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Developing a framework for local climate change adaptation plan (LCCAP): The case of Mandra-Attiki, Greece

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Abstract The present work deals with the development of a preliminary climate change (CC) adaptation action plan at local level. The area of interest area is the greater area of Mandra Municipality, Attica, Greece; a suburban area that in November of 2017 had experienced a major flood incident with human casualties. The suggested methodology follows a combined 2-step, top-down and bottom-up, approach. The top-down approach deals with current CC policies and related guidelines at European, national and regional level, such as: European CC Policy (Green Paper 2030, Climate Neutral Europe 2050), National CC Adaptation Plan (National Climate Change Strategy ESPKA), Regional CC Adaptation Plan of Attica Region (PESPKA), Flood Risk Management Plan of Attica Region with emphasis to the Low Zone Aspropyrgos-Elefsina. In the bottom-up approach we focus on the main characteristics/variables of the area under study that have impacted significantly in the recent flood incident. Natural and man-made environmental variables that are necessary to be monitored on a regular basis are highlighted. A matrix of flood incidents effects is developed in order to define the most affected variables by sector. Among the outcomes of this analysis a road map of requirements will be proposed for local adaptation CC Plans (LACCPs) to increase city resilience in flood events.

Keywords: City resilience, natural and man-made environmental variables, policy implementation, adaptive capacity

1. Introduction

Climate change (CC) is expected to have varying effects on urban and suburban areas. Traditionally, CC responses stemmed from international and national initiatives to mitigate greenhouse gas emissions under the umbrella of the United Nations Framework Convention on Climate Change and the Kyoto Protocol (United Nations Framework Convention on Climate Change, 1992). However, the need to reframe this debate and to give more emphasis to the local causes and impacts of CC have gained significant meaning since the mid to late 1990s (O'Riordan & Jager, 1996). This commonly used adaptation approach seeks to reduce vulnerability to present and future changes by minimizing the direct and indirect impacts, increasing adaptive capacity, meaning the ability to adjust to climate change in order to moderate damages or cope with the consequences (Smit and Wandel, 2006).

2. Local Adaptation Planning Overview

Due to the wide range of adaptation research and practices, the meaning of the term 'adaptation' varies. However, based on International Panel on Climate Change (IPCC) is defined as *"the process of adjustment to actual or expected CC and its effects"* (IPCC, 2014). Differing patterns of adaptation planning and adaptive capacity exist among different regions in Europe. Large cities generally fund their own adaptation plans locally, whereas international and national funding appears more important for adaptation in less urban or with lower density populated territories of Southern and Eastern European regions.

Local adaptation plans can succeed by precise and very pointed assessments of the key pressures and threats (critical points) as results of CC at local level.

The resulting critical points (CPs) selected in this study were based on an exentsive literature analysis of current best practices in adaptation planning and CC plans that occur at a local scale. The proposed critical points are:

- ✓ Critical Point 1: Water quantity is increased or reduced (water quantity or CP1).
- ✓ Critical Point 2: Water quality is improved or deteriorated (water quality or CP2).
- ✓ Critical Point3: The impacts of floods are addressed satisfactory or not (floods or CP3)
- ✓ Critical Point4: Landscape is degraded or restored (Landscape or CP4).
- ✓ Critical Point5: Biodiversity is lost or maintained at the same level (Biodiversity or CP5).

- ✓ Critical Point 6: Urban heat island effects (urban heat island or CP6).
- ✓ Critical Point 7: Sea level rise and loss of coastline (sea level rise or CP7).
- ✓ Critical Point 8: Risk of wildfire (wildfire or CP8).

3. Top Down approach (Policy)

The European Green Deal (EGD) in order to overcome the environmental degradation and the existing threat caused by the CC aims to transform the European Union (EU) into a modern, resource-efficient and competitive economy, ensuring:

- ✓ no net emissions of greenhouse gases by 2050
- ✓ economic growth decoupled from resource use
- ✓ no person and no place left behind

EU economy also aims at becoming climate-neutral by achieving with zero-net greenhouse gas emissions by 2050. This objective is at the heart of EGD and in line with the EU's commitment to global climate action under the Paris Agreement. In Greece, National Policy for CC focuses on strengthening the country's resilience to cope with the effects of CC. It also targets the promotion of adaptation actions and policies in all sectors of Greek economy, with an emphasis on the most vulnerable ones. Adaptation Plans in Greece are developed also at regional level in order to give policy directions to the local CC Adaptation Plans (LCCAPs).

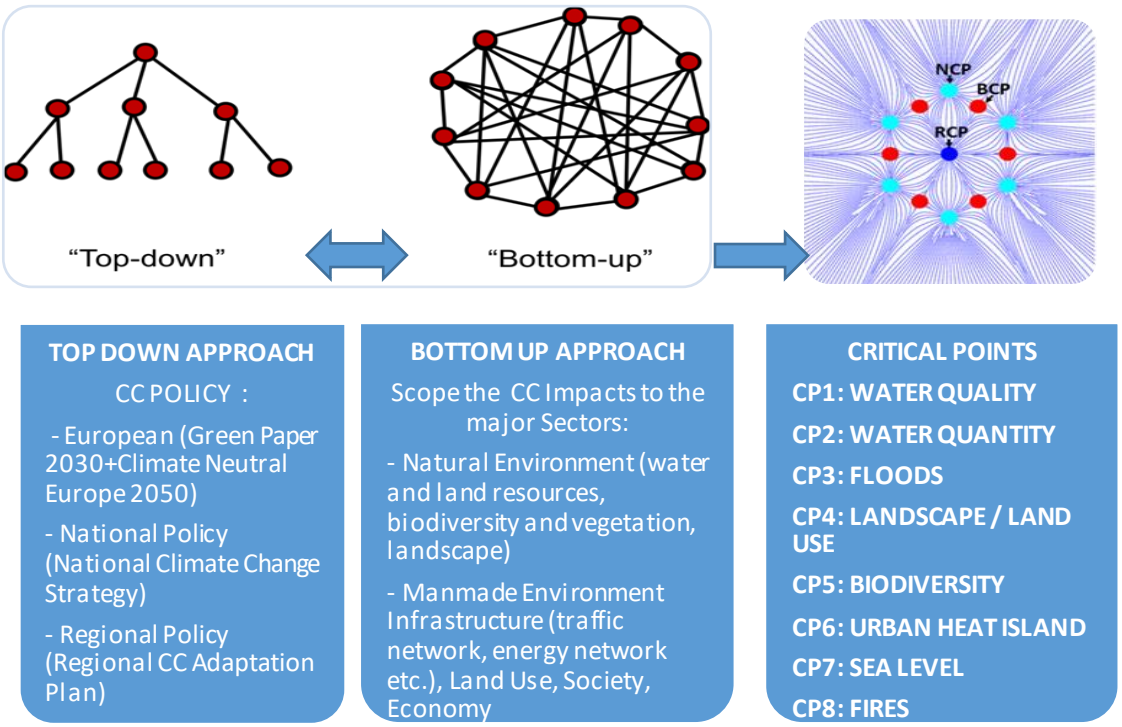

Figure 1. Top down and bottom up approaches highlight the critical points of a LCCAP

4. Bottom up approach

Understanding the limits and barriers of large-scale (local level) adaptation approaches, as well as recognizing the local impacts of CC, there is an increasing support of local, community-led adaptation initiatives (in contrast to national, top-down strategies) (e.g. Amundsen et al., 2018; Campos et al., 2016; EEA, 2014; Fazey et al., 2018; Fuhret al., 2018; Ng et al., 2016; Walker et al., 2015; Aguiar et al., 2018).

Local authorities play a key role in public administration that is crucial for CC adaptation including land use regulation, infrastructure protection, monitoring and inspection as well as emergency planning etc. (Vogel and Henstra, 2015). The growing understanding that CC impacts are experienced mainly locally (Hunt and Watkiss, 2011) led to the fact that many municipalities started designing and implementing local CC adaptation strategies. Focusing on CC vulnerability, it has been recognized the cause/effect relationship behind CC and its impact on people, economic, social and ecological sectors (Fritzsche et al., 2014). Vulnerability is commonly characterized as *the degree to which a system is sensitive and unable to cope with adverse effects of CC, including climate variability and extreme phenomenon".*

5. Area of Interest

On 15 November 2017, an intense rainfall in western Attica led to a sudden flood event mainly affecting the towns of Mandra and Nea Peramos. About 25 people died, while an important part of public infrastructure and

private assets have been completely or partially destroyed. Mandra Municipality is situated at the western part of Attica Prefecture (Fig. 2) covering an area of 427 km^2 and its population is about 18,000 inhabitants.

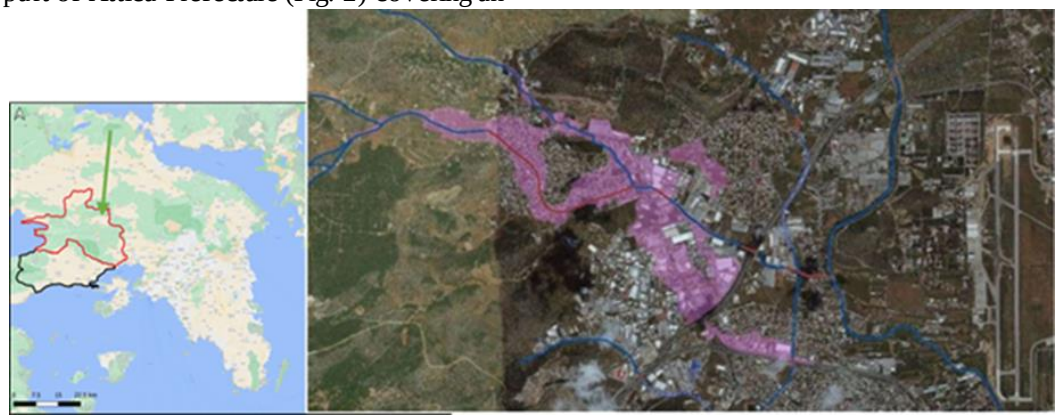

Figure 2. Municipality of Mandra – flooding area (Kontoes et al., 2018)

In order to develop a LCCAP for the area of interest a matrix that highlights the impacts caused by the flood phenomenon on the natural and the manmade environment was designed (Fig. 3). Issues like loss of biodiversity, degradation of the land resources and terrain, socioeconomic impacts and damages on the infrastructure and networks are the variables that were affected mostly by the flood phenomenon. For the purpose of restoring the natural environment and overcoming the previously mentioned problems within the manmade environment three scenarios were developed. According to the relevant CPs for flood phenomena, emphasis was given to land use planning and sustainable water management in order to protect characteristics of the terrain, the agricultural land and biodiversity. The three above scenarios will also be evaluated so that the best one would constitute a baseline for the LCCAP. Based on the CPs also, an indicator system will be developed with aim of monitoring the effectiveness of the proposed local CC adaptation plan.

Impact from the Flood Phenomena – Study area

	Variables	Impact
NATURAL ENVIRONMENT	Biodiversity	5
	Land Resources	5
	Terrain	5
	Climate	2
	Water Resources	3
	Cultural Resources	3
	Landscape	4
MANMADE ENVIRONMENT	Society	5
	Economy	5
	Infrastructure and Networks	5
	Land Use	5

Level of intensity	
very low	1
low	2
medium	3
high	4
very high	5

Figure 3. Main outcomes of flood impact matrix in the area of interest

6. Conclusions

Climate adaptation planning is still an emerging interdisciplinary field and the effectiveness of existing adaptation plans will be fully tested in short and long term time, as communities continue experiencing and adapting to increasing impacts of CC.

In this study, a hybrid bottom-up and top-down approach was used to identify, prioritize and in the end evaluate the performance of a LCCAP. While the bottom-up aspect of the proposed hybrid approach highlights the main variables affected by the flood phenomenon, the top-down aspect focuses on relative to CC policy guidelines at European, National and Regional level.

The resulting CPs of a LCCAP relating to floods will be supported by a relevant set of indicators in order to prioritize suitable measures for each critical variable and to evaluate the effectiveness of the plan. The main "critical" variables in the area under study are land resources and biodiversity, terrain and land-use changes. A successful and sustainable LCCAP can usually be achieved through an effective land-use plan that determines suitable land uses in areas vulnerable to CC (FAO, 2013). Additionally, better water resources management strategies at watershed level (local) can also be a useful tool that indirectly contributes towards this success

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