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Interdisciplinary assessment of sea-level rise and climate change impacts on the lower Nile delta, Egypt

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HIGHLIGHTS

- The EU FP7 CLIWASEC cluster of projects are introduced.
- Interdisciplinary assessment of sea level rise impacts to Nile delta is presented.
- Sea level rise causes complex, inter-related issues in the region.
- CLIWASEC clustering enriched the conclusions compared with singular analysis.
- Policy makers have more of the 'bigger picture', and are better informed.

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ABSTRACT

Climate-induced changes on WAter and SEcurity (CLIWASEC) was a cluster of three complementary EC-FP7 projects assessing climate-change impacts throughout the Mediterranean on: hydrological cycles (CLIMB – Climate-Induced changes on the hydrology of Mediterranean Basins); water security (WASSERMed – Water Availability and Security in Southern Europe and the Mediterranean) and human security connected with possible hydro-climatic conflicts (CLICO – Climate change hydro-Conflicts and human security). The Nile delta case study was common between the projects. CLIWASEC created an integrated forum for modelling and monitoring to understand potential impacts across sectors. This paper summarises key results from an integrated assessment of potential challenges to water-related security issues, focusing on expected sea-level rise impacts by the middle of the century. We use this common focus to illustrate the added value of project clustering. CLIWASEC pursued multidisciplinary research by adopting a single research objective: sea-level rise related water security threats, resulting in a more holistic view of problems and potential solutions. In fragmenting research, policy-makers can fail to understand how multiple issues can materialize from one driver. By combining efforts, an integrated assessment of water security threats in the lower Nile is formulated, offering policy-makers a clearer picture of inter-related issues to society and environment. The main issues identified by each project (land subsidence, saline intrusion – CLIMB; water supply overexploitation, land loss – WASSERMed; employment and housing security – CLICO), are in fact related. Water overexploitation is exacerbating land subsidence and saline intrusion, impacting on employment and placing additional pressure on remaining agricultural land and the underdeveloped housing market. All these have wider implications for regional development. This richer understanding could be critical in making better policy decisions when attempting to mitigate climate and social change impacts. The CLIWASEC clustering offers an encouraging path for the new European Commission Horizon 2020 programme to follow.

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1. The CLIWASEC cluster for the Nile delta: scope and background

Climate change has been one of the main topics in the European Union's environmental policy since 1988. The EU took leadership in developing multilateral climate protection policies in highlighting climate change as a major security issue (Liberatore, 2013). In this context, collaborative research projects related to climate change impacts are supported by the European Commission. Climate change is impacting the Mediterranean region in myriad and distinct ways including increased frequency of flash flood events, droughts or periods of water shortages and rising temperatures (e.g. Christensen and Christensen, 2007; Giannakopoulos et al., 2009). Sea level rise is also an important issue (IPCC, 2013). Observed trends and projections for the future indicate a strong susceptibility to changes in hydrological regimes, an increasing general shortage of water resources and consequent threats to water availability and management. However, it must be clearly stated that as a result of current uncertainties in climate projections and subsequent impact models, an incomplete understanding of the impact of a climate change signal on economic mechanisms and the lack of an elaborate and integrated human security conceptual framework limitations are being imposed on water-related decision-making under conditions of climate change (IPCC, 2013).

CLimate-induced changes on WAtER and SECurITy (CLIWASEC; <http://www.cliwasec.eu>) was a cluster of three complementary, interdisciplinary European Commission Seventh Framework (EC-FP7) funded projects focusing on various socio-physical water-related issues throughout the Mediterranean (Ludwig et al., 2011). The clustering brought together 44 partner institutions from across Europe and the Mediterranean, representing a critical mass of scientific knowledge, capability and collaboration with local stakeholders. In the CLIWASEC cluster, there were 23 study sites throughout southern Europe, the Mediterranean, the Middle East and north Africa (Fig. 1), representing regions with diverse climate, societal and water-related threats being posed to equally diverse populations, levels of development and governmental systems. Of these study sites, the Nile delta region, Egypt (Fig. 1), was common between the projects, and is the focus of this paper.

The three projects comprising the CLIWASEC cluster were: CLIMB (CLimate-Induced changes on the hydrology of Mediterranean Basins);

WASSERMed (Water Availability and Security in Southern Europe and the Mediterranean) and; CLICO (CLimate change hydro-Conflicts and human security). These projects had wide and differing remits, but all focused on a range of water-related security issues throughout the Mediterranean. With respect to this paper, CLIMB (www.climb-fp7.eu), focuses on climate change impacts to hydrological cycles, using extensive field measurements and multi-parametric remote sensing to monitor environmental change and to parameterise and interface land surface models with hydrogeological models in the western Nile delta. WASSERMed (www.wassermed.eu) is focused on assessing water-related security threats, including those to agriculture, tourism and economies. System Dynamics (Ford, 1999) is used to assess water-related security concerns in Rosetta (Nile delta), incorporating agricultural and trade issues. CLICO's (www.clico.org) aim was to understand under what conditions hydro-climatic hazards intensify social tensions or provide a catalyst for cooperation. In the Greater Alexandria case study, the focus of this paper is on the anticipation of potential human security risks arising from a hypothetical scenario of large scale preventative resettlement in response to sea-level rise (SLR). For the purposes of this paper, we use the common Nile delta study area and a common driver (SLR) to highlight the added value of project clustering as opposed to analysing the results from the three projects individually. Fig. 2 illustrates conceptually how the projects interacted, and the aspects that each project focused on to contribute to the integrated assessment presented in this paper.

Egypt has a population of 75 million, 51% of whom live in rural areas and 49% in cities. Its annual average rainfall is characteristic of arid regions and ranges, from south to north, from 51 to 200 mm (OIE). The volume of water consumed in Egypt is 68 km³ of which 86% is dedicated to agriculture. Ninety-five percent of the water derives from the river Nile which crosses in total 10 countries on its 6500 km course. In the context of the construction of the Grand Ethiopian Renaissance Dam under construction on the upper Nile, geopolitical stability requires better knowledge on water threats over the region.

While the CLIWASEC projects had wide research remits, for the purposes of the interdisciplinary research presented in this paper, we focus

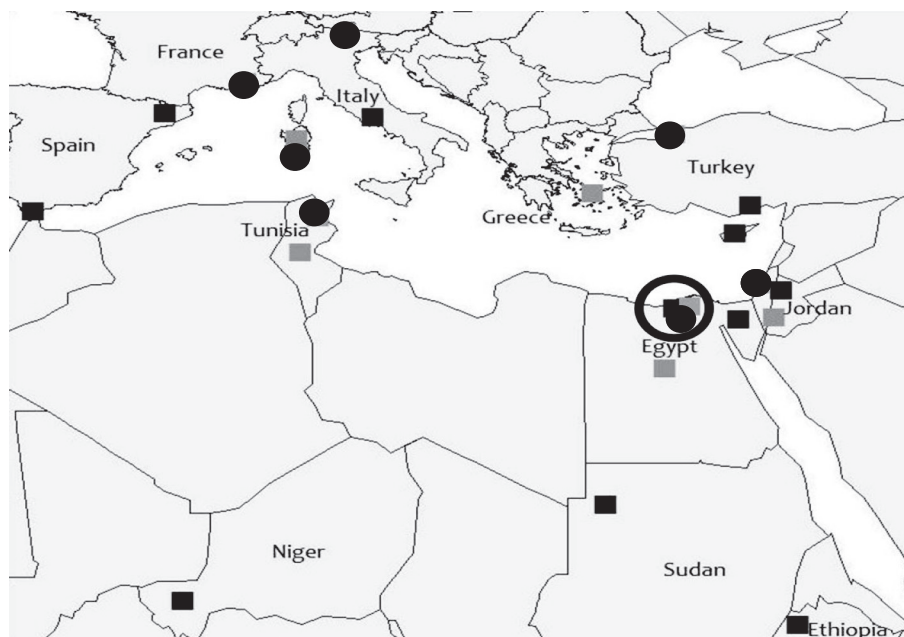


Fig. 1. Locations of the 23 case study areas studied in the CLIWASEC projects. Black circle highlights the common area between all three projects that is the focus of this paper. Black boxes are CLICO study sites, grey boxes are WASSERMed study sites, black circles are CLIMB study sites. The area in the clear black circle is subject to SLR impacts.

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