**Title: Improve Urban Resilience to Climate Change**

**Summary Statement: Preparation of a structured and robust approach to improve Urban Resilience to Global Climate Change**

# Introduction

Current urban planning is based on strategies that address accessibility (transportation), housing, economic development and quality of life needs. The issues involved change over time and according to local public policy at different levels (McPhearson et al. 2014). Resulting urban regions meet, more or less effectively, the city's needs at the time, with a focus on anticipating developments and future needs.

A number of these urban regions have poor resilience in the face of climate change.

“Urban resilience refers to the ability of an urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales-to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity” (Meerow et al., 2016).

Urban climate resilience consists of three parts (Kim & Lim, 2016): the climate change disturbance system, the process of system transition and the preemptive and responsive process. The climate change disturbance system concerns changes in climate conditions (continuous change) and climate variability (abrupt change).

The expected economic, social, and environmental consequences of climate change, global warming and increased recurrence of extreme climate events therefore add new planning issues to our complex urban system. And even more so due to growing city populations: 54% of the world's population lives in urban areas. By 2050, this is expected to reach 66% (World Urbanization Prospects, United Nations, 2014).

How can climate change be integrated into urban planning to improve city resilience to extreme climate events? What are the relevant scales? Which stakeholders should be mobilized? How can uncertainties be taken into account?

Since the MEA (2004) and the publication of numerous scientific works over the past ten years, the role of biodiversity, at all levels, in ensuring the well-being of human populations (current and future) has largely been shown, namely due to its role in climate regulation on local and global levels. The primary urban ecosystem services are:

* Climate regulation: local level (attenuation of urban temperatures by shade from trees, tree evapotranspiration, and presence of bodies of water); and broad level (C sequestration/storage by the soil and trees in the urban area);
* Regulation of water flow;
* Air purification;
* Recreation;
* Regulation and maintenance of soil quality.

Faced with the alarming state of ecosystems worldwide and the realization of how ecosystems can improve a region's resilience, the "Nature-based solutions" concept, as defined by UICN, provides acceptable solutions to address the uncertainty of climate change and its consequences, at the economic and social levels, and in terms of societal expectations.

At the same time, stakeholder networks (developers, engineering specialists, advisors/consultants) aim to bring concrete answers to the regions, notably through climate-change adaptation plans for agglomerations.

In its engineering, consulting and operations services activities in France and at the international level, Egis is particularly interested in issues related to climate change and urban resilience. This is why we've developed **a structured approach to identifying issues and levers for action, in order to propose an action and management plan for natural urban spaces, with the goal of improving the city's resilience.** This approach is consistent with the frameworks for estimating urban resilience that have been published over the past few years. It aims, above all, to help transform knowledge into on-the-ground efforts at the various urban planning levels.

# General approach

We propose a structured and progressive approach that can be applied to different urban planning levels as well as actions that are compatible with a realistic investment program for communities and/or investors. Our approach is based on:

* An assessment of the city's resilience to specific climate events (heat waves, cold, heavy precipitation, high winds, etc.).
* An evaluation of how natural ecosystems contribute to the city's resilience.

These two steps allow for the proposal of courses of action, in terms of planning urban green space but also management of these spaces to improve the resilience of the regions while taking into account other services they produce (recreation, production, etc.) and dis-services.

# Urban region resilience assessment

Every urban region has a unique environment and is vulnerable to specific climate risks. This phase of the assessment is typically based on identification of the following:

* Climatic hazards;
* Potential impacts related to the occurrence of these hazards;
* Populations exposed.

This assessment is spatialized to take into account the specificities of each district (the impacts of a hazard will differ for districts located at high altitude and those on a plain, for example). It can therefore be completed at different scales with increasing accuracy; for example, when working at the scale of a district or even a parcel of property (microclimatic aspect).

This type of assessment is already offered in the context of climate change adaptation plans, on a larger urban area scale. It provides an evaluation of a region's vulnerability to climatic hazards.

Resilience is based on vulnerability but also on a region's ability to react after a hazardous event, as well as its ability to anticipate and manage a crisis (Kim & Lim, 2016). This last point can also be addressed at this stage.

Our objective is to complete the assessment to highlight the current role of ecosystems in a region's vulnerability (next step).

# Evaluation of how natural ecosystems contribute to the city's resilience

This aspect of the assessment is based on:

* A typology of ecosystem services specific to the urban context (based on CICES classification) related to land cover typology;
* A map of land cover (adapted to object of study).

This assessment highlights "priority" services that contribute to vulnerability levels identified in the 1st phase.

For spatial visualization of these contributions, we propose to define the "scope" of each service and ecosystem. For example, the mitigating effect of a green space on a heat island can be represented spatially, either based on a model or bibliographic data, according to the desired precision and issues involved. It is therefore important to take into account who will benefit from each service and the spatial conditions.

Ultimately, we establish a **map of the contribution of natural spaces to urban resilience.**

# An action plan to improve urban resilience

The above assessment allows for the development of numerous levers to reduce the region or district's vulnerability:

* Strengthen services provided by natural green spaces: these vary depending on the type of vegetation, management practices, etc.;
* Create new spaces able to produce services that can address the region's challenges.

For this last point, and given the space constraints specific to the city, the objective is to integrate the idea of producing ecosystem services into development planning and urban renewal. This approach supports "nature-based solutions" and should help promote them.

As an example, city pavement restoration is generally carried out several times a year. In certain areas where vulnerability to climatic hazards (heat islands, for example) is considered problematic and a priority, alternatives to current practices can be proposed; for example, in areas with low levels of traffic, the use of grassed embankments or grassed street gutters.

# Works Cited

United Nations, World Urbanization Prospects, 2014

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