

Preface

This book was written to bridge a gap that we believe is still affecting the scientific literature on climate change in Southern Africa, namely the lack of understanding of hazards and the impact they have on areas prone to them, of the local population's capacity to adapt and local authorities' ability to respond, not to mention the methods used to estimate levels of risk and vulnerability, factors that are useful when planning adaptation to climate change in large cities.

This book is the product of work done by two research teams created by a partnership between Italian universities and African institutions. One of these teams, based at the Interuniversity Department of Regional and Urban Studies and Planning (DIST) of the Politecnico di Torino, is run by Maurizio Tiepolo. Its members include Sarah Braccio, Antonio Cittadino, Magueye Diop, Francesco Fiermonte, Diéthié Ndiaye, Pamoussa Ouedraogo, Enrico Ponte and Stefania Tamea. The other team, based at Sapienza University of Rome's Department of Civil, Building and Environmental Engineering (DICEA), is run by Silvia Macchi and is comprised of 20 researchers from Italy and Tanzania, including Francesco Cioffi, Luca Congedo, Giuseppe Faldi, Laura Fantini, Michele Munafò, Liana Ricci, Matteo Rossi, Giuseppe Sappa, as well as Gabriel Kassenga and Dionis Rugais from Dar es Salaam's Ardhi University.

In May 2010, the two groups joined forces to present the research project entitled *Assessing, Planning and Managing the Territory and the Environment Locally in Sub-Saharan Africa* at the Italian Ministry for University and Scientific Research as part of the call for Research Projects of National Interest (known by the Italian acronym PRIN). The project was co-financed in July 2011 (no. 2009SX8YBH) and developed from August 2011 to October 2013 under the supervision of Maurizio Tiepolo.

In the first few months of work, it quickly became clear that urban vulnerability to climate change was a growing environmental concern in Southern Africa. It was felt that in order to make the comparison clearer, it would be useful to identify case studies involving similar hazards, i.e. sources of potential harm in terms of human injury and damage to health, property, the environment and other things of value. Moreover, when it came to this particular issue, we felt it would be best to choose cases of exposure to effects caused by multiple hazards, such as the floods caused by extreme rains and sea-level rise in dense urban areas, or groundwater salinization resulting from the combined effect of decreasing rainfall and increasing

temperature as well as soil sealing in peri-urban areas. The large coastal cities of Maputo, the capital of Mozambique, (Politecnico di Torino) and Dar es Salaam, Tanzania's largest city (Sapienza University of Rome) were therefore selected.

The results of the preliminary studies conducted by the two research teams were presented at the international Urban Impact of Climate Change in Africa (UICCA) conference, organised in partnership with Turin's provincial government on 16 November 2011 in Turin. Other Italian research centres studying climate change adaptation in Sub-Saharan Africa were invited to attend (the IBIMET-CNR National Research Council's Institute of Biometeorology of Italy, Venice's IUAV Istituto Universitario di Architettura, the University of Florence, and the University of Trento), as well as many Italian local authorities and ministerial departments, so as to broaden the discussion increase opportunities for debate and raise awareness of this issue among the many different levels of cooperation (bilateral and decentralized).

After the conference, this book began to take shape and later saw a further opportunity for verification at the international workshop entitled 'Towards Scenarios for Urban Adaptation Planning: Assessing Seawater Intrusion Under Climate and Land Cover Changes in Dar es Salaam', organized at Sapienza University of Rome on 20–22 April 2013.

The contents of this book range from the assessment of risks associated with climate change to the adaptation strategies for reducing vulnerability in two of the most populated cities on the eastern coast of Africa: Dar es Salaam (4.4 million inhabitants) and Maputo (2.4 million). These two main case studies were supplemented by two complementary studies on Dakar (2.9 million) and the Caia district in Mozambique (Fig. 1).

The conceptual frameworks for disaster risk management and climate change adaptation in the scientific literature as well as in those produced by the main multilateral and bilateral development aid agencies are clarified. Next, the assessment methods and applications concerning the various different factors involved are presented, adapted to situations where information is often lacking or where information is scattered and access to it is limited. We believe this is why this book is so ground-breaking compared to the publications currently available on urban adaptation to climate change in Africa. If this achievement has been attained, it is thanks to the in-depth knowledge of sources of information, combined with the great efforts made to fill gaps by obtaining new data, and thanks also to the practical goal of this research, namely to provide urban authorities with the risk analysis and adaptation planning tools necessary to diminish local vulnerability to climate variability and change.

This approach makes the book particularly useful to graduate students, researchers, and practitioners interested in enhancing their knowledge and skills as regards integrating climate change into applied research and development projects in urban Africa.

The book begins with two introductory chapters that review the current state of adaptation to incremental climate stress ([Chap. 1](#)) and flood risk reduction and



Fig. 1 The 42 largest cities south of the Sahara in 2010. Over 6 million inhabitants (*very large dot*), 4–5 million (*large dot*), 2–3 million (*medium dot*), 1–2 million (*small dot*) (formulated by E. Ponte based on data published by UN-Habitat’s State of the World’s Cities 2012/2013. Prosperity of Cities, 2012)

climate change ([Chap. 2](#)) in urban studies. The body of the book then presents relevant case studies ([Chaps. 3–14](#)), followed by conclusions and recommendations ([Chap. 15](#)).

[Chapter 1](#) (Macchi) examines the issue of adaptation planning in cases where incremental stress on systems of natural resources is foreseen due to the combined effects of climate change and a series of other factors of environmental decay, such as urban sprawl. The chapter particularly tackles the vulnerability of access to water caused by the continued degradation of water sources in peri-urban coastal areas of large Sub-Saharan cities. After situating the issue of adaptation within the international discourse on responses to global warming, the specific spatial context under examination is introduced, together with the guiding concept for vulnerability assessment: the adaptive capacity of inhabitants. In addition, three theoretical pillars for adaptation planning are explored: uncertainty as an opportunity for

an unfettered vision of the city's future; the centrality of incremental environmental stress in assessment of vulnerability to extreme weather and climate events; and crossing boundaries within science and between science and society for an effective and equitable definition of the problem.

Chapter 2 (Tiepolo) illustrates flood risk reduction following extreme physical events attributable to climate change in large cities south of the Sahara. Large cities are understood here as those with a population greater than one million inhabitants, and the term 'extreme physical events' refers to those events whose likelihood in a given place and time is in the 90th percentile. The main hazard that increasingly hits cities south of the Sahara is flooding. In coastal cities, this is caused by extreme rainfall and sealevel rise. The chapter assesses whether there is enough information available to assert—as the literature currently does—that urban flooding is caused by climate change. The scale of flooding and its impacts are then examined. Finally, the current state of knowledge concerning adaptation measures is presented, with a particular focus on strategies and local adaptation plans. Overall, our results have revealed several commonly held misconceptions in the field of adaptation. In particular, understanding of the mechanisms that cause flooding has proven to be virtually non-existent, a gap that makes it difficult to develop and identify adequate adaptation measures, from early warning to stormwater drainage. In addition, the knowledge of adaptation plans and the development of uniformly applied best practices is less advanced than expected. Adaptation plans have been adopted by few large cities, and those that are in place demonstrate considerable heterogeneity, despite years of support from international organizations promoting best practices.

Once the current state of understanding of the entire Sub-Saharan African region is established, the next two parts examine in detail a few case studies from Southern Africa.

Part II (**Chaps. 3–8**) presents the research carried out in Dar es Salaam and concludes with a study carried out in Dakar. The six chapters all refer to the conceptual framework for the assessment of vulnerability to climate change developed by the IPCC (see **Chap. 1**), where adaptive capacity plays a pivotal role. **Chapter 3** (Rugai and Kassenga) begins by considering the impact of climate change and the authorities' ability to respond thereto, focusing mainly on highlighting the fact that unchecked and poorly planned expansion of cities is increasing future risk factors as well as the current expenditure on adaptation paid by communities. **Chapter 4** (Faldi and Rossi) focuses on seawater intrusion in coastal aquifers. This is a complex phenomenon, due to the combination of natural and human mechanisms, and if aggravated by climate change it could have dramatic consequences, such as impeding the use of the majority of the wells that currently meet human and agricultural consumption needs. **Chapter 5** (Congedo and Munafò) investigates urban sprawl, recognising it to be the main non-climatic factor that will accentuate the effects of climate change. This phenomenon affects a great deal of Dar es Salaam's coastal plain, and monitoring it over time is essential if we wish to guide and evaluate the adaptation decisions to be integrated into

urban development planning. The key concept of adaptive capacity is the focus of [Chap. 6](#) (Ricci), which uses it to reinterpret certain characteristics typical of the peri-urban area as essential for guaranteeing the spontaneous adaptation of the local population to present and future environmental changes. An analysis of the information collected in the field leads to a framework proposal for supporting local authorities in decision-making on institutional adaptation. [Chapter 7](#) (Macchi and Ricci) discusses the mainstreaming of adaptation into existing plans and programmes related to the urban development and environmental management sectors. This is an approach to adaptation that is approved by international development agencies, but at the same time has limitations that should be tackled in order to apply it in the right way. Finally, [Chap. 8](#) (Biconne) presents a participatory approach to sharing knowledge among urban players on the environmental, social, and cultural dimensions of climate change. This approach has been tested in the peri-urban settlement of Malika, Dakar, demonstrating its potential as a tool in the decision-making processes of urban adaptation planning.

The second half of the book ([Chaps. 9–14](#)) discusses the city of Maputo and is supplemented by a study on the Caia district in central Mozambique. The theme of these six chapters is the mapping of flood risk in case of extreme heavy rain and sealevel rise. The final result is a risk digital map derived from a special open source GIS, and an initial adaptation assessment, i.e. an initial identification of the options for adapting to climate change and their evaluation according to a set of criteria. Given the lack of literature on risk assessment methods in cities south of the Sahara, researchers decided to tackle the various components of risk separately so as to leave more space for an in-depth illustration of the methods used. Thus, flood hazards due to extreme rains (Bacci) and sealevel rise caused by climate change (Brandini and Perna) are discussed in [Chaps. 9](#) and [10](#). They provide an exhaustive examination of the hazard, which is very rarely discussed in publications dealing with flood risk assessment and mapping, as shown in [Chap. 2](#). [Chapter 11](#) (Braccio) presents the various methods that can be used to identify flood-prone areas. Their use depends on local circumstances (the availability of satellite images with a low cloud cover rate immediately following extreme rain, the availability of local surveys of the flooded areas, etc.). The text then goes on to explain the choice made in the case of Maputo, considering the data and the resources available. [Chapter 12](#) (Ponte) illustrates the choice—among the many options available—to use the equation $R = (H * V * E)/A$ to measure risk, and explains how this equation was used in open source GIS to produce the digital, georeferenced, and updatable map of flood-prone areas. The hazard value calculation identified by Bacci, Brandini, and Perna and the adaptation calculation (Tiepolo, see [Chap. 13](#)) are quantified and the vulnerability and exposure calculation is described in detail. [Chapter 13](#) (Tiepolo) treats the adaptation baseline (existing adaptation) and adaptation assessment (future) separately. In this case, reference is made to the complexities involved in ascertaining the measures currently in place when working on large cities with vast flood-prone areas (57.4 km² in the case of Maputo). Then the text goes on to elucidate the method

chosen to identify the future priority measures and examine their distribution over time. This part ends with [Chap. 14](#) (Ianni) and an analysis of the vulnerability of the Caia district (population of approximately 115,000) in central Mozambique. The main focus of this chapter is the vulnerability caused by the local population's loss of access to the land.

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