therefore has the merit of further improving the impact evaluation, that beyond vulnerability, also evaluates the environmental risk. The terminological modification entails the necessary reference to one method or the other (2007 or 2004), when factors such as the exposure, for example, are considered.

While in AR4 the term exposure is referred to climate factors, in AR5 the concept of exposure leads back to the possible functions of a specific environment, which can be compromised on the bases of a potential impact.

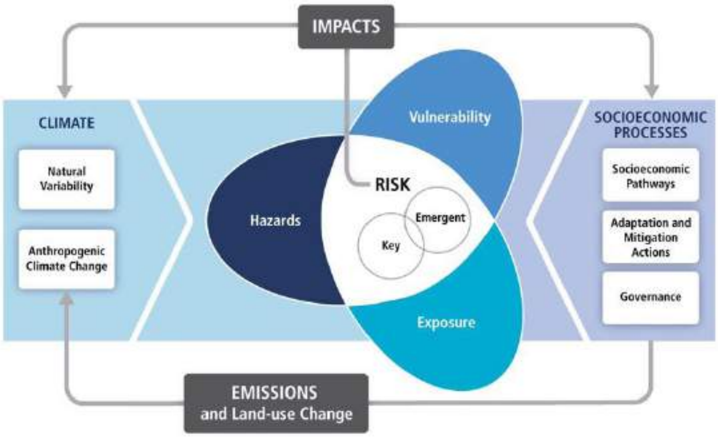

Figure 2 - Diagram of the aspects considered in the risk evaluation approach proposed in AR5 by IPCC. The new methodology, compared to the previous one of 2007, considers the risk towards a potential impact related to climate change. (source AR5-WG2 IPCC, Chapter 19).

The study defines the hazard (that in 2007 was expressed within the concept of exposure) as the potential possibility of an extreme climatic event to happen, that's able to provoke damages as loss of lives, or damages to infrastructures, services and ecosystems.

In this approach the vulnerability is a variable to calculate the risk (and not anymore a process output), and it is defined as the inclination of a system to be negatively influenced by the hazard. It includes also the concepts of sensitivity and adaptation capacity described in the previous methodology. The exposure, as third variable to determine the risk, is intended as the presence or not of infrastructures, services, species and ecosystems, cultural properties in the considered area, that could be negatively influenced by potential impacts.

Referring to the aims of the hereby described study, that is the building of a process able to evaluate the vulnerability from the effects of environmental climate change on quarter scale, the developed methodology finds its roots in the process that is common to all the three evaluation systems described (figure 3). The considered terminology is referred to the IPCC AR5 approach.

The work goal is to return a numerical evaluation of a local scale vulnerability (to arrive to a risk evaluation) for every possible local impact. To reach this goal it's necessary to quantify the sensitivity in every local portion in relation to the supposed impact, and to evaluate the adaptation possibilities. This logical path is the result of considerations emerged after the analysis of all the approaches, characterised by different terminologies.

One of the primary limits of vulnerability (and risk) evaluations, realized to address the urban adaptations processes, is the analysis scale. The adaptation is a set of measures (in structure and governance) linked to a specific local portion, defined in relation to its vulnerability level and risk. To accomplish a vulnerability analysis on urban scale, on the whole town portion, can be useful to know the vulnerability level of a town compared to another. But it suggests very little about where and how territorial government activities could take action. Consequently, it is convenient to clarify that to accomplish a vulnerability (or risk) analysis on local scale, entails having very detailed and homogeneous information about the whole territory. Substantially the fundamental limit, in implementing the analysis processes of urban territory (to adapt them to CC) is the lack of spatial information. This reflection went along with the research in the different applicative experiences. The vulnerability evaluation of the city of Padua, the vulnerability evaluation of some towns of the Metropolitan City of Venice, and the risk analysis of New York City, represented good chances to test the methodology, and to reflect on the employment of new technologies of information as instrument to implement the urban knowledge frameworks.

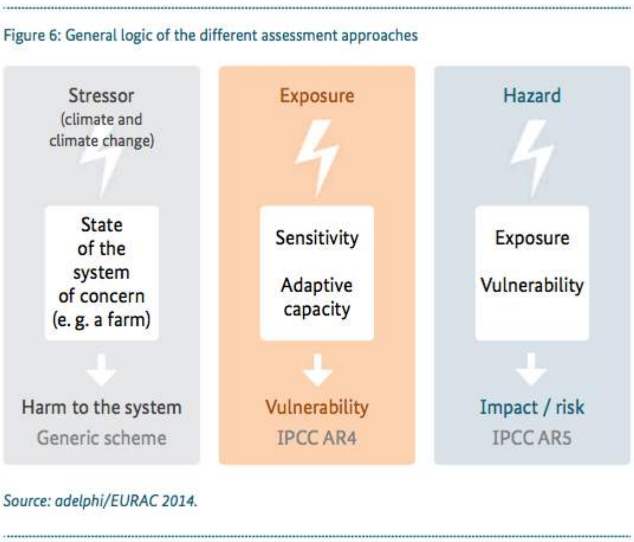

Figure 3 - Diagram of the different approaches in risk and vulnerability evaluation.
(Fonte Fritzsche K, et al, (GIZ), 2014; rework of Adelphi/ EURAC 2014.)

In all the three areas of work, the first difficulty was related to the lack of territorial information to evaluate the territory uniformly on local scale.

The process here expressed and described, inherited by direct experiences of European Planning, represents a path to adaptation integrated in the local territory government activities.

The fundamental reflection considers that a process of urban adaptation shouldn't weigh on the already numerous tasks of local administrations, but it has to find the way to integrate in the already existing processes, and to be implemented through the compulsory instruments of operational city planning. The significant goal of a local adaptation process is to reduce the vulnerability (related to the risk) of a territorial area in relation to an expected impact, increasing in fact its resiliency. The term resiliency is often linked to the concept of climate change, referring to the capacity of a territory to endure damages caused by an expected event. We can say that the vulnerability is the territorial resiliency unit of measure. The relationship between vulnerability and resiliency is not defined, many researchers underline the complementary nature of the terms (Turner 2010, Gallopin 2006), and often they link the resiliency concept to the learning ability of a society, and its capacity of responding to negative events. In wider terms, the undeniable relations between the two concepts are in the measurement of climate change effect: by reducing the vulnerability, and increasing the adaptation abilities, the resilience increases.

Following these consideration, the adaptation process for local governances is articulated in 6 steps (figure 4).

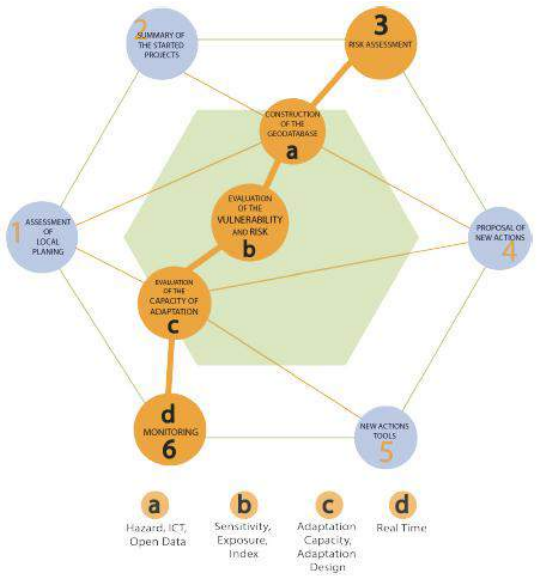

Figure 4 - Simplified diagram of the methodology developed during the work.
Every circle includes different processes designed to support the approach exportability to different cities.

4 VULNERABILITY ASSESSMENT

The backbone that supports the different phases of the assumed adaptation process (a,b,c,d), by producing vulnerability and risk analysis, and fostering the monitoring, is developed with the goal to guarantee the methodology exportation and replicability. The steps sequence, referred to the evaluation of risk and adaptation capacity, was arranged with the goal of guiding the cities towards the elaboration of an adaptation process, by considering the ICT instruments as allied in production, management, sharing of spatial information and territorial knowledge.

The sequence (orange backbone) translates logics and paradigms defined by IPCC in the 5th report (WPII, 2014) and by the UNISDR DDR (Disaster Risk Reduction). As announced, the work goal is to return a quantitative evaluation of urban vulnerability and risk in relation to a potential climate impact. The expected output is a classification of the territory, on local scale, in which every urban portion returns it's own inclination to support the impact. To do it, it's necessary to quantify the sensitivity of the local portion in relation to the alleged impact, and finally evaluate the adaptation possibilities (to implement then through planning process) about exposure parameters. To encourage the work replicability, the study produced some tools, built on computer code SQL, to make more ease (and standard) the calculation of indexes of vulnerability and adaptation capacity evaluation on the possible urban impacts caused by heat waves (Urban Heat Island) and urban runoff. The goal is to maximize the support to integrated decision processes, to facilitate the structuring of multifunctional adaptation measures able to reduce the impact of a possible danger, and together improving the quality of the affected area.

The methodology elaboration is represented by flow charts to facilitate its application in other urban contexts (figure 6).

The process starts with the identification of possible impacts deriving from climate change. The probability of every impact in relation to the referred geographic context, will form the list of impacts to analyse. The inherent specificities of every impact will guide then the structuring of the new geo- database (e.g. urban runoff impact requires different information levels than erosion or desertification impacts). The composed knowledge framework has to be put in relation also to vulnerability indexes (respect to the considered impact). Vulnerability indexes have the function of translating the result of the possible impact on the urban area (in this case the hexagon with side of 60, 80 and 250 meters/side).

At present, the spatial complexity reached by the cities, together with an increasing necessity of analysing and understanding the territory in a even more local scale (that means to aggregate information on population, economy, commercial productions, environmental system etc.), lead to the rediscovery of the hexagonal grid like software GIS spatial analysis model. In the hexagonal grid the angles are reduced to 60°, by drawing the hexagonal shape near a more representative one in the space, that is the circle (picture 5).

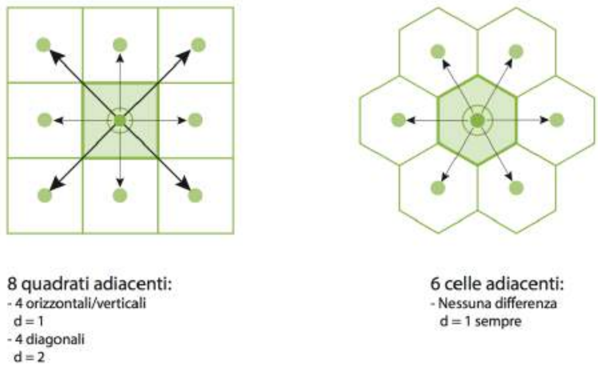

Figure 5 - Representation of the distances between focal points of a square and a hexagonal pattern. (Personal processing). Representation of the distances between focal points of a square and a hexagonal pattern. (Personal processing).

At present, the spatial complexity reached by the cities, together with an increasing necessity of analysing and understanding the territory in a even more local scale (that means to aggregate information on population, economy, commercial productions, environmental system etc.), lead to the rediscovery of the hexagonal grid like software GIS spatial analysis model. In the hexagonal grid the angles are reduced to 60°, by drawing the hexagonal shape near a more representative one in the space, that is the circle (picture 5). The added value in employing the spatial hexagonal pattern model in territorial analysis, is the possibility of producing complex calculations in a very fast and automatic way, by using standardised units to develop the mathematical comparison of identical areas. These cells can be compared to the nearby cells or distant ones, so they provide very precise results and maximize the reading of the spatial reports. The hexagonal decomposition of the space, moreover, facilitate the maps communicability.

The database therefore will include only one table (entity), composed by hexagonal grids, in which every feature will include the value (summed up or medium, according to the information type) of information, created by remote sensing (e.g. vegetation, impervious surface etc.), and then intersected with every hexagon area. In this way all the information are included in one table, facilitating its management. But, even more important, the model allows to examine all the aggregated information we have, related to the portion of territory surface contained in every hexagon.

Once organised the database, by aggregating the information into the entity made of hexagonal geometries, we proceed with expressing the chosen index in relation to the considered impact. The operations have been built through SQL programming that formulates mathematical calculations between the fields of the hexagonal table, in which every line represents a georeferenced hexagonal geometry.

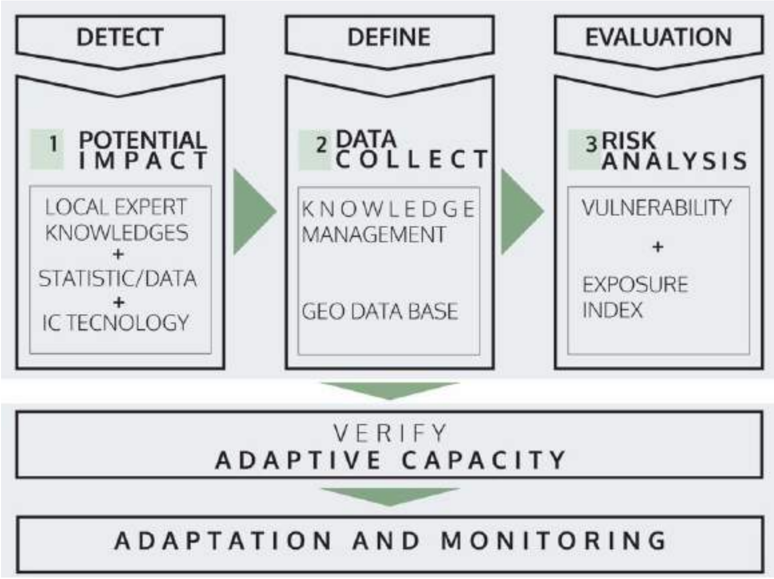

Figure 6 - Simplified diagram of the methodology developed during the Doctorate research. Every point includes different processes aimed to facilitate the approach exportation in different cities (Personal processing).

The operations have been built through SQL programming that formulates mathematical calculations between the fields of the hexagonal table, in which every line represents a georeferenced hexagonal geometry.

The indexes employed for the evaluation of areas subject to accumulate heat (sensitivity), have been identified on the bases of the indexes suggested by A. Mahdavi (2012), (Figure 7).

GEOMETRIC PROPERTIES	SYMBOL	RANGE	DEFINITION
Sky View Factor	ψ_{sky}	0-1	Mean value of the fraction of sky hemisphere visible from ground level
Built area fraction	A_b/A_{tot} A_b : building plan area [m^2] A_{tot} : total ground area [m^2]	0-1	Ratio of building plan area to total ground area; fraction of ground surface with building cover
Impervious surface fraction	A_i	0-1	Ratio of unbuilt impervious plan area (paved, sealed) to total ground area
Built surface fraction 2.0	A_W/At A_W : total wall area [m^2]	>1	Total wall (vertical horizontal)
	As/At $As = (A_R + AW)$ A_R : total roof area [m^2] +	~1	Roofs
Street Incoming Solar Radiation	Kwh/m^2	>1	Potential solar incoming for street surface
Roofs Incoming Solar Radiation	Kwh/m^2		Potential solar incoming for roof surface

Figure 7 - The table summarises the set of indexes employed in the sensitivity analysis of the three pilot areas. For every area have been employed some indexes, according to the available information. A. Mahdavi (2012)

To evaluate the sensitivity, related to the increasing rainfall and possible urban runoff, the methodology considers the employment of the model Soil Conservation Service (USDA, 1972), (figure 8). The model, based on the mm/rain per exact instant, quantifies the interception and the infiltration from the ecosystem services, and distinguishes the efficient rain or the direct runoff.

The database structure contains information, expressed in square meters, referred to the surface atlas, and the formula calculation for every hexagon.

$$P_e = \frac{(P-I_a)^2}{P-I_a+S}$$

Figure 8 - Formula to calculate the specific volume of saturation based on the curve number. In this way the saturation parameter changes according to the covering type (e.g. grass or asphalt). (Source USDA, 1972).

For experimental purpose, we wanted to proceed with the Pe evaluation in a scenario. It examines the rate of the direct runoff, by supposing a rainfall of 45mm3/m2 in a time frame of one day. The indexes are calculated and added up for every hexagonal portion, and return the vulnerability evaluation for Urban Heat Island and flooding, (Figure 9, 10).

Figure 9 – Map of local Sensitivity to Heat Wave. (Personal processing).

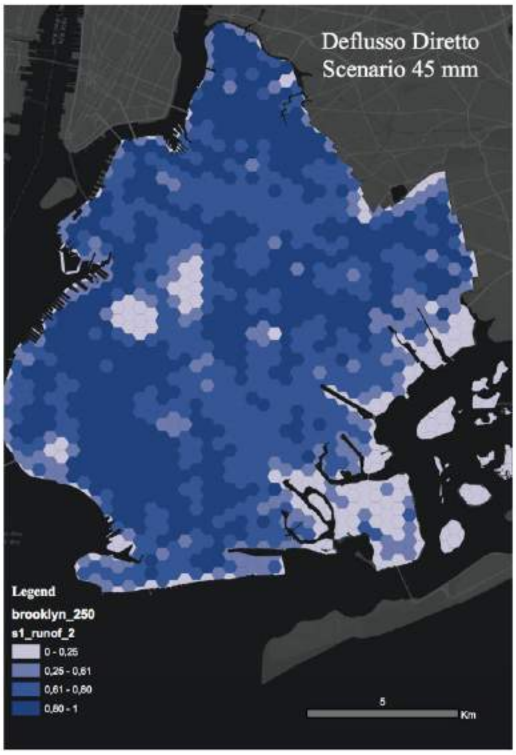

Figure 10 – Map of local Sensitivity to Flooding. (Personal processing).

5 RISK ASSESSMENT

IPCC (2014) defines the risk as “the potential damage, consequent to an impact, in which something valuable can be affected, and the result is uncertain, as the values difference is recognised”. Therefore, to evaluate the risk, after having defined the impact related to the hazard, and classified the territory on the bases of the vulnerability (observing the urban morphology sensitivity to the impact), the research focuses now on the exposure evaluation, by quantifying the urban functions inside every hexagon.

As for the other classifications, the methodology considers:

1. the preparation of necessary informative levels (entity);
2. the phase of information organization into the report database;
3. the phase of migration of all the entities useful for exposure evaluation, into the unique hexagonal entity (by aggregating every information on every intersecting hexagon);

4. the phase of calculation of exposure evaluation indexes (concentration of exposure attributes , e.g. m2 in schools).
5. Creation of an exposure map by summing up the value of every index for every hexagon.

In this way a further urban reading will be created, referred to the functions of the urban fabric on the hexagonal pattern, and every value will be compared with the vulnerability, previously calculated. The risk map is therefore the result of the sum of values expressed in the vulnerability and exposure indexes. In this way a very vulnerable territory, but laking in relevant functions, has a lower risk value than a territory with the same vulnerability level, but containing many more functions (e.g. schools, commercial activities, demographic density, etc.).

The functions evaluated for every hexagonal cell are:

- -population expressed in inhabitants number
- public transport m2
- commercial activities m2
- productive activities m2
- public services m2 (hospitals, schools, public buildings etc…).

The data have been collected from two different sources: the population has been acquired from the Global Human Settlement Layer (GHSL), instead the other functions have been obtained by MapPLUTO 16V2 elaborations.

The risk map (figure 11) is the result of the sum of sensitivity and exposure values.

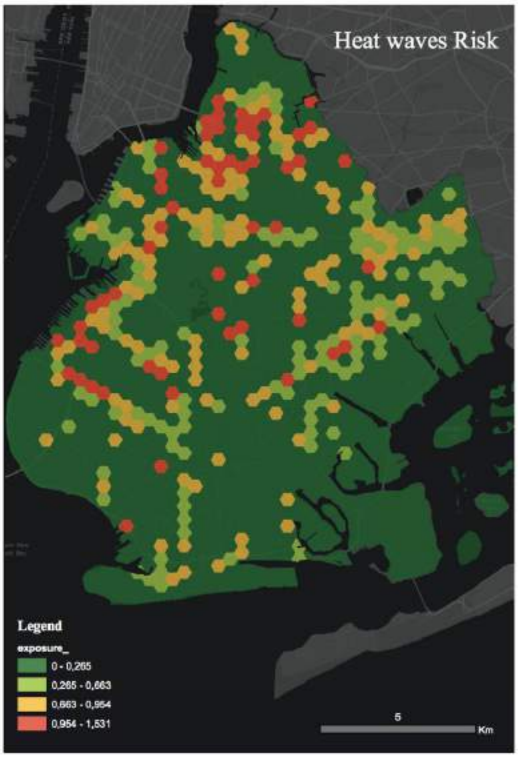

Figure 11 – Map of local Risk to Heat Waves. (Personal processing).

In this way a further urban reading will be created, referred to the functions of the urban fabric on the hexagonal pattern, and every value will be compared with the vulnerability, previously calculated.

6 THE ADAPTATION CAPACITY AS A PLANNING DRIVER TO URBAN RESILIENCE

In the end, the indexes of adaptation capacity, in the developed methodology, have been developed with the aim of supporting the decisional processes on the actions design (on the bases of the territorial conformation of the investigated sector) to adapt the territory to the evaluated risk. The idea of classifying the urban fabric through morphological parameters comes from a study by Steward and Oke (2009) called "Values of geometric and surface cover properties for local climate zones". This work considers the employed methodology very interesting, and useful to characterize the urban classification starting from the parameters identified by Steward and Oke.

Therefore the work is proceeded with the identification of the range of values that characterises one area or another for any index. The ranges of chosen values have the bases on the study of Steward and Oke, and identify 7 urban classes. The work final goal, that is to address the transformation of territories built to adapt to CC, considers the "adaptation capacity" variable, the different types of urban space, and the various morphological features of the city.

The final mould of the described process evaluates the city through a series of indexes, able to classify the city territorial morphologies, by returning a series of urban classes with homogeneous physical features (that is for adaptation options). For every homogeneous area, the research provides for flow charts that collect and explain a series of possible technical measures to reduce heat and water impacts, by considering the opportunity of every territorial class (Figure 12).

The inherent difficulty in the attempt to modify the consolidated territory, constrains to think to the transformation project (to facilitate the adaptation) of an area as sum of relevant measures in project opportunities, city planning instruments, and other opportunities (e.g. EU or national funds for urban renewal).

Therefore, to adapt the city doesn't mean to build new resilient areas, but instead to be able to manage a process in continuous transformation. This entails a long term prevision of solutions for uncertain problems, to find the best possible strategy to apply (in terms of project opportunities, city planning instruments and technique).

To sum up: knowing the morphological and functional situation of an urban district guides the planning towards two important phases: in the analysis phase, it characterizes the risk allowing to trace back the evaluation process in reverse, and identifies distinctive sensitivity and exposure elements; - in the decision process, in which the urban classification, described in the previous chapter, orients the measures selection by considering the adaptation capacity of the contemplated area. The adaptation capacity for every area is the result of the relationship between possibilism (urban spaces, techniques, financing) and opportunities (planning, plan or regulation).

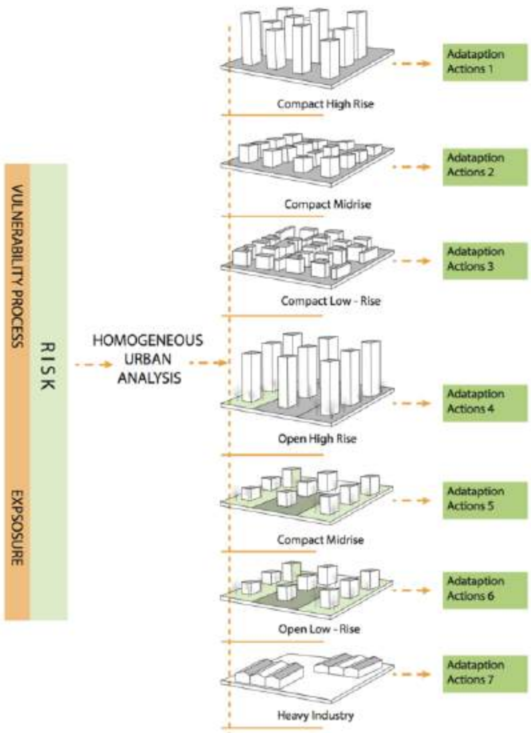

Figure 12 – Logic diagram illustrating the classification of the territory. (Personal processing).

The territorial classification, through the identification of homogeneous morphological parameters, has the aim to support the planning process in the decision phase in planning process. Each of the 7 urban areas considered and classified as examples for the city of Brooklyn, contains some adaptation options that can be applicable, others less applicable.

Every produced profile (figure 13) contains the map that identifies the urban areas that belong to the analysed typology (e.g. Compact Mid-Rise), through the hexagonal pattern. Hexagonal perimeters will be green coloured, orange or red coloured (in the example on vulnerability and risk related to heat waves), representing the risk level.

Therefore every risk map permits to identify the morphologic typology of the endangered area considered.

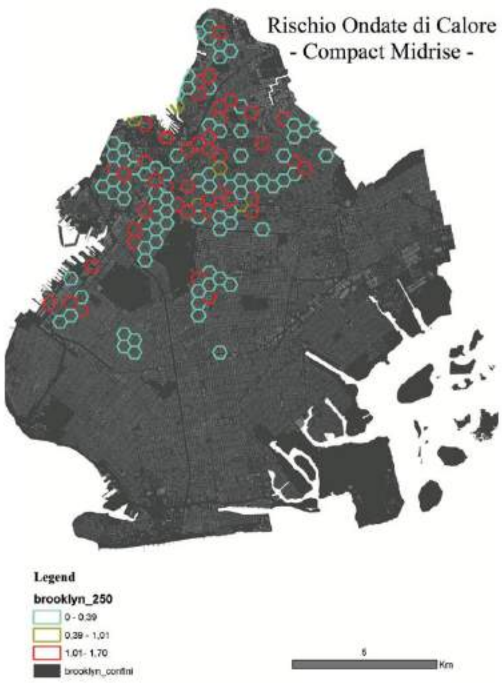

Figure 13 – Map of classification for "compact mid rise". In red, high-risk cells in urban heat island. (Personal processing).

7 CONCLUSIVE NOTES

The climate, stressed by externalities generated by anthropic systems, produces uncertain and geographically differentiated impacts, involving the cities and the territorial government activities. Urban planning and territorial science, in the next years, will be more and more involved in finding immediate solutions towards unexpected and complex problems created by the interaction between territory and abnormal climate externalities.

Spaces and buildings related to local climate aspects, surfaces materials, ecosystemic services, they are all elements that have to regain centrality in the urbanistic project, and have to be related to long and medium term climate scenarios.

Therefore the adaptation of a reinforced territory will have to compensate for vulnerabilities and climate dangers, through modifications that could reinterpret and enhance the urban landscape features (as result to physical geography, human geography and local culture). In this way, the inevitable city adaptation phase can be a chance to renew the urban areas, an opportunity to inspect the abandoned elements and to create new economies.

The territorial government activities will have to be able to re-elaborate analysis practices and project models, to manage the transformation and support the urban resiliency to climate change, with the aim of guiding the changes of the environments built in relation to the risk level; at the same time they should monitor the transformation efficiency in medium-long term.

To work on uncertain scenarios, and with solutions applicable through a sum of projects covering a period of 10-15 years, needs the structuring of a system to manage the information, that would be able to support the complex analysis phases, and to facilitate a monitoring system. The future knowledge frameworks of the cities will have to be integrated, expressed and shared. In this way they can support the territorial government activities in interpreting “not ordinary” dynamics derived from the climate, with ordinary dynamics. Uncertain scenarios, opposed to action urgency, put the city planning practices more and more in contact with the new technologies of information.

These reflections led to the approach development presented in this work. The work fundamental goal was to support a better reading of urban dynamics, through a territorial analysis process that, not only measures the vulnerability level and the risk of every urban portion, but at the same time it fosters the decision processes in choosing the most effective solution according to the subjectivity of the area, and a “real time” monitor of future implemented solutions. The database structure, built and finalized to contain all the information of the knowledge framework, aggregated in hexagonal areas, functions as matrix for the monitoring process. The measures that step by step are implemented in the territories, modify the numerical values of the attributes in the table, and guarantee a comparison between several years. In this way, the process circularity will guarantee the revision of the informative attributes (e.g. m2 of permeability), and it allows to evaluate benefits or possible consequences of the actions that have been implemented up to that moment, and then to rapidly modify them.

The climate variables considered in this work (according to the possible impacts attributable to the rise in temperature and the rainfall intensity), are based on scenarios produced by IPCC, therefore laking of an accurate local evaluation. The studied analysis process is developed to return vulnerability and risk evaluations starting from the hazard trends (as rise of temperature and rise of rain intensity), and to optimise the evaluations with well defined climate scenarios. This element facilitates the use of methodology, and untangles from the necessity of precise local climate drivers.

The new technologies recently applied in city planning practices, allow to modify analysis, planning and methods of territory organization through the spatial information. The possibility of consistently updating data and project, makes the process planning less rigid and linear, and more inherently temporary (Cecchini A., 1999). As observed, the ICT easily guarantee the acquisition of territorial information, by increasing the options to implement and organise the knowledge frameworks.

The flexibility of innovative knowledge frameworks imposes less rigidity to the plan, as direct consequence, so that it better can accept the alterations resulting from the updates of the dynamic knowledge frameworks.

The hereby described process evaluates the vulnerability and the risk from the result of indexes selected on the bases of data acquirable with the currently available technologies. A predictable technologies innovation can generate new informative typologies which can opt for other indexes, or can improve the existing ones.

The employment of information and communication technologies is essential to start an adaptation process that, working on uncertain and long-term scenarios, needs to be developed in dynamic environments.

It's important to highlight that the technologies, considered in the process, are instruments, options to facilitate the work. While maintaining its independence, it helps to identify, in his dynamic, the best options offered by the technological innovation.

The exposure, that is all the urban functions that risk to be compromised by an assumed impact, is the only variable useful to evaluate the risk, that cannot be considered objective. If the sensitivity and vulnerability evaluation is assumed according to empirical measures, the exposure is influenced by the political will of the territorial government and the local culture. In the proposed work, the exposure evaluation has been carried out by assigning the same importance to every entry (population, public transport, commercial activities, production activities and public service). But it's possible and desirable that a local governance may diversify the importance of the entries according to the local political agendas. For example, in an area vulnerable to heat, the population (or specific age categories), or the commercial activities, can be more affecting. Choosing one or another modifies the exposure result, and its risk value.

This is one of the reasons for which the adaptation process has to be participative, and able to investigate the risk perception of the inhabitants of urban areas with high vulnerability.

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