

Riskscapes of flooding

Social dynamics and adaptation in a rapidly urbanising wetland:

The Densu delta case in Accra, Ghana

Fanny Frick-Trzebitzky

Declaration

I declare that I have completed the thesis independently using only the aids and tools specified. I have not applied for a doctor's degree in the doctoral subject elsewhere and do not hold a corresponding doctor's degree. I have taken due note of the Faculty of Mathematics and Natural Sciences PhD Regulations, published in the Official Gazette of Humboldt-Universität zu Berlin no. 34/2006 on 13/02/2006.

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Doctoral Thesis

to obtain the degree of doctor rerum naturalium

(Dr. rer. nat.)

in Geography

Submitted to the

Faculty of Mathematics and Natural Sciences

at Humboldt-Universität zu Berlin

by

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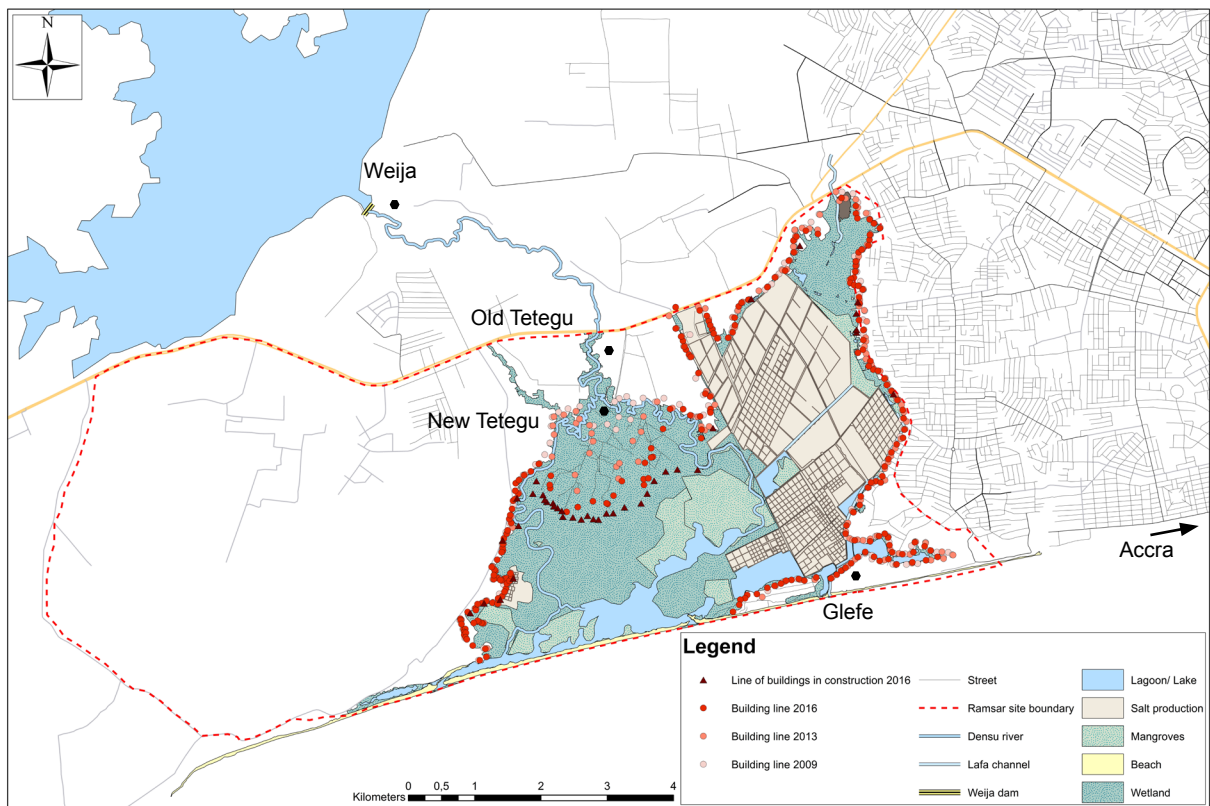
Date of disputation: 17.11.2017



Weija dam, July 2014*



Salt pans, January 2015*



Land use and encroachment in the Densu delta*



New Tetegu, June 2014*



Glefe, January 2014*

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List of abbreviations

AAP	Africa Adaptation Programme
AMA	Accra Metropolitan Assembly
AP	Action Plan
CCA	Climate Change Adaptation
CREW	Community Resilience Through Early Warning
DP	Donor Project
DR	Disaster Risk
DRR	Disaster Risk Reduction
DSS	Decision Support System
EPA	Environmental Protection Agency
GAMA	Greater Accra Metropolitan Area
GIS	Geographic Information System
GNWP	Ghana Netherlands WASH Programme
GoG	Government of Ghana
GSGDA	Ghana Shared Growth and Development Agenda
GWCL	Ghana Water Company Limited
HFA	Hyogo Framework for Action 2005-2015
IPFC	International Policy Framework or Convention
IPCC	Intergovernmental Panel on Climate Change
MESTI	Ministry of Environment, Science and

	Technology
MLGRD	Ministry of Local Government and Rural Development
MMDA	Municipal, Metropolitan and District Assemblies
MWRWH	Ministry of Water Resources Works and Housing
NADMO	National Disaster Management Organisation
NCCAS	National Climate Change Adaptation Strategy
NCCP	National Climate Change Policy
NDMP	National Disaster Management Plan
NDPC	National Development Planning Commission
NGO	Non-governmental Organisation
NLP	National Land Policy
NP	National Policy
NPF	National Policy Framework
NUP	National Urban Policy
NWP	National Water Policy
PGIS	Participatory GIS
PPGIS	Public participatory GIS
QGIS	Qualitative GIS
RS	Remote Sensing
TCP	Town and Country Planning
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change

UNISDR	United Nations International Strategy for Disaster Reduction
UoG	University of Ghana
WASH	Water, Sanitation and Hygiene
WHO	World Health Organisation
WRC	Water Resources Commission
WRI	Water Research Institute

Zusammenfassung

Diese Arbeit zeigt die Reproduktion ungleicher Risikolandschaften von Überschwemmungen auf. Die fortschreitende Urbanisierung in den Küstenregionen der Welt ist mit zahlreichen unterschiedlichen Risiken verbunden, denen sozio-ökonomisch benachteiligte Gruppen in besonderem Grad ausgesetzt sind. Dennoch ist Wissen über soziale Dynamiken, die solch ungleichen Risikolandschaften zugrunde liegen, gegenwärtig begrenzt. Das Densu Delta, ein dynamisch urbanisierendes Feuchtgebiet westlich von Accra, dient hier als Fallstudie, die anhand von qualitativen Daten mit Methoden der Humangeographie untersucht wird. Die übergeordnete Forschungsfrage lautet: *Was sind die Beziehungen und Dynamiken, die die Verteilung von Überschwemmungsrisiken gestalten, und wie verfestigen sich diese in den gegenwärtig stark ungleichen Mustern von Überschwemmungsrisiken rund um das Densu Delta?* Das Konzept ‚Risikolandschaften‘ (‚riskscape‘) wird hier mit Sichtweisen des kritischen Institutionalismus und der Argumentation verbunden, um Prozesse zu analysieren, die eine ungleiche Verteilung von Vulnerabilität und Anpassungskapazität bedingen. Die Ergebnisse zeigen erstens, dass institutionelle und bio-physische Dynamiken eine vielfältige Landschaft von Vulnerabilität erzeugen. Zweitens wird Anpassungskapazität von dynamischen Autoritätsverhältnissen geprägt. Drittens erweitern Unterschiede in Policy-Argumenten auf verschiedenen Ebenen und in unterschiedlichen Sektoren die Implementierungslücke in der Anpassung an Überschwemmungen. Die Arbeit leistet einen Beitrag zur bestehenden Forschung, indem die Rollen von Schlüsselakteuren und von unsichtbaren Praktiken und Institutionen in der (Re-)Produktion von ungleichen Risikolandschaften betont werden. Diese werden hier am Beispiel von Überschwemmungen im Densu Delta in Accra aufgezeigt. Skalenübergreifende Interaktionen in Risikolandschaften und deren praktische Implikationen für die Minimierung von Überschwemmungsrisiken bedürfen der weiteren Forschung.

Die Arbeit ist als kumulative Dissertation aufgebaut. In Artikel A werden die räumliche Verteilung von Risiken und Vulnerabilitäten im Fallstudiengebiet, sowie die Frage, wie Praktiken und Institutionen mit biophysischen Prozessen interagieren und somit Muster sozialer Vulnerabilität erzeugen, untersucht. Artikel B besteht aus einer Analyse von Policyargumenten in der Implementierungslücke in der Anpassung an Überschwemmungen im Fallstudiengebiet. Dazu werden Argumente in Policy Dokumenten Erfahrungen von

Schlüsselakteuren im Densu Delta gegenübergestellt. Artikel C analysiert mit dem Ansatz von ‚Bricolage‘ die Rolle von Institutionen, mit einem Schwerpunkt auf Interaktionen zwischen ‚formalen‘ und ‚informellen‘ Institutionen in der Verteilung von Anpassungskapazität.

In diesem Rahmentext wird in der Einleitung zunächst der Forschungsstand zu ungleicher Verteilung von Risiken in Städten zusammengefasst, mangelndes Wissen über zugrunde liegende Dynamiken als Forschungsproblem identifiziert und die Fallstudie vorgestellt. Der Forschungsprozess, der zur Auswahl und Justierung des konzeptionellen und Analyserahmens geführt hat, wird im Hintergrundkapitel beschrieben. Dabei wird auf zwei Arbeitspapiere und ein Buchkapitel verwiesen, die als drei ergänzende Publikationen aus diesem Forschungsprozess hervorgegangen sind. Konzeption und Methoden der Forschung werden an dieser Stelle kritisch reflektiert. Anschließend werden die Ergebnisse der drei eingereichten Publikationen präsentiert. Die Ergebnisse verdeutlichen unterschiedliche Aspekte der Risikolandschaft Densu Delta. Schließlich werden im Fazit die Beiträge dieser Arbeit zur Forschung zu Risikolandschaften, zu institutioneller Bricolage, sowie zu Städten herausgestellt und deren Bedeutung für den Umgang mit Überschwemmungen in schnell urbanisierenden Gegenden hervorgehoben. Wie Ungleichheiten in den Gemeinden der Fallstudie verringert werden können wird ebenfalls in diesem Kapitel andiskutiert. Ergänzende Forschungslücken werden identifiziert. Auf den Rahmentext folgen die eingereichten Artikel (Anhang I), weitere aus dieser Forschung hervorgegangene Publikationen (Anhang II), sowie ergänzende Angaben zum Datenmaterial (ergänzendes Material).

Summary

The thesis shows how uneven landscapes of urban flood risk are (re)produced. Coastal urbanisation comes with multiple risks, to which the poor are particularly exposed. Social dynamics underlying uneven riskscapes are however poorly understood. The Densu delta in Accra, a dynamically urbanising wetland, is analysed as a case based on qualitative data with methods from human geography. The overall research question is: *What are the relations and dynamics that shape the distribution of flood risks, and how are they materialised in the currently highly uneven patterns of flood risk around the Densu delta?* The concept of ‘riskscape’ is applied through lenses of critical institutionalism and argumentation to analyse the processes behind uneven distribution of vulnerability and adaptive capacity. Findings are that firstly, institutional and bio-physical dynamics produce a diverse landscape of vulnerability. Secondly, dynamics of authority shape adaptive capacity. Thirdly, disparities in policy arguments widen implementation gaps in adaptation to flooding. The research contributes to the existing literature in highlighting the role of actors and underlying practices and institutions in shaping multiple uneven riskscapes. In the present research the reproduction of uneven riskscapes of flooding is shown for the Densu delta case. Further research ought to look at cross-scale interactions between riskscapes and their practical implications for flood risk reduction.

The thesis is structured as a cumulative dissertation. In article A, the spatial distribution of risks and vulnerability in the case study area, and how practices and institutions interact with biophysical processes to form patterns of social vulnerability, are assessed. Article B consists of an analysis of policy arguments in the implementation gap in flood risk governance in the case study area. Arguments in policy documents are contrasted with key stakeholders' experiences of implementation on the ground. Article C is an analysis of the role of institutions, focussing on the interaction between 'formal' and 'informal' institutions in the distribution of adaptive capacity through the lens of institutional bricolage.

In the framing text, the limited understanding of dynamics underlying uneven distribution of risk in cities is stated as the research problem in the introduction, and the case is briefly introduced. The research process towards selection of the analytical and methodological approaches applied is described in the background section, drawing on three additional publications (two working papers and a book chapter). Conceptual and methodological aspects are critically reflected upon. Subsequently the combined findings of the three articles are presented and discussed, highlighting different aspects of the flood-riskcape in the Densu delta. Finally, contributions to research on riskscapes, institutional bricolage and cities are highlighted and the relevance of the findings for dealing with flooding in urbanising areas pointed out in the conclusion. Ways of reducing inequities in the case study areas are discussed in this section, as well. Further research needs are identified. The framing text is followed by the full articles (appendix I),

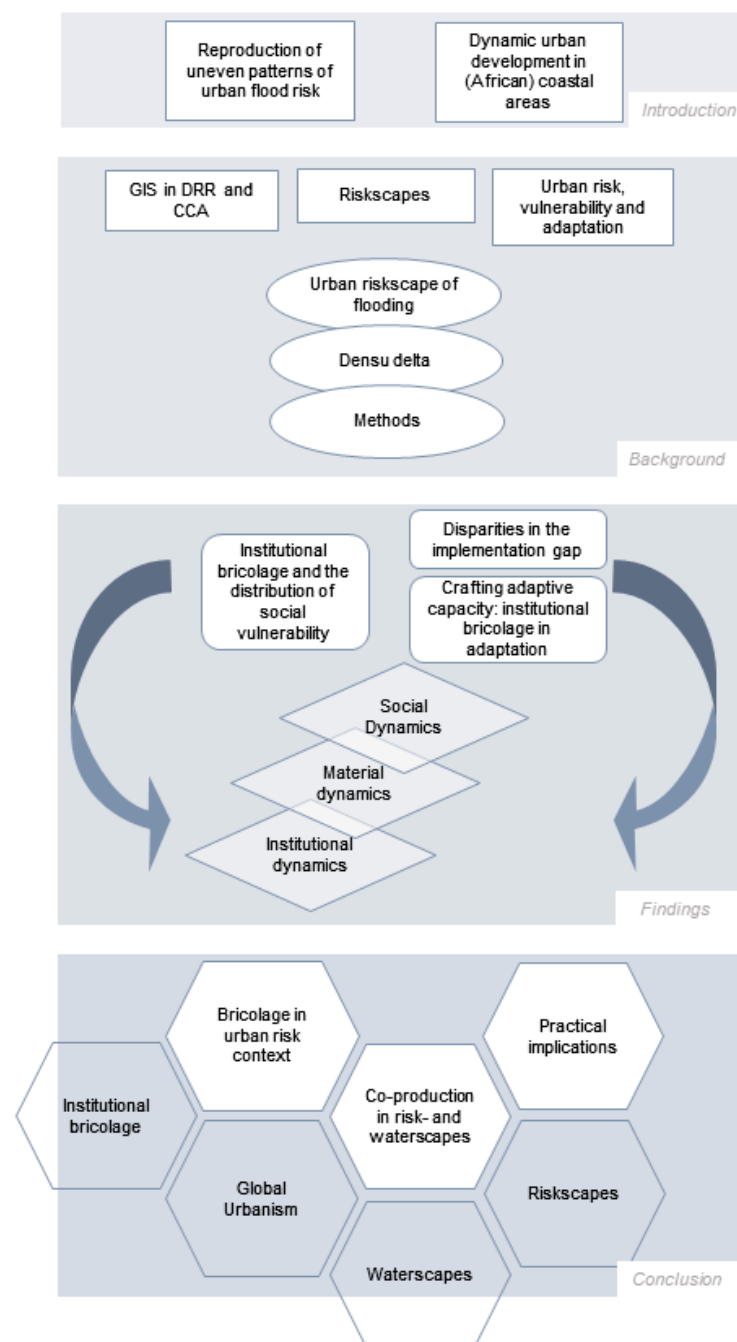


Figure 1 Structure of thesis as presented in the framing text. Own design.

additional publications supporting the background section (appendix II), and further information on the data used in this research (supplemental material).

Foreword

Creating a more liveable urban environment was my main ambition when I took up my studies in environmental planning. If open spaces were designed well – so I was convinced – people regardless of their background would benefit from the environmental, recreational, health, social, and even democratic benefits of open (green) space, and I considered these effects to be of crucial importance given ongoing urbanisation across the globe. Five years on I realised how little planning can do to level off urban environmental inequalities, especially when planning decisions are taken in politicised context, and urban residents have far greater concerns than protecting the environment or taking care of open spaces. Studying artisanal fishery in Accra, the complexity and intensity of forces shaping land and resource use struck me. The planning instruments and bureaucratic processes I had learned about appeared utterly inadequate to capture, let alone shape these forces. Situations of extreme urban risk in one of West Africa's largest and most deprived settlements appeared to me as the outcome of a technical school of urban / environmental planning that was entirely wrong. Working with fishermen in the centre of Accra taught me how essential understanding of mechanisms and concerns on the ground is to possibly being able to make sustainable plans. My further search for understanding the driving forces of uneven urban development that ought to be tackled in development planning led me away from planning disciplines, towards undertaking a PhD in (human) geography on power dynamics in urban landscapes of risk.

Acknowledgements

I have only been able to conduct the research and complete the thesis thanks to the enormous support from many people.

First of all, I would like to thank my supervisors Antje Bruns and Mark Pelling who have guided me through this process with a lot of enthusiasm, knowledge and sympathetic support.

I am especially grateful towards Frances Cleaver for the open discussions we had in London and her close reading of my manuscripts engaging with her work on institutional bricolage.

I thank the Heinrich Böll Stiftung for funding my research, and IRI THESys (Humboldt University) and WaterPower (Trier University) for providing additional financial support for conferences, field work and data collection.

My warm thanks go to the team of WaterPower for the critical feedback on my papers and presentations, for making my final field stay in Accra even more enjoyable, and especially Lara Bartels and Rossella Alba for always being there to discuss PhD-life questions – not as colleagues but as friends. Without the knowledgeable and focused input by Ravi Baghel and the speedy assistance of the students at the Governance and Sustainability Lab in formatting text, maps and figures I could not have submitted my manuscripts in the little time frames I had shortly after giving birth to my daughter.

A special thanks goes to all those who have made my research stays abroad so pleasant and fruitful: Mark Pelling, Frances Cleaver, Kelly Power, Hayley Leck, Johannes Moes, and Santa Pedone in London, and Samuel Agyei Mensah, Chris Gordon, Martin Oteng-Ababio, Ernest Olerthey, Raphael Atanga, Kofi Owusu, Antje Bruns, Esther Danso Wiredu, Sarah Kunkel, Cephas Kagblor, Kwaku Apau, Joel Asiedu, and the residents of the ‘Obroni house’ in Kotobabi Down in Ghana. I expressly thank all those participating in this research for their time and commitment.

Meeting many great people with inspiring research projects at the Graduate Program of IRI THESys and the Transformation Research Cluster at Heinrich Böll Foundation has been a fundamental source of motivation throughout my PhD studies. Thank you all for repeatedly challenging my ideas from your various backgrounds and standpoints, for the intense discussions on how and why to conduct transformation research and what this actually means, for many brilliant presentations and workshops, and above all for always creating a vibrant atmosphere of a diverse, collective search of ways towards (a) more sustainable future(s). I will miss this a lot.

My manuscripts would not have improved in the way they did without the detailed and critical feedback of the PhD-writing group. I thank you for seemingly never being tired of reading my drafts and for the encouraging discussions, also concerning PhD life in general. Many anonymous reviewers have contributed to sharpening the papers that form the core of this thesis. I greatly appreciate the support provided by the special issues’ editors Peter Feindt and Arabella Fraser who have continuously guided me through revision processes. John Nevin and Christina Lee have been extremely supportive in language editing.

I most deeply thank my family and friends for all their support, encouragement and patience towards my research, as well as their refreshing curiosity that often helped sharpening ideas and language. For all the loving care Selma received from her grandparents, aunts and uncles, and further babysitters while I was writing up. My husband Jakob has been the backbone of my research. I thank you for everything, from your open ear and critical questions on the topic to organising our family life around my schedules, and for your unconditional backing throughout.

1. Introduction

Not only in Ghana, but across the globe people have been moving to cities, and they have been moving to the coasts. Nowadays coastal cities are growing disproportionately not only as a result of migration, but also from natural growth. These dynamics of urban growth intersect with coastal ecological systems that are particularly vulnerable, and dynamics of environmental change that affect them in multiple ways. Coastal cities are affected by upstream river modification and pollution as well as by sea level rise and storm surges, caused by changes in land use, agricultural practices, climate change, etc. (to name only selected drivers and impacts; see Bruns & Frick, 2013 for further discussion). Particularly in rapidly growing cities where urban development outpaces planning, hazard-prone sites are settled on by the urban poor who lack resources to settle on safer grounds (McGranahan, Balk, & Anderson, 2007). In other cities, hazard-prone sites are also settled on by more affluent people who deploy large shares of resources to protect themselves from hazard impacts, whereas less affluent people live on less exposed sites but experience greater risk due to their lack of resources to prepare and cope (e.g. Collins, 2008; Cutter, Mitchell, & Scott, 2000). These patterns lead to the question: what are the power dynamics that shape differential patterns of risk?

My personal journey from a technocratic understanding of urban development to a political ecology perspective reflects the development of planning as a discipline as it has become more aware of critical political geography and post-colonial thought. What has been addressed in critical geography and development studies for decades is now increasingly discussed in planning: whether a plan contributes to human well-being depends not so much on the allocation of resources and space for specific purposes on paper, or based on indicators, but on the power relations, societal preferences and priorities any plan interacts with in its design and implementation (Blanco et al., 2009; Goodfellow, 2013; Harrison, 2006; Watson, 2009). Dealing with dynamics and uncertainties has always been an issue in planning as plans are essentially based on assumptions made about future development. However, dynamics and uncertainties have long been addressed as numerical values, assuming rational choice (e.g., in scenario techniques), and power relations have been poorly addressed (Allen, 2003). Although the awareness of postcolonial perspectives has entered geography – more precisely environmental justice and political ecology – earlier than planning schools, geographic understanding of power dynamics in cities is still limited (Cook & Swyngedouw, 2012).

In Accra, the coastal capital of Ghana, many dynamics that characterise contemporary urban risk are at play. These are urban change, interaction of environmental risks, and institutional dynamics. To begin with, the city has been growing constantly over the past decades, and is now spreading beyond the administrative boundaries of the Greater Accra Metropolitan Area (Stow et al., 2016). Adjacent districts and municipalities have hence become additional stakeholders concerned with issues of urban development. Secondly, one of the most visible environmental risks affecting Accra is flooding, which has occurred close to annually and caused personal losses, displacement of hundreds of thousands of people, and damages of more than 50 million USD since the beginning of the 21st century (Amoako & Boamah,

2014). Over 366.000 people in informal settlements are considered to be particularly exposed and vulnerable (Amoako & Inkoom, 2017). For many dwellers, however, other risks are a greater concern, namely crime, fire, access to land, water and air pollution. When several hazards coincide, detrimental effects are exacerbated, as the flood-fire-disaster in June 2015 has shown, where flooding caused an explosion at a petrol station that led to the death of 159 people (Smith Asante, 2016). Thirdly and last, the institutions that are involved in flood risk governance are multiple given the expansion of the city across administrative boundaries, the legal plurality in land and water governance under both customary and statutory regulations, and the activities of the private sector, international donors and non-governmental organisations. Dynamics moreover arise from a recent re-organisation of metropolitan districts within Greater Accra.

Power dynamics link to institutional dynamics, and here is why flooding is particularly interesting to study as an example of an urban risk pattern: decentralisation has led to a shift in responsibility towards lower levels of decision-making. At these lower levels decision makers are faced with many acute risks that require immediate action, whereas flooding tends to be a more 'distant' risk limited to specific times of the year and to specific areas. Specifically in poor, dynamic cities (for instance in Africa), tackling such risks is not a priority compared to constant risks from fire, crime, epidemic diseases linked to sanitation and water, etc. The same applies to individuals' or groups' risk prevention strategies particularly in deprived settlements (Pelling & Wisner, 2012). Hence flooding tends to be an increasingly important risk as a result of inaction. In Accra this is exemplified in the reoccurrence of flooding and its impacts on people, infrastructure and economic activities despite knowledge of manageable causes (such as maintenance of the drainage system) and anticipation of flooding during the rainy season (Amoako & Boamah, 2014). In response to perceived inaction in the mitigation of flood impacts, the international Red Cross has become reluctant to provide relief assistance (Modern Ghana News, 2013). Flooding is moreover relevant to the analysis of power in urban development as it can be considered a visible instance of anthropogenic climate change that challenges the sustainability of established urban development plans (Hetz & Bruns, 2014). It has been analysed as an object of adaptation to climate change that exposes institutional and power dynamics in urban governance and planning (see, for instance, Blok, 2016; Hetz, 2016; Næss, Bang, Eriksen, & Vevatne, 2005).

Governance of urban (flood) risk entails not only the formal distribution of power to take decisions and implement action. Important aspects of how flood risk is governed are how institutions interact, how they adapt to changing circumstances, and how they learn (Næss et al., 2005). More broadly speaking, institutional dynamics influence what kind of strategies to prevent flooding and adapt to its impacts are developed and implemented. These dynamics are more or less visible, and more or less formal. More visible institutional dynamics such as shifting framing of flood protection have been analysed (e.g., Wesselink, Warner, & Kok, 2013). So have less formal dynamics in formal institutions, namely social learning within agencies concerned with flood management and adaptation to climate change (Næss et al., 2005). Invisible dynamics in informal institutions, however, are rarely described. Actor-

centred and critical institutionalism views stress the role of actors in shaping institutional dynamics across boundaries of formality/informality (Cleaver & De Koning, 2015; Mayntz & Scharpf, 1995). Mechanisms by which institutions are transformed, tinkered with and reinvented have been described for the context of natural resource governance (Cleaver, 2012). I argue that these mechanisms also shape governance of urban flood risk because the institutions and actors involved are similarly diverse, and the material dimension of flood risk also dynamic (see paper C, pp.I-53-79¹).

Power asymmetries in urban environmental and risk governance have produced mismatches between what is suggested in research, in policy documents, and what is implemented to reduce impacts from environmental hazards. These mismatches have been analysed as a ‘science-action gap’ in the context of adaptation to climate change (Moser & Dilling, 2013), and as an ‘implementation gap’ in disaster risk reduction. I argue that in the context of urban flood risk governance, the two ‘gaps’ overlap: as one gap between science and policy (design), and one between policy (design) and implementation. Hence when looking at policy arguments, as I do as one part of my thesis, it is important to consider potential gaps both in the translation of suggestions from research into policy design, and in bringing written policy into practice (see also Gaillard & Mercer, 2013). Being aware of the different contexts (abstract - research, strategic – policy design, practical – implementation) that policy arguments are developed in appears particularly important in the context of the Global South, where dominant assumptions underlying research enquiries and policy development have been shown to misinterpret local conditions of risk for a long time (Adger, 2001; Macamo, 2013; Wisner, 1988). However, the science-action gap has been described for Western contexts (Moser & Dilling, 2013), meaning the domination of ‘Western’ ideas in policy recommendations on adaptation to climate change has not been challenged by this strand of research.

Both risk (hazard x exposure x vulnerability) and adaptive capacity (option space for taking action to reduce disaster impacts) are shaped by a combination of bio-physical processes and social relations and norms (Wisner, Blaikie, Cannon, & Davis, 2004). An example from flood risk is the following: conversion of permeable soil to an impermeable surface enhances surface runoff, which contributes to potential flooding. A normative preference for sealed surfaces on open spaces, parking lots, etc. spurs the respective conversion of surface properties. Social relations determine the acceptability of land surface conversion and other practices that contribute to flooding. Power relations moreover shape perception of risk and vulnerability, and consequently the level of adaptive action taken in anticipation of a flood event. Power is also decisive for building up resources to be able to cope and adapt. Both the bio-physical and the social processes and relations are particularly dynamic in rapidly urbanising areas, creating uneven landscapes of risk and environmental justice. In Accra, environmental injustices – particularly with regard to environmental health – have been well documented, for instance by Stoler et al. (2012). The influence of dominant discourse on local development has also been analysed from critical standpoints by Afenah, (2012) and

¹ All references to the submitted papers and additional publications in this framing text refer to the pages in the appendices, not to those of the original publications.

Oteng-Ababio (2013b), showing that a domination of Western concepts and views of development in policy design and implementation has reproduced patterns of uneven development and risk.

The case of the Densu Delta in Accra is a critical incidence of multiple pressures interacting in a context of flood risk, urban development pressure, and informality. Urbanisation has been particularly strong over the past two decades, and migrants settling in the area come from diverse backgrounds, including several ethnic groups from Ghana such as Ewe, Adas, Akans, Gangmes and tribes from northern Ghana, as well as neighbouring countries and returnees from further abroad (Amoako & Inkoom, 2017; Interview ID 28). A setting of plurality in governance between traditional and governmental authorities adds a further dynamic, especially because land ownership in the area is unclear and highly contested (Barry & Danso, 2014). The case moreover illustrates the implementation gap in urban adaptation, as the area is not supposed to be developed under the local planning scheme, as well as according to the Ramsar Convention for the protection of rare bird species, under which the Densu delta wetland has been declared a nature conservation site. Despite these regulations, encroachment into the wetlands is ongoing. The level of risk exposure and vulnerability is diverse within the delta. Adaptation is a response necessary to deal with the multitude of environmental changes and associated risks (see paper B, pp. I-29-30). At the same time, observed implementation gaps in current urban development and environmental regulations raise the question of what barriers there are to implement adaptation, and how these can be overcome to enable environmentally just development.

The co-production of tangible and constructed factors of risk and adaptive capacity means that the materialisation of power and other social relations in a bio-physical landscape of flood risk is an important factor in the evolution of uneven landscapes of risk (see appendix IIC, p. II-35 for an extended discussion of co-production in uneven landscapes). In a political ecology take, I understand environmental risk to be the result of embedded power relations. Only the transformation of these power relations (embedded in discourse, politics, trade, etc.) will result in sustainable reduction of environmental risks. Hence sustainable adaptation to environmental risk is one that leads to transformation (Pelling, 2011; Revi et al., 2014). The overall research question therefore is: What are the relations and dynamics of power that shape the distribution of flood risks, and how are they materialised in the currently highly uneven patterns of flood risk around the Densu Delta?

The landscape of risk in Accra described is an example of a riskscape as described by Müller-Mahn and Everts (2013): layers of different risks are not only spatial (as pointed out by Cutter et al., 2000 and in environmental justice research). Individuals and social groups have different perceptions of risk and construct risk priorities differently. Accordingly, how layers of different risks overlap is very different to, for instance, a fisherman in Jamestown (the old centre of Accra) compared to a National Disaster Management Organisation (NADMO) officer (cf. Codjoe, Owusu, & Burkett, 2014; Oteng-Ababio, 2013a). What this thesis shows in the example of the Densu delta, west of Accra, is that differences in riskscape are not only constructed differently, they are also experienced differently in materiality. To show the materialisation of power relations within riskscape, the implementation gap in adaptation to

flooding and distribution of social vulnerability and adaptive capacity are analysed through policy arguments and institutions.

The thesis is designed as a cumulative dissertation. Three peer-reviewed articles form the core of the thesis (table 1). The thesis furthermore draws on a book chapter and two working papers (table 2). The individual articles make contributions to literature on the implementation gap in adaptation, to institutional bricolage by applying it to an urban risk context, and to riskscapes by looking at the role of twilight institutions in their making. The respective analytical and methodological approaches, findings and contributions are presented in the individual articles, and an overview is provided in tables 3 and 4. This framing text is organised in four sections, namely introduction, background, findings and conclusion. The purpose of the following section ('background') is to present and discuss conceptual and methodological aspects that have not been discussed in the three articles, the book chapter and the working papers. The focus is on the research process, i.e., on how analytical concepts and the case study were identified and operationalised to address the research question. Findings of the individual articles are summarised and further findings emerging from the joint reading of the individual articles presented under 'findings'. Their implications for research and policy practice are discussed in the conclusion, and further research needs are identified.

Table 1 Overview on papers submitted and analytical foci (appendix I)

Paper	(A) Institutional bricolage and the production of vulnerability (Frick-Trzebitzky, Baghel, & Bruns, 2017)	(B) Disparities in the science-policy-action gap (Frick-Trzebitzky & Bruns, 2017)	(C) Crafting adaptive capacity: institutional bricolage in adaptation to urban flooding (Frick-Trzebitzky, 2017)
Analytical focus	Role of institutions shaping the distribution of vulnerability	Contrasting policy arguments with practitioners' experience of implementation	How institutional bricolage shapes the distribution of adaptive capacity

Table 2 Overview on further contributions (appendix II)

Paper	(A) Risk and adaptation in (African) cities (Frick, 2016a) (Working Paper)	(B) GIS in flood risk research (Frick-Trzebitzky, 2017) (Working paper)	(C) Travelling through the Densu delta: Location, Place and Space in the Waterscape (Frick, 2016b) (Book Chapter)
Analytical focus	Identifying conceptual frame to study risk, vulnerability and adaptation in an African city	Identifying limitations of GIS based understanding of social vulnerability and patterns in riskscapes	Co-production of land and water in the Densu delta waterscape

2. Background: Analysing the Densu delta as a riskscape of flooding

In the three contributions to this thesis, the theoretical foundations of institutional bricolage, twilight institutions, riskscapes and policy argumentation have been presented and operationalised for the analyses of dynamics in social vulnerability, implementation and adaptive capacity. In this background section of the framing text I explain challenges in conceptualising dynamic patterns of risk. I subsequently show how and why institutional bricolage and policy argumentation were chosen to address these challenges (because they make invisible institutions and power relations explicit without losing sight of the material reality of social conditions). I refer to the two working papers for comprehensive literature reviews backing the selection of the analytical lenses. The operationalisation of the approaches chosen to understand dynamic riskscapes and answer the research question is

presented in the section ‘research design’, illustrating how the three articles fit together. The case study approach and methods applied have been described in the individual articles. Here I explain the process of case selection, describe the case and its various levels in context, and reflect on methodological aspects that I haven’t found room for in the articles, but that I consider essential for this thesis. References to the book chapter complement the case description.

2.1 Pinning down theoretical foundations

Review of the literature on urban risk patterns has highlighted that understanding their emergence has been limited by disconnected disciplinary perspectives (see appendix II A and B). I consequently chose to identify relevant perspectives that provide alternatives to commonly used approaches and that promise to be more integrative. As such I identified critical institutionalism/bricolage and discourse/argumentation perspectives as relevant (appendix B and paper B). This increased focus on social and institutional dynamics in risk patterns/ landscapes of risk led to a refined lens of urban riskscape. Drawing on both working papers I propose combining ‘riskscape’ with critical perspectives on institutions and policy arguments in vulnerability, implementation and adaptation to close this gap from a social sciences perspective.



Figure 2 Accra in the context of the global distribution of cities of > 5 mio inhabitants. Map shows cities with 5-10 million inhabitants (small dots) and with more than 10 million inhabitants (large dots). Design by Felix Zohlen, Alexandra Matthes and the author based on data from UNDP (2014) (amended from a joint submission to the Planetary Urbanism competition by the Journal Arch+)

Risk is accumulating in cities in the context of urbanisation and urban growth. African cities have been ranked among those cities facing the greatest risk in the World Risk Report 2014 (Bündnis Entwicklung Hilft, 2014). Urban water risk has gained increasing attention as an issue of security in water supply, as well as of protection from flooding. Both risks are intensified due to impacts of migration, climate change and other factors of global environmental change (appendix IIA). Figure 2 shows the disproportionate location of large cities along the coasts, where they are particularly exposed to risks from coastal hazards and flooding and exacerbate coastal environmental change (Newton et al., 2012).

As urban water supply and discharge turn into safety concerns, the academic landscape concerned with urban water and flood risk has been reconfigured. Risk, its components and its patterns have been conceptualised and analysed in various disciplines with different approaches and methods (table 3). Key terms have been defined in the fifth IPCC report to streamline definitions (Agard et al., 2014; box 1). They have,

Box 1 Key definitions of risk, social vulnerability, adaptation, adaptive capacity, riskscape as used in this thesis

risk is the “potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard” (Agard et al., 2014, p. 1772);

vulnerability is the “propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt” (Agard et al., 2014, p. 1775);

adaptation is the “process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. Incremental adaptation [refers to adaptation] actions where the central aim is to maintain the essence and integrity of a system or process at a given scale. Transformational adaptation [is the adaptation] that changes the fundamental attributes of a system in response to climate and its effects” (Agard et al., 2014, p. 1758);

adaptive capacity is the “the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.” (Agard et al., 2014, p. 1758);

riskscape is “a combination of material aspects that can be located in a physical landscape, and the ways in which individuals or communities make sense of them in and through everyday practices.” (Müller-Mahn & Everts, 2013, p. 28)

however, not been combined in an overarching conceptual frame that would allow for assessing the multiple dimensions of urban risk patterns coherently (see appendix IIA, pp. II-3; 10-11).

Table 3 Scholars, research questions and key concepts used in different disciplines studying risk, vulnerability and adaptation. Excerpt from appendix IIA.

Natural sciences	
Hazard research	Influential scholars: Frank Press Research questions: What are the natural/ environmental triggers that create hazards? Key concepts: Rational behaviour; risk as a complex concept, combining objectivist and constructivist views, vulnerability as an outcome of exposure, fragility and lack of resilience
Applied sciences	
Climate Change / Adaptation research	Influential scholars: Mark Pelling, Neil Adger Research questions: How do people adapt to climate change? Key concepts: vulnerability, coping, adaptation, adaptive capacity
Urban research	Influential scholars: Christine Wamsler, Cassidy Johnson, Patricia Romero-Lankao Research questions: How can disaster risk reduction be mainstreamed into urban planning? Key concepts: Focus on everyday-hazards and resilience
Disaster studies	Influential scholars: Susan Cutter Research questions: What are human responses to hazards? Focus on reducing vulnerability Key concepts: vulnerability, risk
Social Sciences	
Development studies	Influential scholars: Robert Chambers, Piers Blaikie, Harold Brookfield Key concepts: Climate change, adaptation, mitigation, governance, livelihoods
Risk research	Influential scholars: Ben Wisner, Terry Cannon, Piers Blaikie, Ian Davis Research questions: Who is marginal in society? When? In what kind of situations? Key concepts: Vulnerability (defined as the product of susceptibility and coping), marginalization, realist vs deconstructive approaches, Pressure and Release model (PAR), livelihoods, coping
Vulnerability research	Influential scholars: Jörn Birkmann Research questions: What are the drivers of vulnerability? Key concepts: resilience, marginality, susceptibility, adaptability, fragility, and risk

Holistic approaches

Global change research / sustainability science

Influential scholars: B.L. Turner, Claudia Pahl Wostl

Research questions: Who and what are vulnerable to the multiple environmental and human changes underway, and where? How are these changes and their consequences attenuated or amplified by different human and environmental conditions? What can be done to reduce vulnerability to change? How may more resilient and adaptive communities and societies be built?

Key concepts: Vulnerability (defined as the product of exposure, sensitivity, resilience), coupled human-environment systems, resilience, governance, risk as a complex concept, combining objectivist and constructivist views, vulnerability as an outcome of exposure, fragility and lack of resilience

Urban planning, development assistance and disaster risk reduction have a lot of intersections in urban risk governance as socio-economic conditions, the layout of cities and infrastructure determine people's capacity to cope with or adapt to risk. Vice versa, disaster impacts affect urban conditions (Wamsler, 2006). Nevertheless, assessments and approaches to navigating (urban) risks remain disintegrated and follow disciplinary divides, as I show in appendix IIA. The spatial overlap of social vulnerability and exposure as quantifiable social vulnerability has been pointed out by Cutter et al. (2000). Müller-Mahn and Everts (2013) and Mustafa (2005) have further assessed how risk components that are more difficult to measure, such as perceptions and discourse, play out in spatial patterns of risk. Their takes hint at the role of power relations in shaping riskscapes (appendix IIA, p. II-14). In an analysis of competition over land and water in the Densu delta (appendix IIC) I have shown that social and material patterns in the case study area are co-produced. Both relations of power and the distribution of land and water were exposed as highly dynamic (p. II-42). These lenses and insights informed the preliminary research frame for analysis of the Densu delta riskscape (Figure 3).

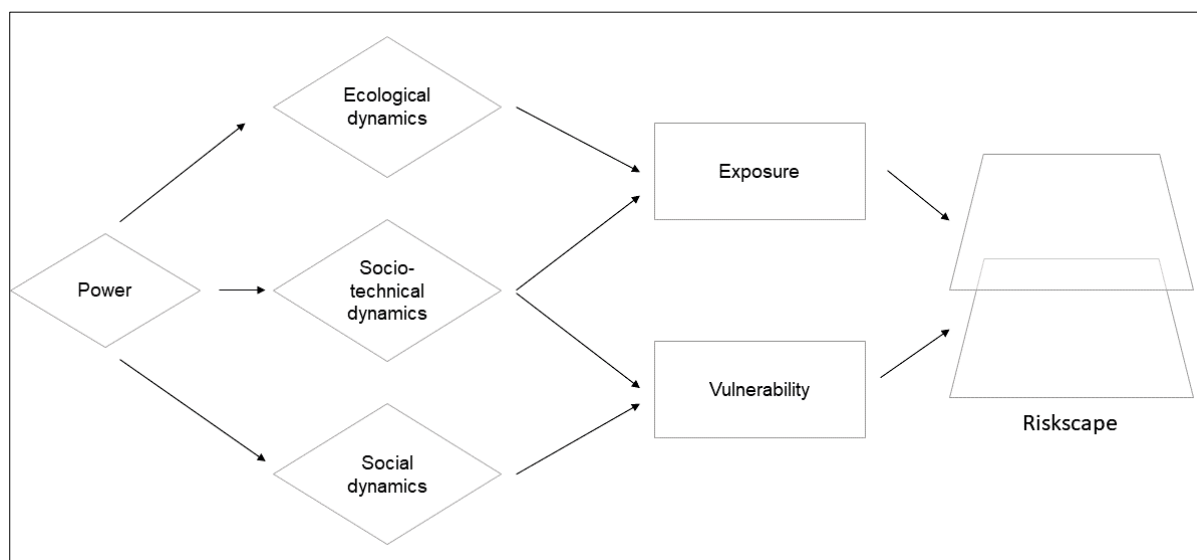


Figure 3 Preliminary research frame: Dynamic background conditions shape patterns of vulnerability and exposure. Own design.

How can the spatial distribution of risk and vulnerability be assessed? The call for integration of different perspectives on risk (cf appendix IIA for an extended discussion) raises questions on how geographical concepts of risk and vulnerability have been operationalised and what spatial patterns their application has revealed, as well as what they have been unable to show. The literature review of geographic risk and vulnerability assessments in appendix IIB reveals a bias towards easily quantifiable, measurable risk and vulnerability indicators in

geographical risk assessments. Risk and vulnerability assessments often apply geographical information systems (GIS) and decision support systems (DSS) to represent and analyse complexity and uncertainty (see appendix IIB, pp. II-22-23). Limitations of GIS and DSS approaches to risk and vulnerability assessments have been stated with regards to the integration of ecological and social models and of incoherent datasets (Cutter, 2003). GIS and DSS approaches have been further criticised for not addressing issues of power and differential vulnerability, and participatory and qualitative approaches have been proposed in response (Elwood, 2011) (appendix IIB, pp. II-24). Participatory qualitative GIS, however, is also limited in addressing power, as power relations and political context shape which data is collected and assessed. (Craig, Harris, & Weiner, 2002; Smith, Barrett, & Box, 2000).

By contrast, social relations and institutions that shape the reproduction of risk patterns are poorly captured in geographical assessments. Underlying social dynamics shape adaptive capacity, the counterpart of vulnerability, in multiple ways (see paper C, pp. I-54-55). A multitude of indicators of adaptive capacity have been defined (Adger & Vincent, 2005; Brooks, Neil Adger, & Mick Kelly, 2005; Pelling & High, 2005) that are, however, rarely assessed in their spatial dimension in the context of flood risk (see appendix IIB, pp. II-26-28). Informal institutions are an important factor of social capital, a component of adaptive capacity (Adger, 2003; Abheuer, Thiele-Eich, & Braun, 2012; Pelling & High, 2005). Individuals' personal relations furthermore shape adaptive capacity within organisations (Næss et al., 2005; Pelling, High, Dearing, & Smith, 2008). The interaction between formal and informal institutions is a core component of adaptive capacity. Its analysis provides understanding of dynamics in patterns of risk and vulnerability that cannot be captured in GIS and DSS (see appendix IIB, pp. II-25-28 for a more detailed presentation of this argument).

While “good enough” or “fit for purpose” approaches have been proposed to address vulnerability and adaptation in conditions of complexity and uncertainty (e.g. Rijke et al., 2012), the literature review on geographical approaches to risk, adaptive capacity and vulnerability presented in appendix IIB has shown that assessment of underlying social dynamics ought to be combined with GIS/ DSS approaches to avoid reproduction of power relations. Adaptation research requires further attention to institutions' and social relations' role in a riskscape (appendix IIA, pp. II-13-14). This dimension of the riskscape is the focus of this thesis. Figure 4 depicts the revised frame for this research.

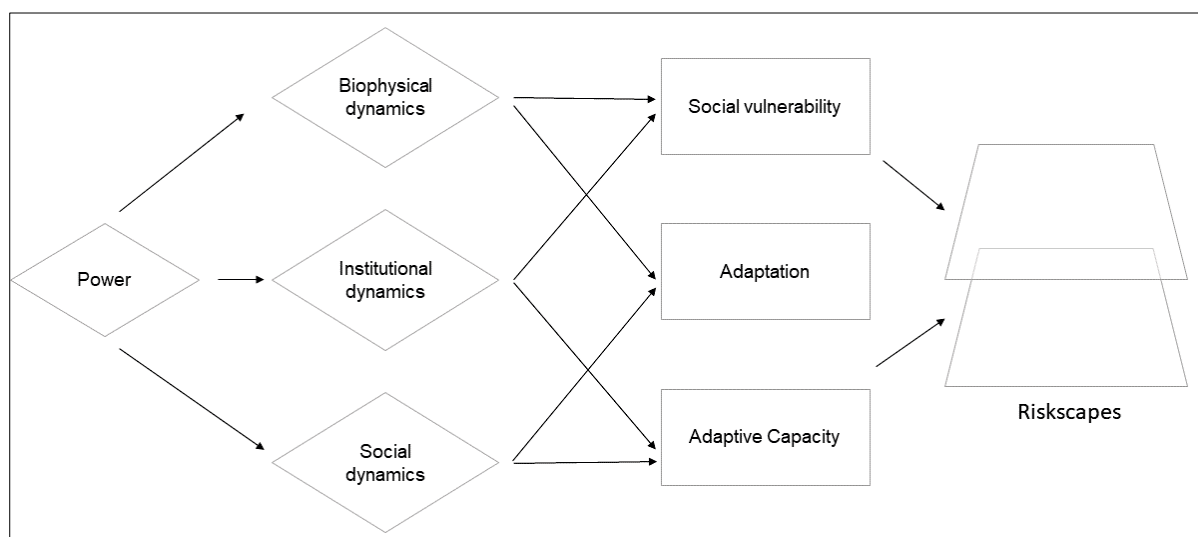


Figure 4 Revised research frame: bio-physical, institutional and social dynamics shape patterns of social vulnerability, adaptation and adaptive capacity. Own design.

Next to institutions and power relations, policy arguments importantly shape where and whether adaptation occurs and risk is reduced. Whether (academic) knowledge is being used in adaptation practice depends not only on what knowledge is being generated with which methods. Rather, what is considered ‘knowledge’ about risk, vulnerability and adaptive capacity, and how it is communicated is key in implementation of adaptive strategies (Hinkel, 2011). Limiting factors in adaptation to urban flooding result from a disintegrated discussion on risk reduction and adaptation, as has been pointed out for instance by Wamsler (2006). The scholarly debate on urban adaptation is shaped by separate climate, risk and development research communities, which only started merging ideas and concepts over the past decade, with the first disaster-related report by the intergovernmental panel on climate change (IPCC) published in 2012. Equally in policy practice, disaster risk management and development communities have largely worked in separate fields, until the urgent need of adaptation (in addition to mitigation, which had dominated climate change actions before) made mutual relevance evident. Differences, however, are only slowly overcome, amongst other reasons out of fear of enhanced competition over public resource funds that follow a disciplinary divide. As a result, measures developed in different disciplines are not coordinated and tend to interfere with or even override other adaptation efforts (see appendix IIA for a more detailed discussion).

Research on environmental risk policy moreover suggests that the “science-action gap” (Moser & Dilling, 2013) is shaped by the wide-spread assumption in both academia and policy practice that society/environment relations can be managed and policies can be implemented in a top-down manner. This assumption has been proven wrong by a number of case studies that have shown how local conditions, knowledge, values, institutional practices and learning, as well as power relations are decisive to adaptation and disaster risk reduction on the ground (see paper B, p. I-30-31 and paper C, pp. I-54-55 for the respective literature reviews).

To capture patterns of risk and adaptation, riskscapes therefore needs to assess dynamics in institutions, power relations, policy arguments and implementation. As I have outlined in

appendix IIA (p. I-13), 'riskscape' builds on the notion of 'landscape' as a way of conceptualising processes that shape visible and invisible patterns in a spatial unit. The definition of landscape as a section of the earth's surface has long been the foundation of geography as a discipline studying landscape (Carol, 1956). Differentiation of definitions has informed diversification of approaches in geography, for instance assessing landscape through discourse and representation in cultural geography (Duncan, 1995; Terkenli, 2001). While increasing specialisation in nature-centred and human-centred approaches to landscape has arguably led to the separation of geography into practically two disciplines, 'landscape' can also serve as a common frame to integrate different theoretical and analytical perspectives necessary to solve 'real-world problems' (Cosgrove, 1990; Müller-Mahn, 2005). Three interlocking aspects of landscape are the visual (form); the cognitive (meaning), processes and experiences (function). They all "vary in time, space, and social context" (Terkenli, 2001). The suffix 'scape' has been transferred to specific human-environmental interactions to stress the socio-natural co-production of 'waterscapes' (Budds & Hinojosa, 2012), 'riverscapes' (Allan, 2004), etc. These conceptualisations share critical perspectives on society-nature interactions such as political ecology or environmental justice. In waterscapes, for instance, flows of water are analysed as both the product of and a means to substantiate relations of authority and legitimacy that are constantly contested among social actors. Social power relations and the resource are co-produced in infrastructure, land use, discourse, and other biophysical structures and social practices. Waterscapes are highly dynamic in space and time (Budds & Hinojosa, 2012).

The landscape approach has also been borrowed in risk and vulnerability research to assess the socio-environmental production of spatial patterns of risk and vulnerability. 'Riskscape' or 'Hazardscape' are concepts that encompass both the processes that produce risks / hazards, and their spatial distribution (Müller-Mahn & Everts, 2013). Dynamics of gender, politics, religion, socioeconomics, etc. tend to create risk-/hazardscapes in which disadvantaged groups are both most exposed and most vulnerable to environmental hazards (Cutter et al., 2000; Mustafa, 2005). Definitions and approaches to risk- and hazardscapes differ. Parallels can be drawn to different approaches to landscape analysis, which Terkenli (Terkenli, 2001) has summarised as spatial analysis, systems and networks analyses, and semiotic or hermeneutical analyses (Terkenli, 2001). Integrating the three approaches appears to remain a challenge in analyzing the production of patterns of risk and vulnerability.

First of all, Cutter et al. (2000) have introduced the term 'riskscape' in geography from an environmental justice perspective, using it interchangeably with 'hazardscape'. They stress the role of socioeconomic and biophysical vulnerability in the assessment of riskscapes, which they identify by spatially intersecting indicators of vulnerability and exposure. The outcome of Cutter et al.'s spatial analysis approach to riskscape is a map that shows an important dimension of riskscape (the spatial dimension), but is less apt to identify social structures, processes and (power) relations that contribute to its production because it focuses on quantifiable indicators (Müller-Mahn & Everts, 2013). Assessing the multi-dimensional complexity of vulnerability requires taking into account the myriad aspects of vulnerability, addressing its multiple dimensions and conceiving vulnerability as a process rather than a

state (Birkmann 2007, Turner et al. 2003). In this respect, an analysis of riskscape needs to be based on a conceptual model that is more sensible to dynamics of time and power than that proposed by Cutter et al.

Secondly, Mustafa (2005) defines hazardscapes from a political ecology perspective, based on definitions of landscape as social space, and landscape as a way of seeing (Mustafa, 2005, p. 570). Accordingly he understands hazardscape as "simultaneously, an analytical way of seeing, which asserts power, and a social space where the gaze of power is contested and struggled against to produce the lived reality of hazardous places" (Mustafa, 2005, p. 566). In his conceptualisation and case study of an urban hazardscape in Pakistan, Mustafa stresses the role of material, discourse and policy factors in the distribution of flood hazard and vulnerability. He looks at aspects of power through the role of discourse and policy action in shaping the material reality of flood susceptibility. His approach reveals power relations in discourse and policy practice that reproduce the overlapping of high susceptibility and low coping capacity in the Lai river delta. He points to the role of institutions as deserving further attention in hazardscape analysis.

Finally, following Müller-Mahn and Everts' definition of riskscapes as "practised and constituted in practice" (2013, p. 26) which are "interwoven and need to be analysed in relation rather than in isolation" (ibid., pp. 27-28), riskscapes are moreover shaped by human agency and spatial dynamics. Both Cutter et al.'s and Mustafa's approaches share a territorial view of riskscapes, concealing the overlapping and cross-scale interactions of individual and shared riskscapes (Müller-Mahn & Everts, 2013). Müller-Mahn and Everts' approach additionally stresses the role of (informal) action in the interaction of temporal and spatial scales. Their definition speaks to an agent-based network approach to landscape (cf Terkenli, 2001). Their concept, however, does not (yet) provide a clear analytical frame for assessment of a riskscape, and it conceals the material dimension of overlapping and interacting riskscapes.

In sum, riskscape and hazardscape are distinct from one another as "hazardscape depicts the current situation of hazards at a place, [whereas] riskscape illustrates the potential damage" (Khan & Crozier, 2009). While hazardscape focuses on the processes that have led to current (uneven) patterns of susceptibility and vulnerability in a specific place, riskscape is more concerned with the combined generation of potential vulnerability and adaptive capacity in cross-scale interaction and temporal dynamics. An actor-centred analysis of riskscape looking at institutions and practices appears useful for a more comprehensive understanding of the co-production of urban landscapes of risk and vulnerability. As highlighted in Mustafa's concept of hazardscape, policy and institutions are key factors in the materialisation of social relations and dynamics in the distribution of risk and vulnerability.

2.2 Developing the research design

I understand ‘riskscape’ as a landscape of risks. Here I focus on flooding, analysing hence the riskscape of flooding. I furthermore focus on patterns of adaptation, vulnerability and adaptive capacity within the riskscape of flooding. A riskscape is both a spatial unit of ecological processes and material flows that potentially create risks (here: floods), and the spatial manifestation of societal relations (power constellations). The co-production of risk is linked to risk perceptions and experiences. Different social groups live in different riskscapes, depending on their perception and experience of flood risk in relation to other risks. The interaction of multiple experienced risks is addressed in articles A and B. The focus on adaptive capacity and social vulnerability within the riskscape allows for identifying social patterns that play out in the material dimension of the riskscape. Adaptive capacity is understood as the ability to cope with future hazard events. Social vulnerability is understood as the combined hazard exposure and ability to cope with hazard impacts (see also box 1). Both components of risk are strongly influenced by power relations, and are addressed in articles A and C.

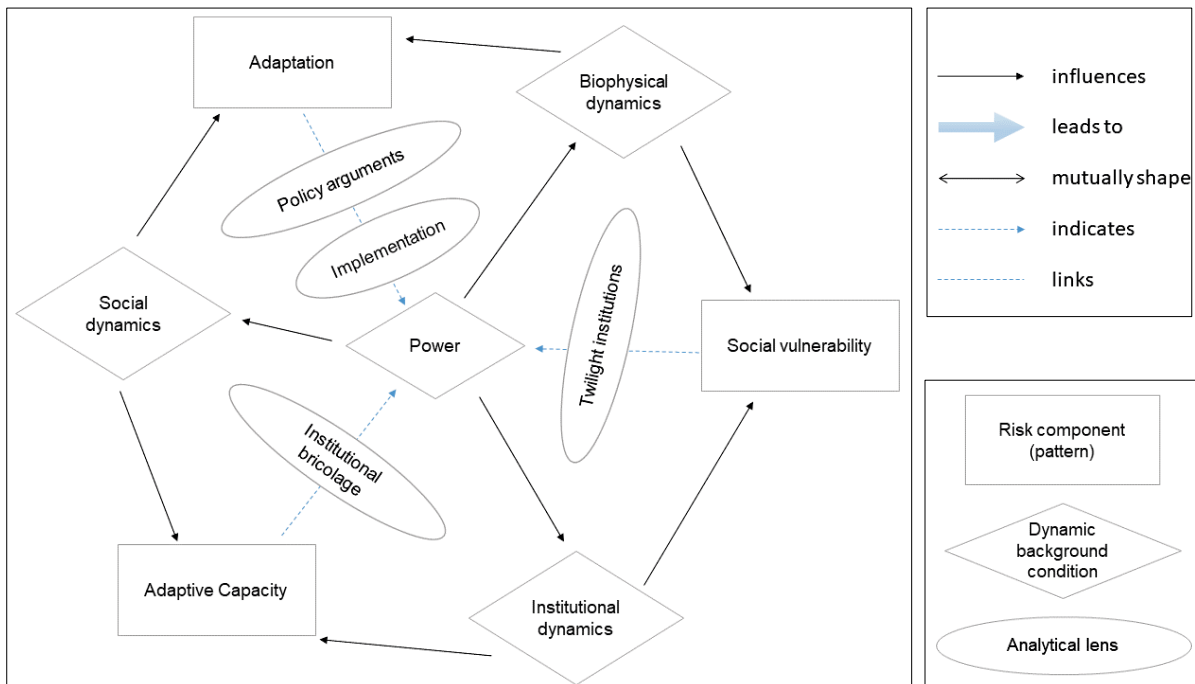


Figure 5 Analytical frame: policy argumentation, twilight institutions and institutional bricolage are lenses to assess how power shapes patterns of vulnerability, adaptive capacity and adaptation. Own design.

Practices in the riskscape shape the distribution of adaptive capacity and vulnerability. They are analysed here through the lenses of twilight institutions, policy arguments in deliberative action and institutional bricolage. Policy arguments link knowledge, or discourse, to policy practice, and therefore show the materialisation of power relations. Institutional bricolage and twilight institutions highlight dynamics across the conceptual formal/informal divide (see box 2 for an overview of key definitions and papers A (pp. I-6-7), B (pp. I-31-32) and C (pp. I-56-59) for further discussion on how these frames fit to the present analysis).

Box 2 Key terms on institutions and argumentation applied in this thesis

Institutional bricolage is the crafting of institutions beyond formal arrangements (Cleaver, 2012)

Institutions are “designed arrangements of varying degrees of publicness and formality (committees, associations, user groups, burial societies), institutionalized interactions as embodied in kinship and social networks, relations of reciprocity and patronage and in norms and practices deeply embedded in habits and routines of everyday life” (Cleaver, 2012, p. 14)

Twilight institutions are institutions that “operate in the twilight between state and society, between public and private” (Lund, 2006, p. 687)

A *policy argument* is “a complex blend of factual statements, interpretations, opinions and evaluations” (Fischer & Gottweis, 2013, p. 429). A practical policy argument links statements on conditions (such as flood risk) and goals (such as risk reduction) to possible actions or strategies (such as adaptation). It moreover builds on underlying assumptions about causal relations, for instance between actions and intended and unintended consequences that are not always made explicit (Brun & Betz, 2016). Premises on goals, conditions, activities and effects are combined in policy arguments (Fairclough, 2016). (Excerpt from paper B, p. I-35)

Twilight institutions are arrangements exercising public authority in a grey zone of formality and legitimacy, combining both institutions that have formal legitimation, and to institutions considered ‘informal’ (Lund, 2006). Institutional bricolage describes the mechanisms by which institutions are constantly reconfigured and patched together (Cleaver, 2012). Twilight institutions and institutional bricolage are of particular relevance in the African urban context, where a plurality of institutions striving for public authority is typical (see papers A, p. I-7 and C, p. I-55). The role of twilight institutions and institutional bricolage shaping the spatial dimension of the Densu Delta flood riskscape is addressed in paper A.

Policy arguments blend factual statements, interpretations and evaluations, linking statements on goals to possible actions (Brun & Betz, 2016; Fischer & Gottweis, 2013). Contrasting policy arguments with decision makers’ experiences can show where policy arguments are unrelated to local conditions, causing the implementation gap to widen (paper B, p. I-32). Arguments on strategies for reducing flood risk are traced in policy publications and compared with stakeholders’ experience of policy implementation in paper B.

Cleaver (2012) has categorised mechanisms of institutional bricolage as ‘elements of bricolage’. A review of case studies on informal institutions in urban development, land and water governance indicates that three elements are particularly relevant for the present case. These are the invention of tradition, leakage of meaning in the transfer of institutional practice and symbols from one institution to another, and naturalisation by analogy of institutional practices and symbols. They are relevant to understanding adaptive capacity in the Densu delta flood riskscape because the area is undergoing rapid change in land and water use in which the interaction of traditional and governmental institutions plays a major role (see paper C, pp. I-57-58). How institutional bricolage shapes adaptive capacity in the Densu delta is presented in paper C.

Table 4 Overview of articles, analytical foci, data, methods and case selection applied

Article	(A) Institutional bricolage and the production of vulnerability (Frick-Trzebitzky et al., 2017)	(B) Disparities in the science-policy-action gap (Frick-Trzebitzky & Bruns, 2017)	(C) Crafting adaptive capacity: institutional bricolage in adaptation to urban flooding (Frick-Trzebitzky, 2017)
Analytical focus	Role of institutions shaping the distribution of vulnerability	Contrasting policy arguments with practitioners' experience of implementation	How institutional bricolage shapes the distribution of adaptive capacity
Data	Interviews, field observations, maps, census data	Policy documents, interviews, field observations,	Policy documents, interviews, field observations
Methods	Mixed methods	Argument analysis, qualitative content analysis	Qualitative content analysis, stakeholder mapping
Case	Glefe and Tetegu / Densu delta	Densu delta / Accra	Glefe and Tetegu / Densu delta

2.3 Identification of the case

The research draws on a case study of the Densu delta, west of Accra. The delta is a wetland protected as a nature conservation site while at the same time facing the highest urbanisation rate within Ghana over the past decade. It is located on the administrative boundary of Accra Metropolitan Area and Ga South district. Spacious new housing development, extremely deprived settlements and traditional fishing communities are all located within a small distance. The culmination of environmental degradation, administrative challenges and social inequality in a context of rapid urbanisation makes it an exemplary case for studying risk in African cities, where multiple sources of risk interact in dynamic ways (see Adelekan et al., 2015). Accra is moreover an extreme case of global forces shaping local urban development (see Grant, 2009). Here flooding is caused by both natural and anthropogenic factors (Amoako and Boamah, 2014), and is therefore particularly insightful to study the riskscape.

The decision to conduct research on riskscape in Accra was furthermore the outcome of my personal research background (experience of conducting field research in Accra), academic justification (urbanisation in West Africa has been particularly dynamic and relatively poorly researched, see Bruns & Frick, 2013), and pragmatic aspects of research conditions (an existing network of relevant contacts through prior research and the WaterPower project, low language barriers as English is the official language in Ghana, and relatively good availability of local research and data, compared to other West-African cities). The Densu delta was selected as a case at a preliminary field visit to Accra in January 2014 during which key stakeholders at governmental authorities, NGOs and at research institutes were consulted. During the visit the Densu delta was repeatedly pointed out as a particularly dynamically urbanising area on the fringe of Accra affected by regular flooding. The exceptional rate of urbanisation in the area has recently also been stated by Stow et al. (2016) who identified Ga district, in which the delta is located, as one of the most rapidly urbanising areas nationwide (p.36). Stakeholders in planning authorities stated a particular interest in understanding the dynamics of urbanisation and encroachment into the wetland, which is formally protected as a Ramsar site for the protection of rare bird species and is to be kept free from development (as described for instance in appendix IIC).

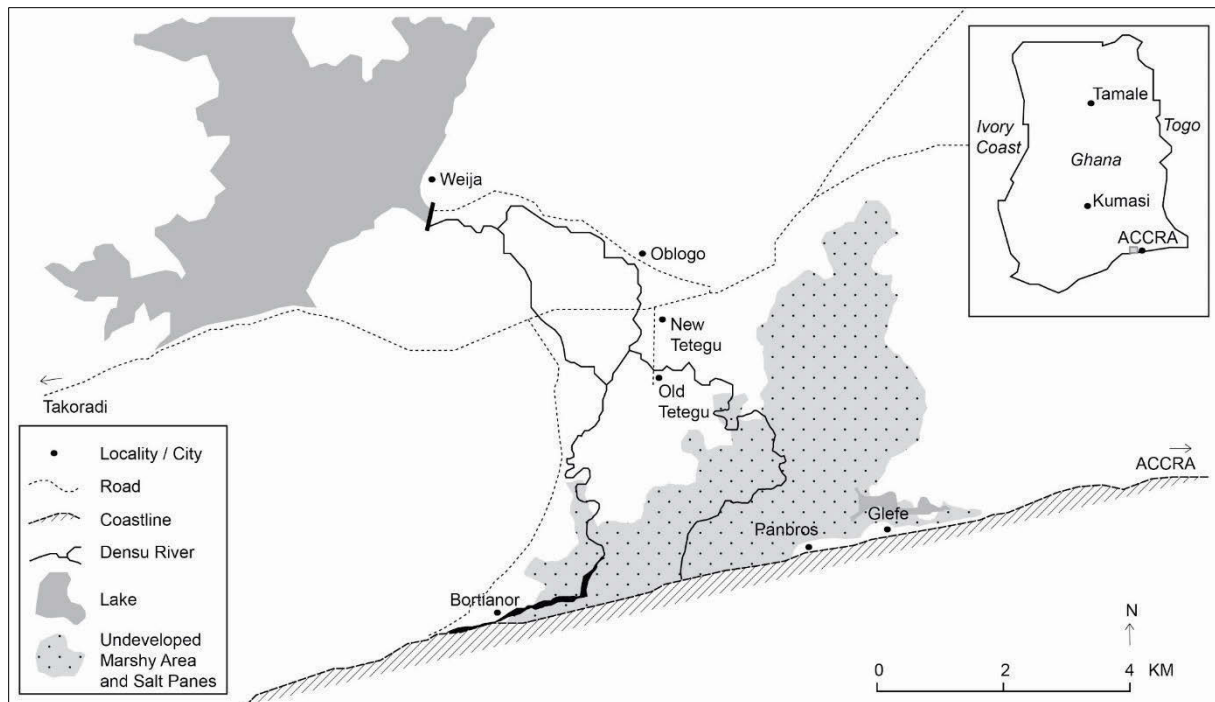


Figure 6 Case study area: The Densu delta. Own design, published in paper C.

Two localities, Glefe and Tetegu, have been analysed in detail. The two localities were selected for in depth analysis based on literature, newspaper articles and preliminary interviews stating exceptional levels of flood risk and vulnerability in both localities (see for instance Appeaning Addo & Adeyemi, 2013), and following site visits across the delta. They were moreover chosen because they reflect the wide range of housing conditions of communities in the delta observed during site visits, with Glefe being one of the most deprived settlements of Greater Accra, and large houses of relatively affluent settlers in Tetegu (see appendix IIC, pp. II-37-39).² Figure 7 shows encroachment into the officially undeveloped wetland area, and an approximation of the associated change in sealed surface.



Land reclamation with waste in Glefe



Encroachment into the wetland south of Tetegu

² The observed difference in housing and socio-economic conditions between Glefe and Tetegu is not confirmed by the latest census for which data was recorded in 2010 (Ghana Statistical Service 2012). This is likely to be the result of unclear boundaries of the localities, as particularly Tetegu is expanding into the protected wetland, as well as of the rapid ways in which conditions in the localities have been changing (see also paper A)

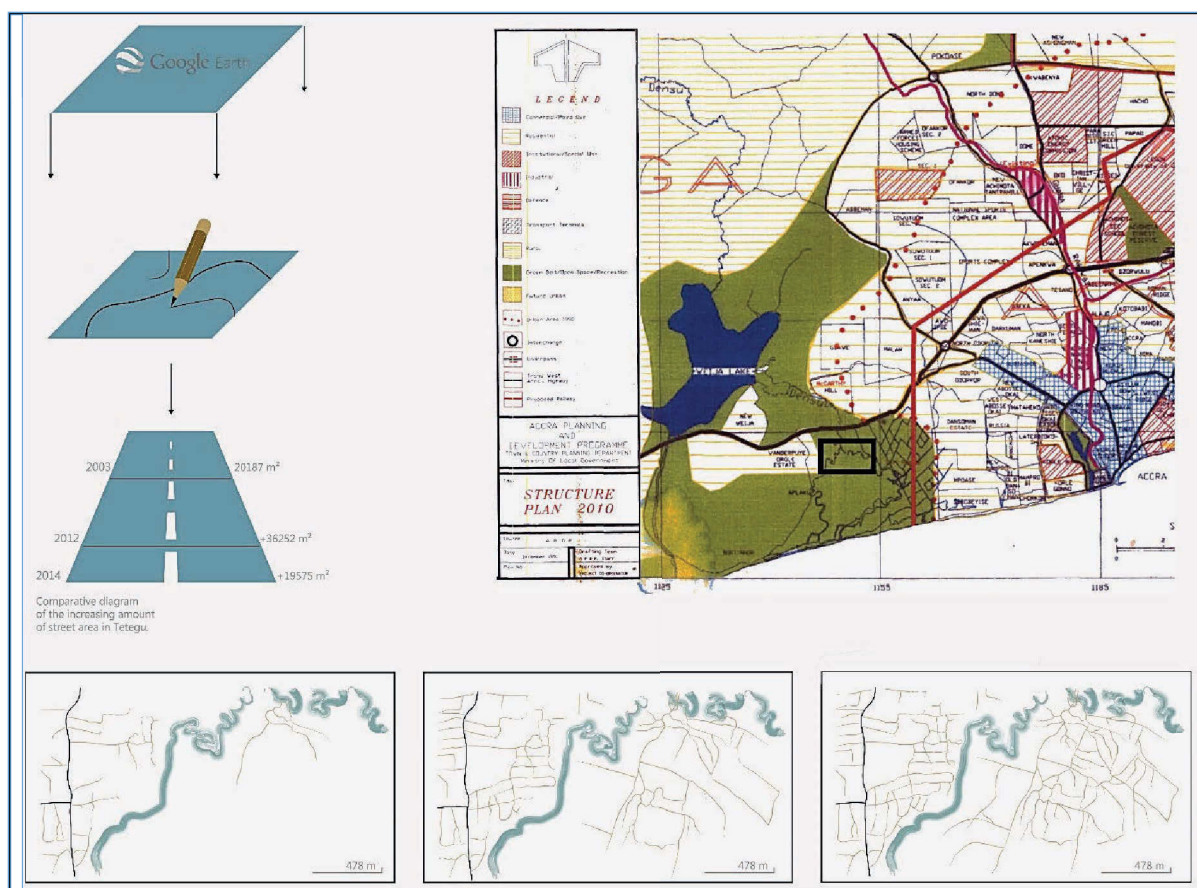


Figure 7 Street development into the Densu delta protected area in Tetegu traced from Google Earth satellite images and field data. Design by Felix Zohlen, Alexandra Matthes and the author (adapted from a joint submission to the Planetary Urbanism competition by the Journal Arch+).

The articles treat the case(s) at different levels, as indicated in table 4 (row 5). In the construction of the cases I have avoided drawing clear spatial boundaries or defining a level of scale to highlight the dynamic interactions producing risksapes in the case study area. I have described how both land and water flows are objects of contestation among key actors, and how the contestation over power to control these resources creates landscapes that are constantly changing, as land is reclaimed from Sakumo lagoon in Glefe, and water discharge amounts are negotiated at Weija dam (Appendix IIC). Paper A additionally shows discrepancies between boundaries drawn on official and semi-official maps and conditions mapped on the ground, and between socio-economic indicators collected in the 2010 census and observations made in transect walks (p. I-12).

The Densu delta is hence defined as the low-lying area through which the river Densu meanders downstream of the Weija dam before entering the sea. The delta is situated on the border of GAMA, separating Ablekuma South Submetropolitan district (within AMA) from Ga South municipality. The area is part of traditional Ga lands but wetlands have been settled on by Ewe and Fante fishermen (Tyroller, 2016). Migration not only by fishermen has resulted in broad ethnic diversity (Amoako & Inkoom, 2017). Land is family owned and highly contested, involving violent conflicts. Unclear land ownership has led to pockets of undeveloped land within built-up areas and encroachment into areas unsuited for development (under formal building regulations) (Barry & Danso, 2014). The area is

important to Accra as the source of drinking water, collected from Weija lake and treated on site by the state-owned company GWCL. It also hosts one of the largest open waste dumps, Oblogo. Both water and waste infrastructure and services are connected to environmental injustices in Accra, as has been documented by Stoler et al. (2012) and Owusu, Oteng-Ababio, & Afuto-Kotey (2012). A detailed description of environmental interactions in the delta and in the localities Glefe and Tetegu is presented in appendix IIC under the heading ‘A Journey along the Densu Delta’ (pp. II-36-39).

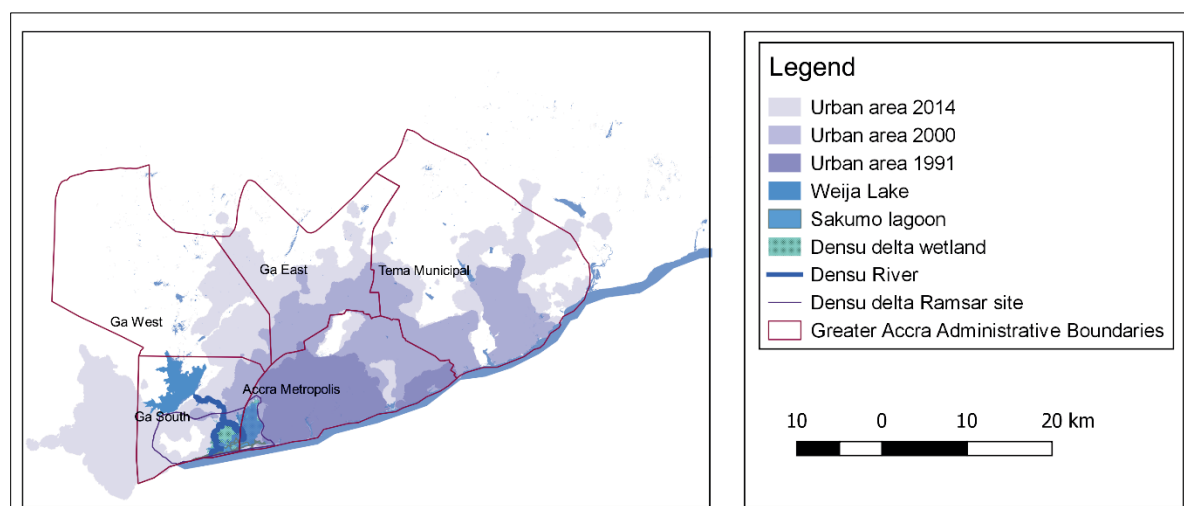


Figure 8 Urban growth of Accra and into the Densu delta. Own design based on the Atlas of Urban Expansion, 2016.

Urban flooding in Greater Accra has repeatedly had dramatic consequences in the past decades (see table 5, also paper C and Amoako & Boamah, 2014).

Table 5 Major flood hazards and their impacts in Accra (2000–2015). Source: Amended from Amoako, Boamah 2014 (data for 2000–2012) with data from interviews, newspaper articles and Amoako, Inkoom 2017

Date	No. of communities affected	No. displaced	Casualties	Estimated cost of damage (million US\$)
7 May and 5 June 2000	49	6584	12	5.65
1 June 2001	65	41,450	13	10.00
6 January, 9 and 13 June 2003	25	2787	3	2.54
18 June 2003	30	3140	5	1.71
13 April 2004	9	250	–	0.61
12 March 2005	22	2370	3	7.35
13 June 2007	40	13,140	5	1.14
27 March 2008	12	1456	–	0.91
19 June 2009	33	15,616	7	4.12
20 June 2010	42	19,833	17	2.78
25 and 26 Oct 2011	149	65,236	14	4.72
June and October 2012	157	6888	4	2.18
May and June 2013	(no data)	(no data)	(no data)	(no data)
5-12 June 2014	4	4166	3	(no data)
3 June 2015*	(no data)	> 8000	159	0,38

* damage and casualties associated with flooding and fire which occurred in combination

The delta is flooded regularly from dam spills, and as a result of increased conversion of wetlands into surfaced areas (see paper B, p. I-33 for further description of the causes and dimensions of flooding in the delta). The coastal strip of the delta is moreover affected by a relative rise in sea levels and shoreline recession. Experiences of shoreline recession and coastal inundation over the past decades have led coastal settlers to adopt adaptive practices

such as temporal relocation (Oteng-Ababio, Owusu, & Appeaning Addo, 2011). During the field research, the Densu delta was flooded from 5 to 12 June 2014, following heavy rainfall in the Eastern Region upstream of the Weija dam, and subsequent opening of all dam gates. During the flood event, one death and 4,105 affected persons were recorded in Ga South by NADMO (interview ID 039). A further flood event that occurred during the time of research became known as a ‘twin disaster’, as the combination of flooding and an explosion at a petrol station in central Accra caused the death of an estimated 152 people and displacement of 8,000 persons on June 3 2015. The event was not analysed in this thesis as it occurred after data collection had been completed. It has to be stated, however, that it may have affected perceptions and priorities identified in this research, such as policy argumentation (see Frick & Alba, 2015 for a brief review of discourse in newspaper articles on the event).

Finally, the Densu delta is an example of an area where other hazards receive greater attention than flooding, despite flooding having seemingly devastating impacts. In the analysis of the Densu Delta as a waterscape (appendix IIC) I have identified a plurality of risks that presently shape the Densu Delta. I have moreover shown how power relations shape material dynamics on the ground. Pollution, fire and access to land and water are risks of major concern to social groups living in the Densu Delta. Conservation of endangered bird species is a concern of international players and national agencies (appendix IIC, p.43). Assuming that international players and national agencies have greater influence on policy design than local groups this indicates a gap between intervention design and need, as I have later shown and present here in paper B.

2.4 Methodological reflections

Overview of methods. Methods applied in the present research have been presented in the individual articles. An overview is given in table 4. The main field work was conducted from April to July 2014, following a preliminary visit in January 2014. Additional interviews and consultations with academics from the University of Ghana (UoG) were held in January 2015 (see supplemental material for lists of interviews conducted and participatory field observations made). Interviews were conducted at different levels of governance (see figure 9) with experts, key stakeholders and a sample of residents selected by convenience (street interviews, see table 6).

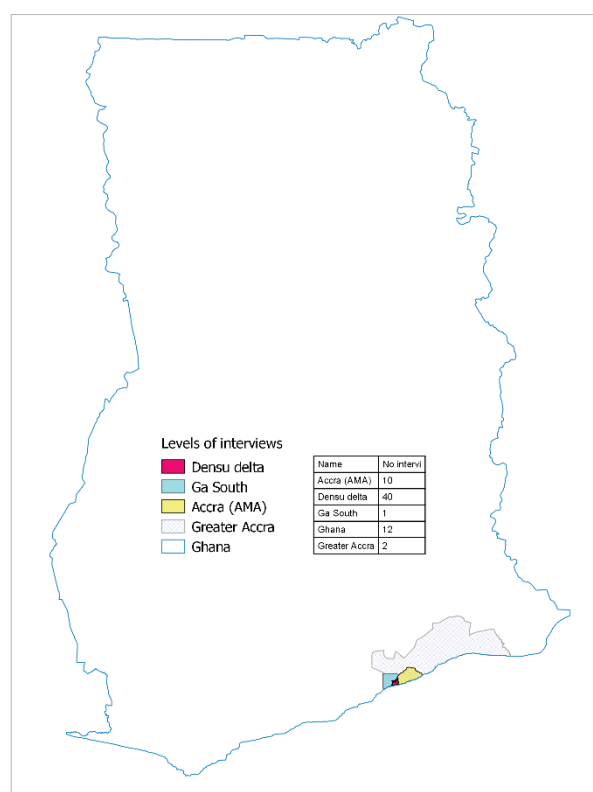


Figure 9 Spatial levels of interview partners' stakes and action. Own design

Conducting research involving the participation of people required ethical clearance for the field work which was obtained from UoG under reference number ECH 063/13-14. Field access was facilitated by a geography student of UoG who approached the assembly member in Glefe and assisted in identifying key actors in Tetegu. He subsequently assisted in translating, as well as in identifying and navigating the stakeholder groups in both localities. In Glefe, allowance for conducting the research was sought from assembly member and the local chief to whom the assembly member referred before conducting other interviews. Here both conversations, as well as subsequent interviews with key stakeholders, revealed a local routine in dealing with external visitors/ researchers: Expectations towards the outcomes of my research and from alleged connections to NGOs in Europe were raised. In Tetegu, by contrast, consent for conducting research and local positioning towards me as an outside researcher was much more diverse and less strategic, producing more genuine responses. An example are the responses to questions on the severity of flooding in the localities, which several respondents in Glefe connected to statements on need for help, whereas respondents in Tetegu rather emphasised their resilience towards flooding.

Table 6 Interviews by level of scale, type of interview and organisation

	Densu delta	Ga South	Accra (AMA)	Greater Accra	Ghana
Type of interview					
Experts	10	1	9	2	10
Stakeholder	21	0	1	0	2
Street	10	0	0	0	0
Type of organisation					
Government	4	1	7	1	6
NGO	1	0	2	0	3
Donor	0	0	0	0	1
Private sector	2	0	1	0	1
Other	31	0	0	1	0

Access to key decision makers was gained through personal contacts at the Water research institute (WRI), NADMO, Town and Country Planning (TCP) (national level), and following formal enquiries, and subsequently through contacts made throughout the research. Interviewees were further identified based on information provided in interviews, on web-pages, and in documents. Participatory observations were noted down and recorded during accompanied field site visits with key stakeholders, meetings of the disaster risk committee at AMA, and a trip of governmental officials to the Densu delta organised by NADMO shortly after the June 2014 floods (see supplemental material).

Methodological constraints and biases Conducting interview-based ethnographic research in Ghanaian agencies and localities as a white, European, educated woman exposed me to core questions of positionality. Interview situations often had a flavour of expectations of access to financial support, business opportunities, or even migration aspirations that I had to engage with during the interviews and filter in the analysis. Relying on an interpreter in the street interviews meant that I missed some opportunities for follow-up questions on topics

that my interpreter skipped in shortened translations to keep the interview flow. At the same time my obvious position as an outsider facilitated questions on everyday practices and habits that insiders are likely to gloss over or take for granted, and that 'local' researchers face difficulties in eliciting responses to, as Ghanaian PhD students have reported to me. Discussing the meaning of responses and observations on long bus rides with my field work assistant/interpreter moreover supported thorough reflections. To validate my interpretation of the data collected I had long discussions with researchers and professors at the University of Ghana and a senior officer at NADMO.

The research design purposefully focussed on the collection and analysis of qualitative data to assess the dynamics of power in riskscapes. Assessments of flood risk, social vulnerability and adaptive capacity are commonly centred on quantitative data, and qualitative assessments explaining underlying dynamics are urgently needed, as I have argued in appendix IIA and B. The present research makes an important methodological contribution in this respect. However, it also comes with several limitations. The initial research design had envisaged an overlaying of my own qualitative spatial data with secondary data on the distribution of flood risk. The secondary data I collected during the fieldwork from key authorities was however of limited use to displaying spatial patterns of risk and vulnerability. Limitations in the data sets resulted from unclear or missing geographical references (for instance location names rather than spatial extent/ shapefiles; missing reference files), large gaps in data rows, and maps and other data not being made available. As the collection of secondary data was in itself a time-consuming process, I did not have the time and resources to collect quantitative primary data during my field work after detecting the limitations of the data sets. As a consequence, the spatial patterns of social vulnerability visualised in paper C are at a small scale that is of limited use to local stakeholders such as assembly members or community group leaders. Spatial interactions described both here and in paper C appear abstract as they are not visualised with a clear spatial reference, and are therefore not as accessible to local stakeholders, as would be desirable to facilitate decision-making.

The limitation of a focus on qualitative data in combination with poor availability of quantitative data further extends to communicating the relevance of the findings to decision makers at higher levels. Essentially, the census data for both localities appear grossly outdated given the encroachment mapped and the projections made for the wider region in ongoing research (Stow et al., 2017). In the absence of more up to date population data for the localities, the number of people potentially affected by flooding in the case study area cannot be stated. These limitations show the importance of integrating qualitative and quantitative assessments of flood risk, vulnerability and adaptive capacity. Riskscapes provides a frame that facilitates the integration of qualitative and quantitative data in a GIS from a conceptual perspective. Further work needs to be done to enable this integrative approach analytically and methodologically, by defining adequate indicators, displaying data with unclear boundaries, etc.

Biases emerge from my personal research interest in understanding power relations and the critical perspectives chosen for the analysis. Common to these perspectives is a particularly critical standpoint towards formal, top-down decision-making and the respective authorities,

that bears the danger of glossing over power relations at the local level, as has been alerted in the context of post-colonial perspectives more generally (Pieterse, 2000). I engaged with this bias in selecting interview partners at different levels and from different sectors, and by analysing power relations at the locality level in particular. Further biases result from my interactions with interview partners. As described above, these were influenced by my position and expectations raised towards me in the field. They were further shaped by the way I could relate to my interview partners and vice versa. Interviews with women and with stakeholders in the urban and environmental planning sectors, for instance, were particularly open and yielded the most insightful responses. I reduced this bias by interviewing more than one expert in similar positions, and by meeting and interviewing key stakeholders more than once.

I want to conclude this section by highlighting the advantages and disadvantages of approaching the overall research question in a cumulative dissertation. Disadvantages result primarily from transferring this format from quantitative approaches to a qualitative inductive research design. In this research appropriate analytical questions were difficult to anticipate prior to data collection, and were refined considerably throughout the time of research. As new questions emerged, the focus and relation between the individual articles changed. As a result, articles do not form a clear sequence or hierarchy to answering the research questions, but rather approach it from different directions. This structure may appear counterintuitive to the reader. In a monography, the different perspectives and analytical discussions would have followed an in depth description of the case, and the cyclical approach in analysing the case could have been described more organically. Moreover, the publishing process and context inevitably impacted the focus of the individual articles. Two of them were published in special issues and were accordingly tailored to pick up ongoing discussions in further contributions, and based on editors' interests. As analytical designs were sharpened throughout the revision processes, the foci of the articles were narrowed and links to the overall research question became less obvious. Delays in the revision, particularly of paper B (submitted in February 2015, accepted in June 2017), furthermore had a strong impact on my progress.

Advantages resulted from the detailed feedback in reviews, and opportunities to discuss my work with experts for instance at an authors' workshop of the special issue on discourse in environmental policy and planning, and with co-authors. Constructing the case slightly differently for each publication enabled analysing different aspects of it that might have been concealed in a more continuous description of the case.

3. Findings: Power shapes the Densu delta riskscape in multiple ways

The key findings of the three articles are that institutional dynamics drive differential exposure and vulnerability, the material landscape of flood risk is reproduced in policy argumentation, and actors actively navigate between dynamic institutions and shape the material landscape of flood risk. How these individual findings contribute to the research question is summarised in table 7. Further findings emerge from the combined analysis of the results presented in the three papers. All in all, the research findings highlight the ambiguous

roles of key authorities, namely intergovernmental organisations and traditional authorities, and how power shapes social and institutional dynamics and ultimately the riskscape of flooding in the Densu delta in multiple ways. Figure 11 illustrates how the findings of the individual papers combine to an understanding of the influence of power on riskscapes.

Table 7 Overview of findings and contribution

Article	(A) Institutional bricolage and the production of vulnerability (Frick-Trzebitzky et al., 2017)	(B) Disparities in the implementation gap (Frick-Trzebitzky & Bruns, 2017)	(C) Crafting adaptive capacity: institutional bricolage in adaptation to urban flooding (Frick-Trzebitzky, 2017)
Key findings	Tinkering, re-invention and transformation of twilight institutions shape the distribution of vulnerability.	Causal relations are not presented and undisclosed premises do not speak to practitioners' experiences of implementation practice; the implementation gap is widened.	Chieftaincy structures and their transformation are decisive in adaptation and the distribution of adaptive capacity.
Contribution to overall research question	Institutional dynamics drive differential bio-physical exposure and social vulnerability in space, time and by social status	The material landscape of flood risk is reproduced in discourse practice in policy	Actors actively navigate between dynamic institutions and shape the material landscape of risk through their practices

3.1 Summary of key findings

Paper A provides detail on the complex relationship between power, risk and space and the respective dynamics. For the sake of analytical clarity, the contribution is focused on social vulnerability as a component of risk that is more specific in space and time than risk or adaptive capacity because it refers to the combined exposure and capacity to cope and adapt (paper A, p. I-6; also IIA, pp. II-9-11). Findings are that power relations/ contestations within traditional authorities and between them, between governmental authorities, and between levels and centres of the hierarchical polycentric governance system produce a highly differential pattern of vulnerability to flooding in the delta. More specifically, institutional dynamics, property rights, gender and income conditions (class) shape a diverse and dynamic pattern of vulnerability to flooding (paper A, pp. I-23 ff.). The diversity of dynamic riskscapes in the Densu delta is exposed as an outcome of actors' practices, which link dynamics in power and institutions to material landscapes of risk and vulnerability (paper A, pp. I-20-23).

Paper B highlights the construction of the Densu delta riskscape in argumentation on flooding. Local decision makers are faced with a construction of riskscapes that doesn't match their experiences, and that may even be at odds with them. This is the result of disparities in the presentation of causes, consequences and strategies towards urban flood risk in policy documents that render informed decision-making difficult (paper B, pp. I-42-43). Blue-printing of arguments from supra-national to national and local policy documents and across sectors contributes to an overlapping of riskscapes, but not integration of those relevant to the delta. The overlapping of riskscapes constructed at different levels of decision-making and in different sectors whilst not being coordinated on the ground creates a further hindrance to implementing strategies targeted at the reduction of flood risk (pp. I-39-42). The paper contributes to the overall research question in showing that the uneven distribution of

adaptation in the riskscape is also the outcome of contestations over meaning that have been played out in incoherent argumentation, for instance on who is most vulnerable.

Paper C adds further detail to the role of institutional bricolage in the riskscape. Here the role of institutional bricolage in the distribution of adaptive capacity has been assessed. The main contribution to the overall research question is in showing that adaptive capacity is created in different riskscapes and can be transferred between them. For example, the Tetegu neighbourhood association obtained adaptive capacity in dealing with flooding as a side effect of pro-actively engaging with risks from eviction and absence of basic infrastructure (p. I-67, also box 3). Institutional dynamics in one riskscape alter adaptive capacity in other riskscapes, as the same example shows: the instalment of gutters discharging access water in New Tetegu has negatively affected access to water among fishermen in Old Tetegu for whom access to water is a greater concern than flooding (p.I-69). Institutional bricolage is a way of navigating the riskscapes. Here authoritative processes and their uneven outcomes, shifting world views, leakage of meaning between institutions, and reinvention of tradition in land allocation have been exposed as mechanisms of institutional bricolage that are particularly relevant in the Densu delta riskscapes (pp. I-69-71).

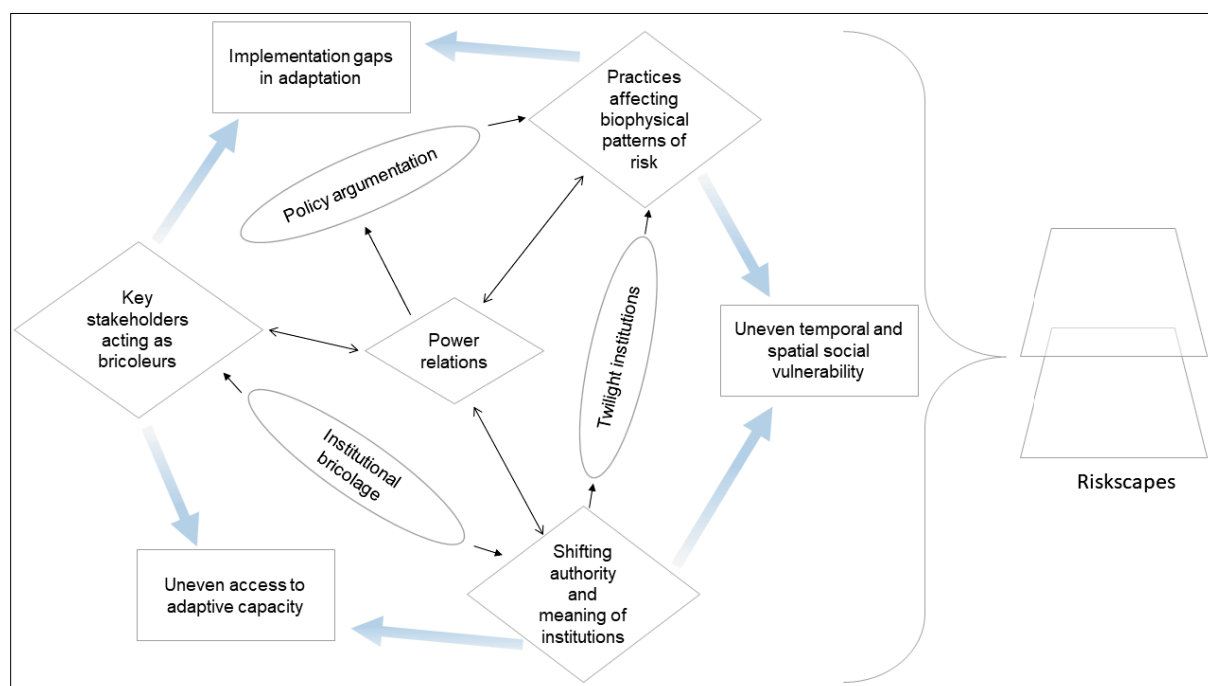


Figure 10 Key findings: patterns and interactions in the flood-riskscape of the Densu delta. Own design.

Across the different lenses on the Densu delta riskscapes presented in the individual articles, three major insights are gained on dynamic interactions in riskscapes. Firstly, authoritative processes and belief systems/ world views are dynamic and produce dynamic patterns. Secondly, riskscapes are diverse and plural, and they overlap and interact. Thirdly and lastly, key actors both enable and hinder adaptation. These forces of dynamic interactions in riskscapes create moving constellations of riskscapes. An example of community adaptation to flooding and its effects within the riskscape from Tetegu is provided in box 3 to illustrate the discussion of findings below.

3.2 Authoritative processes, world views and dynamic riskscapes

Authoritative processes are exposed in both institutional bricolage shaping adaptive capacity and social vulnerability, and in policy argumentation. Authoritative processes in institutional bricolage are most visible in land allocation and negotiation over infrastructure. Here dynamics in authoritative processes become evident in the shift of authority of informal settlers in Tetegu who reach increasing levels of legitimacy

Box 3 Adaptation in Tetegu and its multiple effects. Text taken from article C

Institutional arrangements to outbalance counterproductive on and off site consequences of households' (mal-) adaptation have had mixed results in the Densu delta. After settlers in Tetegu had discharged their water onto adjacent plots at the beginning of the informal development of middle and high income houses, a house owners' association was formed to collectively organise the installation of drainage, as well as further basic infrastructure, such as roads and water supply. A prerequisite for public infrastructure provision would be the authorisation of the settlement. The value of the members' properties was a decisive factor in the association's lobbying of local government as the municipality would benefit from authorising the settlement in the form of property taxes. Consequently, the association succeeded in obtaining building permits for the houses already erected in 2010 (see also Frick, 2016).

Members of the association and the community's chief successfully pushed for the adjustment of dam gate openings and early warning by GWCL, which led to chiefs and assembly members being considered in dam gate management (see subsection above). The events reveal the formation of a community group and the formalisation of urban land use through building permits – though not primarily targeted at the reduction of flood risk – as important steps towards a process of adaptation to environmental and crime risks. At the same time the formalisation and subsequent adaptation process is spurring continuous development into the Densu delta. As a consequence of reduced natural retention space, regular flooding increases in frequency. More and more people are exposed as the population in the delta increases.

and power to perform authority in shaping water flows through lobbying key decision makers (chiefs and local government) (cf paper C, pp. I-67-69; box 3). Another example is the phenomenon of 'fake chiefs' who perform authority in land use development by simply claiming to be in charge. Dynamic world views among chiefs have changed the meaning of 'drinks' in allocation of land (paper C, p. I-69).

Authoritative processes in policy arguments are visible in blue-printing of strategies from general documents developed at supranational levels, such as the Hyogo Framework for Action (HFA) or the Ramsar Convention on Wetlands (Ramsar convention). They are particularly noticeable in the domination of general arguments in spite of more detailed information being available, for instance on differential vulnerability (paper B, p.I-38). Dynamics emerge from the interaction of authoritative processes in policy formulation and those in implementation, as local leaders perform greater authority in selection of strategies for implementation than national or supranational policy arguments. In policy arguments, belief systems were transformed 'from above' when NADMOs paradigm shifted from relief to prevention (paper B, p. I-39).

Dynamic patterns produced by authoritative processes and belief systems/ world views are patterns of policy implementation that do not follow formal plans and hierarchies. For example, shifts in perceptions on 'good' approaches (from preferences of hard to soft solutions to flood management, from relief to risk prevention) are not mirrored at all levels. As a consequence, those concerned with implementation decide individually how to interpret and navigate different beliefs and associated expectations (paper B, pp. I-42-43). Social vulnerability is reshaped in its spatial dimension as shifting authorities lead to shifts in land use, exposure, and distribution of, and access to, basic infrastructure (paper A, p. I-22). In the context of changing relations of authority, and shifting meaning of symbols of legitimacy, people's adaptive capacity is also constantly reshaped (paper C, pp. I-70 ff.). More recent

migrants tend to experience greater social vulnerability and lack of adaptive capacity than more established settlers, but this is not always the case, as the following examples show: Fishermen in the traditional fishing village of Tetegu are negatively affected by drainage infrastructure constructed by more recent settlers in the newer part of Tetegu upstream. Because of this effect, the lower affluence of fishermen compared to more recent settlers, and the construction materials used, fishermen have lower adaptive capacity and higher social vulnerability to flooding than more recent migrants (paper C, p. I-66). A second example is the vulnerability of a Tetegu opinion leader running for assembly member who – despite a high adaptive capacity resulting from his extended social network in the community - had to resettle and rebuild his house following land disputes among customary leaders (interview ID 025).

3.3 Plural, diverse and interacting riskscapes

Different priorities in risks shape plural riskscapes in Tetegu, with fishermen being more concerned about water supply (for drinking/ cooking/ washing as well as for fish harvest) than about flooding, and a shift from concerns about flooding/ infrastructure to crime among more recent settlers (paper C, p. I-67). The house owners' association was initially founded to negotiate basic infrastructure and building permits (addressing risks of environmental sanitation and eviction), later became active in the modification of dam openings (addressing risks of flooding), and lately in protecting the community from armed robbery. This illustrates how one group of people engages in different riskscapes, i.e. multiple patterns of risks. In Glefe and Tetegu, adaptive action has always come with negative implications for the adaptive capacities of others or in the future (paper C, p. I-72). This shows the interaction of riskscapes through practices that affect more than one aspect of adaptive capacity and vulnerability. For instance, fishermen experience relatively high risk from water pollution and low risk from flooding, whereas members of resident associations previously experienced high risk of flooding, to which they adapted, and now their prior risk is crime (armed robbery). One of assembly members' most pressing concerns is the haphazard development of petrol stations in residential areas/ wetlands (field note ID 02), and the wildlife division/ Ramsar convention is concerned with the protection of habitats (risk: biodiversity loss). Riskscapes change not only over time, they also vary depending on the time of the year and day. Likelihood of flooding is greater in the rainy season and women tend to be more vulnerable and have less adaptive capacity during the day when most men are outside of the locality for work, and practices shaping the landscape of vulnerability have both spatial and temporal effects (see paper A, pp. I-16-20).

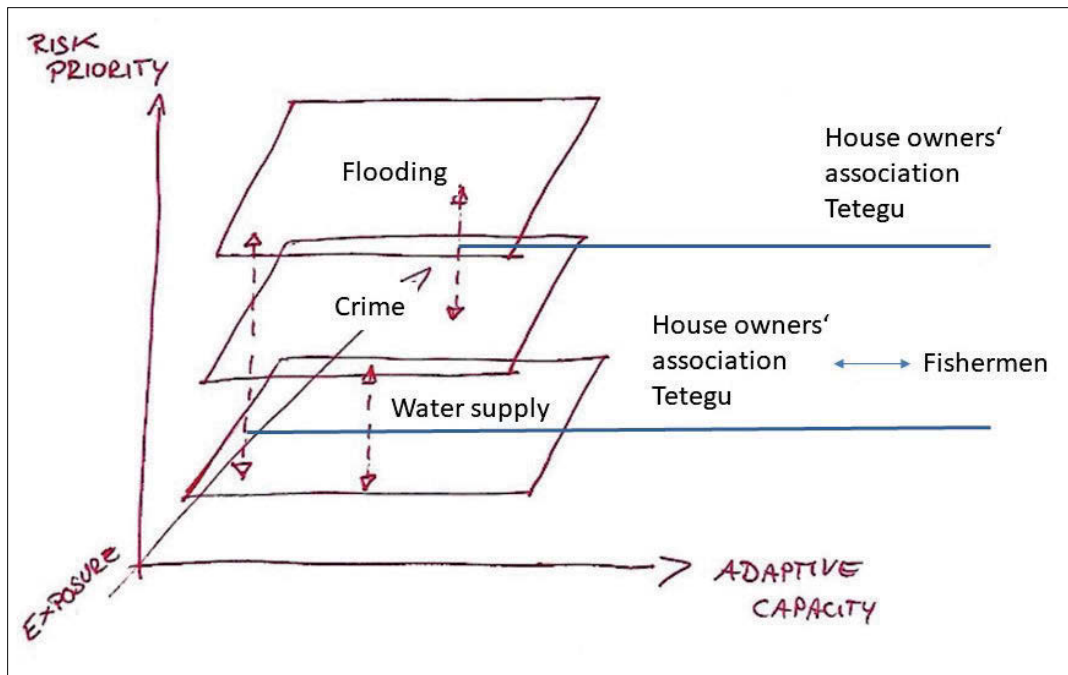


Figure 11 Interaction of multiple riskscape. Own design.

3.4 Role of individual actors

The crucial role of chiefs and assembly members as well as fake chiefs and community group members in triggering change in institutions and practices has been described in articles A and C. These actors form strategic alliances with others to bring about shifts in the governance of risk and water. Examples are house owners and the chief in Tetegu negotiating for infrastructure development (see box 3), or the assembly member in Glefe pressuring first government, and later the media for drainage infrastructure. In the context of land governance, by contrast, it appears that individual actors can draw on legitimising symbols in an unclear setting even without allies. Here (proclaimed) customary leaders define rules and conditions of access to land based on their personal world views and interests, defying both governmental legislation and traditional norms. Their authority is, nevertheless, performative, as the role of customary chiefs in land use governance is acknowledged in a formalised arrangement of legal pluralism (see box 4) and among settlers. Disputes over customary land ownership are carried out among leading stool members. Governmental regulations on land use are

Box 4 Customary land governance in Ghana/ the Densu delta

A *stool* signifies the chiefly office in Akan-speaking Ghana, referring to the furniture on which chiefs sit while in office (Berry, 2008)

Customary land: "The 1992 Constitution vests all customary lands—which constitute approximately 80% of the land in Ghana (...)—in the appropriate stool, skin or land owning family on behalf of and in trust for their people, and confirms that such lands be managed according to the fiduciary duty of the traditional authorities towards their people on the basis of customary law, which is recognised as a source of Ghanaian law" (Ubink & Quan, 2008, p. 199)

Legal pluralism is a conceptual frame that acknowledges the plurality of legal systems, for instance of government and church (Benda-Beckmann, 2002). In the Densu delta, land is owned by stools and governed by chiefs according to customary law. Natural resource and land use, however, fall under statutory law. Customary land transactions are to be reported to the government, although this is barely put in practice (Ubink & Quan, 2008).

Land disputes in the Densu delta are often violent and result from competing land ownership claims among different stools and stool members in successor disputes, spurred by urbanisation pressures (Barry & Danso, 2014).

difficult to enforce on stool-owned land particularly due to the legacy of governmental land acquisition from stools without compensation in the past. In lack of effective control over or mediation of land conflicts (box 4), settlers are vulnerable to expropriation of their land held in leasehold.

Also within authorities, individuals play a crucial role. In particular at lower hierarchical levels, officers are confronted with a mismatch of formal policies and local expectations, as identified in article B. Navigating disparities implies modification and selection of formal strategies to be implemented, in combination with a neglect of formal regulations where other interests appear higher. An example is the case of drainage provision in Glefe. Here the sub-metropolitan district had long followed formal regulations in arguing that the respective infrastructure should not be provided as the area ought not to be developed in the first place. This position was further supported by engineering consultants' assessments. However, when the local assembly member reached out to national media and the situation of the locality became known nation-wide, the authorities changed their position and initiated pavement of the main road and construction of open sewers.

All examples of individual actors' and groups' practices affecting risk and land access have been shown to spur or hinder adaptation to flooding, depending on the respective actors' interests, world views, institutional context, as well as on the level of scale at which the effects are looked at. Infrastructure provision to settlers in the Densu delta (as a flood-prone area) has reduced the vulnerability of those connected to it, but reduced adaptive capacity downstream, and triggered enhanced exposure throughout the delta.

In sum, the findings show from different perspectives how power shapes social and institutional dynamics, and ultimately landscapes of flood risk in the Densu delta, in multiple ways. Institutional dynamics, actors and practices shape the Densu delta riskscape. Authoritative processes, plural and diverse institutions, and individual actors determine differential risk patterns, and therefore who is most at risk.

4. Conclusion

I have introduced this framing text with the underlying question of how power shapes risk patterns. I have further explained how the question has been sharpened and broken down to be addressed in three separate articles. Throughout this process questions on the relationship between social dynamics, risk, flooding and urban governance emerged with regards to what constitutes the research object, and what analytical lens is needed to understand the object. In other words, have I studied riskscapes to understand social dynamics (in urban governance), or have I studied social dynamics (through the lenses of institutional bricolage and policy) to understand risk? How important is understanding flood risk? The focus changed over the course of the research. As explained in the introduction, my initial motivation for conducting this research was a desire to identify those social dynamics that create uneven patterns of risk, hence the second question was at the centre of the research. This is most evidently addressed in paper A, which identifies twilight institutions and assesses their effects on the distribution of risk.

As I dug deeper into the mechanisms of institutional bricolage and discursive practices (here: policy argumentation) through which social dynamics materialise in patterns of risk, vulnerability and adaptation, I became increasingly interested in the social dynamics themselves. An important theme in paper B is how power relations (and dynamics within them) play out in policy design and implementation. Adaptation to urban flood risk serves as a case, and policy argumentation as an analytical lens. Implementation gaps in related sectors (urban planning, nature conservation, climate change) are also assessed briefly. Targeted further towards understanding general social dynamics is paper C, where a detailed analysis of the case study provides insights into institutional bricolage in general, and its implication for the distribution of adaptive capacity more specifically. As I am concluding, I want to highlight that risksapes is a frame that allows for analysing social dynamics to understand risk in cities. Here institutional bricolage and policy argumentation are social dynamics that have been studied in detail. The case of a flood riskscape in the Densu delta has contributed to a better understanding of institutional bricolage, highlighting the role of key stakeholders acting as bricoleurs, and of the effects of policy argumentation on implementation on the ground. More importantly from a practitioners' perspective, however, the detailed analysis of the riskscape of flooding in the Densu delta has improved understanding of social dynamics that shape multiple, dynamically interacting risksapes through institutional bricolage, patterns in argumentation, practices and twilight institutions.

4.1 Co-production, knowledge and power in dynamic urban risksapes

The findings presented in the three articles and in this framing text make contributions to several relevant bodies of literature, as well as to transformative adaptation towards reduced flood risk in the Densu delta. An important overall contribution lies in applying lenses that stress dynamics and process and bridge dichotomies of formal/informal, local/global to a case in Africa. “The acknowledged mismatch between theory and the grounded urban experiences of the cities of the South raises the dilemma of whether new theory or new ‘facts’ should lead the way in illuminating a more general understanding of Southern urban processes” (Parnell & Pieterse, 2015, p. 6). The approach adopted here offers original ways of conceptualising and analysing the city without notions of development and planning that have rendered African cities illegible to social researchers (Macamo, 2013). The findings have identified disparities in policy arguments causing the science-action gap – here at the level of implementation in adaptation to flooding. The proactive patching together of institutions beyond formal design was revealed to constantly reconfigure patterns of urban risk. As much as social relations were shown to shape patterns of risk, material patterns of flood risk have influenced relations of power and collaboration. Flooding is exposed as a co-produced hybrid nature (cf. Budds & Hinojosa, 2012). These findings suggest not only that disparities in policy arguments similarly shape other areas of urban governance. They moreover raise important questions on the way knowledge is produced and shared in the interaction of science and action/ of theory and urban experiences. At the same time the analytical lenses have not been developed and applied exclusively in and for African cities but have proved insightful in understanding (urban) risk similarly in cities elsewhere. Both conceptually and

empirically, the present research therefore contributes to global urbanism from a much needed African case study perspective (Parnell & Pieterse, 2015).

In addition to this overarching contribution, more specific contributions are made to the concepts applied. Chiefly, the findings emerging from the combined analysis of the three articles contribute to a sharpened conceptualisation of ‘risksapes’ and ‘institutional bricolage’. Risksapes are shown to be both constructed in arguments and experienced in practice, and to materialise in spatial and non-spatial patterns of social vulnerability, implementation and adaptive capacity. Authoritative processes and belief systems/ world views have been identified as specific instances of power that shape how institutions interact in risksapes. Intersections of risksapes have been described that result from different risk priorities among social groups. This adds to the analysis of risksapes’ interaction based on location as described by Müller-Mahn and Everts (2013). However, whereas the authors explain the interaction of risksapes by the spatial overlap of discourses and practices of different stakeholder groups, targeted at different risks, I have shown that risksapes are dynamic and diverse, and interactions therefore less clear cut. Stakeholder groups’ risk priorities change, based on the effects of both discourse (here: argumentation) and material practices.

Applying mechanisms of institutional bricolage, actors actively navigate different risksapes and therein create and reshape intersections between them. As I have concluded in paper C, linking a bricolage perspective to that of urban assemblage by which the city is described as in “constant emergence and process [with] multiple temporalities and possibilities” (McFarlane, 2011, p. 206) would provide further understanding of the interactions of actors, knowledge and institutions in urban patterns of risk (paper C, pp. I-73-74). Blok (2016) has studied assemblage in climate risksapes on an urbanising site in Surat (India) that appears to resemble the situation in the Densu delta in many ways, and identified urban planning as the “disjunctive juggling of non-coherent risksapes, each wedded to their own forms and scales of urban change” (Blok, 2016, p. 615). While his work has drawn out important ways in which knowledge is included and excluded in the construction of risksapes across scales, the present research contributes in showing how the ‘disjunctive juggling’ takes place among multiple stakeholders engaged in adaptation to flooding in the Densu delta.

Risks of pollution, fire, access to land and water and biodiversity conservations interact with the distribution of flooding, as I have illustrated at the example of land-water interactions at different sites within the delta (appendix IIC). Re-assessing the findings of the waterscape / competition analysis with the findings of the present research in mind adds to further understanding of uneven development in the Densu delta. Just as local and global practices shape how water is co-produced in the Densu Delta waterscape, so they are involved in the creation of risksapes of water and land supply, flooding, fire, water, biodiversity and pollution. Struggles in competition and contestation over the control of the resources water and land and their use reveal a dynamic setting of power relations that are constantly negotiated. The analysis of the waterscape has revealed how contestations over power (here: to control resource use) have tangible effects on dynamics in the bio-physical landscape, as land is reclaimed from waterbodies to secure territory, and access to infrastructure is

negotiated (appendix IIC, pp. II-41-42). Ranganathan (2014) has shown that mafias perform authority in the waterscape in Bangalore by transcending boundaries of formal/informal, by diverse political practices, and by engaging in land and water markets (pp. 98-102). As these practices have similarly been shown to perform authority in the Densu delta riskscapes, policy arguments, twilight institutions and bricoleurs which link power to institutional, social and material dynamics in the riskscape are also highly relevant to the combined analysis of “flows of water, power and capital” (Budds & Hinojosa, 2012, p. 124) in urban waterscapes.

The plurality and diversity of interacting riskscapes has also been described by Müller Mahn and Everts (2013). Taking pastoralists in East Africa as an example, they have shown how different risks are topical to international organisations and pastoralists. To be more precise, they have shown how different risks are produced as topical in discourse, and how these discourses affect what strategies are suggested and implemented, and conflicts between them. My research reveals a similar overlapping of constructed risk priorities. Complementing the riskscapes literature, my findings moreover show that risks are different to different groups also in their bio-physical dimension, as a result of interacting practices, arguments and beliefs. Moreover, risk priorities change over time (throughout the day, the year, as well as following interventions such as adjustment of dam openings; paper A, p. I-15). Interactions between practices, actors and institutions have been described in articles A and C, highlighting their co-benefits and negative implications on patterns of social vulnerability and adaptive capacity.

Empirically, the research contributes to closing the knowledge gap on understanding implementation gaps in urban adaptation in Africa. It does so in identifying disparities in policy argumentation and the authoritative role of chiefs and other bricoleurs. The critical role of chiefs in land and water governance particularly in urban settings in Ghana/Africa has been stated in the literature (Earle, 2014; Grischow, 2008; Lund, 2008; Ubink & Amanor, 2008; Ubink & Quan, 2008), as well as by interview partners (e.g. interview ID 060). The ambiguity of chiefs’ role(s) as traditional leaders and representatives acting in the interest of a people, as educated professionals and as players in real estate markets has been stated, for instance by Boafo-Arthur (2003). It has, however, not been addressed in the context of adaptation or disaster risk reduction. Here the empirical contribution has practical implications, as well. What this research adds is a differentiated understanding of chiefs’ role in land and risk governance in Ghana/ peri-urban Accra. I have described not only the implications of practices in land allocation on people’s vulnerability and adaptive capacity, but also the mechanisms by which both acknowledged and proclaimed chiefs claim legitimacy and perform authority. Understanding these mechanisms and their implications for patterns of flood risk, vulnerability and adaptive capacity complements literature on chieftaincy in Ghana, and is of practical relevance to policy makers in urban and risk governance.

Given that the social processes and dynamics identified were shown to shape different urban risk(scapes), the findings are particularly relevant for urban (risk) governance in general, rather than for urban flood risk reduction in particular. As I have highlighted in the introduction, it has been argued that understanding urbanisation in Africa and planning for

peri-urban areas not only on this continent have been limited as a result of inadequate concepts (Macamo, 2013; Parnell & Robinson, 2013). Here I have applied relatively new concepts developed based on cases (not only) from Africa to a dynamic peri-urban West African context. The findings have made linkages between authoritative processes, world views and policy arguments, and implementation gaps in urban environmental planning and risk governance explicit. In highlighting and explaining dynamics in the respective processes, views, arguments and in patterns of urban development, this research makes both an empirical and a conceptual contribution to understanding the dynamic context to which planning visions in urban Africa need to speak in order to facilitate environmentally just, transformative adaptation and urban development.

4.2 Practical implications for urban (flood) risk governance

Practical implications for navigating the risksapes of the Densu delta emerge from the empirical contributions. To begin with, authoritative processes in policy formulation and implementation were found not only in the top-down blue-printing of strategies from international framework conventions to national policy documents, but also in the undermining of land use regulations by local power games over the control of land. Here customary chiefs as well as ‘fake’ self-proclaimed chiefs were identified as key individuals performing authority. In identifying dominant ideas, arguments and institutional processes that have created barriers to adaptation, as well as those that have facilitated adaptation, the research has presented findings that suggest that collaboration with key actors is critical to implementation. Policy documents as well as interviewed policy makers state the need for involvement of traditional authorities in policy design and implementation. As this research shows, the involvement of traditional authorities must be mindful of the contested legitimacy among chiefs, particularly in a rapidly urbanising context, and of institutional mechanisms that lead to traditional leaders not acting in the stool’s interest. In pointing to the key role of assembly members and community group leaders in developing and implementing adaptive strategies, the findings moreover highlight the importance of also involving these stakeholders in policy design and implementation.

Secondly, as the plurality of risksapes and the crucial role of actors and institutions in navigating them have been exposed, there are indications that different risksapes can be navigated (more) strategically. Analysis of the implementation gap reproduced in policy arguments (article B) has revealed that a simplified presentation of the implementation context in policy arguments reproduces an implementation gap. The finding that social groups live and navigate (in) different risksapes means that addressing differences in risk priorities could avoid mal-adaptation. Improving background conditions to enhance adaptive capacity and reduce vulnerability to multiple risks has been promoted under the concept of resilience in national and supranational policies and programs, for instance in CREW under UNDP (2012). However, my research has shown the pitfalls of such an approach as whether adaptive capacity is used to adapt was shown to depend on institutional context, authoritative processes and world views. Moreover, I have argued that flooding tends not to be the prime

risk of urban poor settlers and local governments but still causes damage and needs to be addressed to reduce inequalities in urban development. Minding potential effects of practices in one riskscape on another therefore seems more promising than strengthening resilience in a one size fits all solution. I have explained and visualised interactions of twilight institutions, actors and practices in riskscapes in figure 5, paper A (p. I-23). Developing this schematic representations further to model interactions would facilitate identification of co-benefits, synergies and conflicting outcomes of practices in multiple riskscapes, and could improve urban planning for adaptation in a dynamic context of multiple risks.

Based on the above discussion, the critique of current policy as formulated in paper B (pp. I-42-43) has to be slightly reframed. The formulation of general rather than targeted strategies is in itself not a constraint in adaptation to flood risk. As this research has shown, the reduction of risk in one riskscape may enhance adaptive capacity in other riskscapes, and therefore risk there. This effect is also embraced in urban risk governance approaches on ‘resilience’ (Evans, 2011). However, I have also shown that adaptive action in one riskscape may affect adaptive capacity in other riskscapes negatively. Embracing this effect of ‘mal-adaptation’ in policy design would imply a clear presentation of co-benefits and trade-offs in navigating urban riskscapes. As I have shown, the dynamics in which riskscapes interact are not arbitrary but actively shaped by key actors who more or less consciously navigate multiple institutions and risks. Engaging with key local actors and their knowledge is crucial to finding a pragmatic balance of generalised approaches and tailoring to local conditions (see also Gaillard & Mercer, 2013).

As I have explained in more detail and with references in appendix II A (pp. II-10-11), the need for integration of urban planning, development assistance and disaster risk reduction has been acknowledged but rarely put into practice. Particularly in African cities, the causes and effects of urban risks are diverse and cut across sectoral divides of urban planning, natural hazards, socioeconomic development, etc. Challenges arise from disintegrated conceptual approaches, academic and practical communities, and funding mechanisms. The disintegration has been reinforced lately by separating leading multilateral UN conferences on sustainable development goals, financing for development, disaster risk reduction, and climate change (Kelman, Gaillard, & Mercer, 2015), to which urban development was added with the UN Habitat III conference held in 2016 (appendix IIA, p. II-11). As goals, instruments and allocation of resources for the coming decades have been defined in separate communities at these conferences, competition between sectors rather than integration of topics has been stimulated. Here I have shown how the separate emergence of policy arguments creates disparities and results in an implementation gap of top-down policy (paper B), and highlighted the uneven riskscapes the overlapping of multiple perspectives on risks has produced. These findings gain particular relevance in the context of “tribalism and separation” (Kelman et al., 2015, p. 26) in United Nations’ processes and associated funding allocations in policy and research.

4.3 Constraints and limitations

The contributions of the present research are partly limited due to constraints emerging from the conceptual and methodological approaches applied. Methodological limitations and biases have been outlined under the subheading ‘methodological reflections’ above.

Conceptual constraints emerge, first of all, from the broad scope the research started off with. The initial research frame (figure 3) envisaged a comprehensive analysis of diverse conditions and elements composing landscapes of risks across scales. To assess these diverse dimensions and elements would have been more suited for a research group, rather than an individual PhD student. Arguably, the revised research frame (figure 4) is still very ambitious for an individual researcher in a context where secondary data is difficult to access³. It was therefore continuously narrowed down towards the analytical frame (figure 5). The narrowing down occurred stepwise as the individual papers were drafted. The working papers (appendices IIA and IIB) were written to justify the focus on institutional bricolage, adaptive capacity and social vulnerability in riskscape. The focus on policy arguments in the implementation gap in paper B, by contrast, is the outcome of repeated revisions over a period of more than two years. While the paper has certainly improved through the revisions, the sharpening has implied dropping important aspects of the riskscape. These are chiefly cross-scale interactions of discourse and practice in adaptation to flooding, and interactions (and disparities) at the science-policy and media-policy interfaces.

As I have concluded in appendix IIB and paper C, qualitative, participatory mapping ought to complement spatial analyses of adaptive capacity. I have assessed spatial and temporal linkages and effects of institutional bricolage in paper A, and described patterns of land-water interactions (appendix IIC), social vulnerability (paper A) and adaptive capacity (paper C). Overlapping these patterns with spatial locations of narratives, for instance on perceived risk and adaptive capacity and of patterns mapped by key stakeholders, would have added an important lens on discourse and power in the riskscape (see also Müller-Mahn & Everts, 2013; Mustafa, 2005). It would, moreover, have facilitated visualisation of the multiple dimensions of the riskscape. The omission of this lens in the present research is partly the result of the methodological limitations stated above, of the tailoring of the research frame towards institutional bricolage and policy argumentation, and from constraints in time and resources for further research.

Assessing riskscape as a holistic frame that acknowledges the interaction of multiple risks through a case study on flood risk raises questions about the fit of the frame, the research question and the material. In particular, how can the fit of policies and plans for adaptation to flooding be assessed (paper B) when at the same time I argue that adaptive capacity travels between riskscape and is often the side-effect of adaptive action targeted at other risks (papers A and C)? A danger looms of constructing a misfit between policy (targeted at adaptation and flood risk reduction) and intervention needs on the ground (holistic

³ I have argued above that the case was selected because data is relatively easily accessible. This may be true in comparison with other West-African cities. However, accessing secondary data was linked to great efforts in placing data requests, pressuring people and waiting in front of office doors, and the data obtained turned out to be of little use in many cases where datasets were incomplete or inconsistent.

approaches) through incoherent selection of material for analysis. This danger was addressed by using multiple sources to identify policy documents for analysis, including some that do not address adaptation or flooding in particular (see paper B, pp.I-36 and 53-55). Interviews centred on flooding, but were held with stakeholders representing and interacting with different sectors and touched on implementation in the respective fields (land use planning, sanitation, water supply, etc.; see paper B, pp. I-37 and 55). Nevertheless, the focus on flooding limits understanding of the interactions of riskscales in the Densu delta. Again, constraints in time and resources demanded this focused lens.

The need for drawing boundaries of the research object similarly constrain understanding of institutional dynamics in the riskscales, in particular with regard to the interaction of scales. As twilight institutions cut across established policy sectors and institutional bricolage is often invisible, analysing them required zooming into the case to the level of two localities. Here the complexity of institutional dynamics was shown in detail (papers A and C). However, institutions at larger levels were assessed in a more conventional, static sense showing formal institutions only (see paper C, pp. I-61-66). The underlying arguments made implicitly in policy documents as identified in paper A hint at the influence of invisible institutions and practices also at larger levels and within formal institutions (see also Næss et al., 2005; Pelling et al., 2008). Assessment of these would complete understanding of the riskscales relevant to the Densu delta.

Applying an institutional bricolage lens to the present case has enabled a detailed description of practices and dynamics that shape adaptation in the Densu delta. While insightful for understanding how adaptation works, the present analysis bears the danger of suggesting that embedded and twilight institutions ought to be replaced by formal, designed institutions because of the uneven outcomes of institutional bricolage in the Densu delta, or, on the other hand, that no policy intervention is needed because bricoleurs are pro-actively creating adaptive capacity. As an anonymous reviewer of a previous draft of paper C has noted, ‘playing with bricolage begins to conceal the need for action on reducing flood vulnerability’. Reducing social vulnerability in the Densu delta is, however, a pressing issue as more and more people are potentially affected by flooding and its effects. The role of policy argumentation in the implementation gap presented in paper B suggests that top-down designed policies are similarly shaped by power relations and have uneven outcomes on the ground, as the institutional practices identified in the delta do. A more comprehensive analysis of institutional bricolage across levels would have enabled a clearer message towards policy making.

4.4 Further research needs

Both contributions and limitations point to further research needs, on both conceptual and empirical levels. First and foremost, the interaction of different riskscales and scales should be researched further. Here they have been described conceptually and based on examples. For a comprehensive analysis, the assessment of separate riskscales should only be the starting point for a closer analysis of interactions between them. Mapping and modelling

riskscapes' interactions in a participatory mixed-methods approach would facilitate visualising dynamic riskscapes and deriving policy-relevant conclusions on how institutional bricolage can be used strategically in policymaking. Because arguments made in policy processes at a global level (at the United Nations) were shown to directly influence local riskscapes, an approach to scale 'jumping' or 'shifting' (Goodman, Boykoff, & Evered, 2008) appears most appropriate. Further research ought to look into how discourse interacts with the bio-physical, social and institutional dynamics identified in the present analysis. Particularly with regard to bio-physical and social dynamics, further quantitative assessments are needed to complement the understanding of riskscapes in the present case. Drawing on urban assemblage perspectives next to institutional bricolage and policy argumentation would further elicit how riskscapes are co-constructed in discourse and material interactions. The present research moreover calls for further explorations of twilight institutions and institutional bricolage in other fields of urban environmental governance. Given the dynamics in institutions for land use and tenure identified in the present case and in similar analyses of riskscapes in Surat (Blok, 2016) and waterscapes in Bangalore (Ranganathan, 2014), urban land use planning appears particularly insightful for further research on how institutions evolve and transform to shape cities.

To summarise and conclude, the present research has exposed twilight institutions and their spatial and temporal effects, disparities in policy argumentation and key stakeholders acting as bricoleurs as core elements that link power relations to patterns of flood risk. There is indication that these are similarly relevant to urban patterns also in other areas of governance. Further research ought to be devoted to developing riskscapes, bricolage and policy argumentation frames further to assess patterns of urban change in more detail, and to combining them with modelling and participatory approaches in data collection and analysis to generate knowledge for transformative urban change.

5. References

- Adger, W. N. (2003). Social Capital, Collective Action, and Adaptation to Climate Change. *Economic Geography*, 79(4), 387–404.
- Adger, W. N. (2001). Scales of governance and environmental justice for adaptation and mitigation of climate change. *Journal of International Development*, 13, 921–931.
- Adger, W. N., & Vincent, K. (2005). Uncertainty in adaptive capacity. *Comptes Rendus Geoscience*, 337(4), 399–410. doi:10.1016/j.crte.2004.11.004
- Afenah, A. (2012). Engineering a Millennium City in Accra, Ghana: The Old Fadama Intractable Issue. *Urban Forum*, 23(4), 527–540.
- Agard, J., E.L.F. Schipper, J. Birkmann, M. Campos, C. Dubeux, . . . and T.E. Bilir (eds.). (2014). Annex II - Glossary. In Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, . . . and L.L. White (Eds.), *IPCC 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1757–1776). Cambridge, New York: Cambridge University Press.
- Allan, J. D. (2004). Landscapes and Riverscapes: The Influence of Land Use on Stream Ecosystems. *Annual Review of Ecology, Evolution, and Systematics*, 35(1), 257–284. doi:10.1146/annurev.ecolsys.35.120202.110122
- Allen, A. (2003). Environmental planning and management of the peri-urban interface: perspectives on an emerging field. *Environment and Urbanization*, 15(1), 135–148. doi:10.1177/095624780301500103
- Amoako, C., & Boamah, F. E. (2014). The three-dimensional causes of flooding in Accra, Ghana. *International Journal of Urban Sustainable Development*, 1–21. doi:10.1080/19463138.2014.984720
- Amoako, C., & Inkoomb, D. K. B. (2017). The production of flood vulnerability in Accra, Ghana: Re-thinking flooding and informal urbanisation. *Urban Studies*, 139(1), 004209801668652. doi:10.1177/0042098016686526
- Appeaning Addo, K., & Adeyemi, M. (2013). Assessing the impact of sea-level rise on a vulnerable coastal community in Accra, Ghana. *Jàmá: Journal of Disaster Risk Studies*, 5(1), 1–8.

- Abheuer, T., Thiele-Eich, I., & Braun, B. (2012). Coping with the impacts of severe flood events in Dhaka's slums: The role of social capital. *Erdkunde: Archiv für wissenschaftliche Geographie*, 67(1), 21–35.
- Atlas of Urban Expansion. (2016). The City as a Unit of Analysis and the Universe of Cities: Accra. Retrieved from www.atlasofurbanexpansion.org
- Barry, M., & Danso, E. K. (2014). Tenure security, land registration and customary tenure in a peri-urban Accra community. *Land Use Policy*, 39, 358–365. doi:10.1016/j.landusepol.2014.01.017
- Blanco, H., Alberti, M., Olshansky, R., Chang, S., Wheeler, S. M., Randolph, J., . . . Watson, V. (2009). Shaken, shrinking, hot, impoverished and informal: Emerging research agendas in planning. *Progress in Planning*, 72(4), 195–250. doi:10.1016/j.progress.2009.09.001
- Blok, A. (2016). Assembling urban riskscape. *City*, 20(4), 602–618. doi:10.1080/13604813.2016.1194000
- Boafo-Arthur, K. (2003). Chieftaincy in Ghana: Challenges and Prospects in the 21st Century. *African and Asian Studies*, 2(2), 125–153. doi:10.1163/156920903322149400
- Brooks, N., Neil Adger, W., & Mick Kelly, P. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change*, 15(2), 151–163. doi:10.1016/j.gloenvcha.2004.12.006
- Brun, G., & Betz, G. (2016). Analysing Practical Argumentation. In S. O. Hansson & G. Hirsch Hadorn (Eds.), *Logic, argumentation & reasoning: Vol. 10. The argumentative turn in policy analysis. Reasoning about uncertainty* (pp. 39–77). [Cham]: Springer.
- Bruns, A., & Frick, F. (2013). Coastal Cities at Multiple Risks - the Case of Accra. *Mainzer Geographische Studien*, 55, 59–77.
- Budds, J., & Hinojosa, L. (2012). Restructuring and Rescaling Water Governance in Mining Contexts: The Co-Production of Waterscapes in Peru. *Water Alternatives*, 5(1), 119–137.
- Bündnis Entwicklung Hilft. (2014). WorldRiskReport 2014. Retrieved from www.WorldRiskReport.org
- Carol, H. (1956). Zur Diskussion um Landschaft und Geographie. *Geographica Helvetica*. (11).
- Cleaver, F. (2012). *Development through bricolage: Rethinking institutions for natural resource management*. Abingdon, Oxon, New York, NY: Routledge.
- Cleaver, F. D., & De Koning, J. (2015). Furthering critical institutionalism. *International Journal of the Commons*, 9(1), 1–18.
- Codjoe, S. N. A., Owusu, G., & Burkett, V. (2014). Perception, experience, and indigenous knowledge of climate change and variability: The case of Accra, a sub-Saharan African city. *Regional Environmental Change*, 14(1), 369–383. doi:10.1007/s10113-013-0500-0
- Collins, T. W. (2008). The political ecology of hazard vulnerability: marginalization, facilitation and the production of differential risk to urban wildfires in Arizona's White Mountains. *Journal of Political Ecology*, 15, 21–43.
- Cook, I. R., & Swyngedouw, E. (2012). Cities, Social Cohesion and the Environment: Towards a Future Research Agenda. *Urban Studies*, 49(9), 1959–1979. doi:10.1177/0042098012444887
- Cosgrove, D. (1990). Landscape studies in geography and cognate fields of the humanities and social sciences. *Landscape Research*, 15(3), 1–6. doi:10.1080/01426399008706316
- Craig, W. J., Harris, T. M., & Weiner, D. (Eds.). (2002). *Community participation and geographic information systems*. London, New York: Taylor & Francis. Retrieved from <http://www.worldcat.org/oclc/58964616>
- Cutter, S. L. (2003). GI Science, Disasters, and Emergency Management. *Transactions in GIS*, 7(4), 439–445.
- Cutter, S. L., Mitchell, J. T., & Scott, M. S. (2000). Revealing the vulnerability of people and places: A case study of Georgetown county, South Carolina. *Annals of the Association of American Geographers*, 90(4), 713–737.
- Duncan, J. (1995). Landscape geography, 1993-94. *Progress in Human Geography*, 19(3), 414–422.
- Earle, L. (2014). Stepping out of the Twilight?: Assessing the Governance Implications of Land Titling and Regularization Programmes. *International Journal of Urban and Regional Research*, 38(2), 628–645. doi:10.1111/1468-2427.12112
- Elwood, S. (2011). Geographic Information Science: Visualization, visual methods, and the geoweb. *Progress in Human Geography*, 35(3), 401–408. doi:10.1177/0309132510374250
- Evans, J. P. (2011). Resilience, ecology and adaptation in the experimental city. *Transactions of the Institute of British Geographers*, 36(2), 223–237. doi:10.1111/j.1475-5661.2010.00420.x
- Fischer, F., & Gottweis, H. (2013). The argumentative turn in public policy revisited: Twenty years later. *Critical Policy Studies*, 7(4), 425–433. doi:10.1080/19460171.2013.851164
- Frick, F. (2016a). *Risk and Adaptation in (African) Cities* (Water Power Working Paper Series No. 2). Trier. Retrieved from Trier University website: http://www.waterpower.science/uploads/5/3/1/1/53111533/2_frick-fanny_risk-and-adaptation.pdf
- Frick, F. (2016b). Travelling Through the Densu Delta: Location, Place and Space in the Waterscape. In J. Niewöhner, A. Bruns, P. Hostert, T. Krueger, J. Ø. Nielsen, H. Haberl, . . . D. Müller (Eds.), *Land Use Competition* (pp. 333–346). Cham: Springer International Publishing. doi:10.1007/978-3-319-33628-2_20
- Frick, F., & Alba, R. (2015). 'Twin disaster' and the politics of blaming in Accra floods. Retrieved from <https://blogs.kcl.ac.uk/water/2015/06/29/twin-disaster-and-the-politics-of-blaming-in-accra-floods/>
- Frick-Trzebitzky, F. (2017). *GIS – what can and what can't it say about social relations in adaptation to urban flood risk?* (WaterPower Working Paper Series No 15). Trier: Governance and Sustainability Lab, Trier University.

- Frick-Trzebitzky, F. (2017). Crafting adaptive capacity: institutional bricolage in adaptation to urban flooding in Greater Accra. *Water Alternatives*, 10(2), 625-647.
- Frick-Trzebitzky, F., Baghel, R., & Bruns, A. (2017). Institutional bricolage and the production of vulnerability to floods in an urbanising delta in Accra. *International Journal of Disaster Risk Reduction*, 26, 57-68. doi: 10.2016/j.ijdr.2017.09.030.
- Frick-Trzebitzky, F., & Bruns, A. (2017). Disparities in the Implementation Gap: Adaptation to Flood Risk in the Densu Delta, Accra, Ghana. *Journal of Environmental Policy & Planning*, 1-16. doi:10.1080/1523908X.2017.1343136
- Gaillard, J. C., & Mercer, J. (2013). From knowledge to action: Bridging gaps in disaster risk reduction. *Progress in Human Geography*, 37(1), 93-114. doi:10.1177/0309132512446717
- Ghana Statistical Service. (2012). *2010 Population & Housing Census: Summary Report of Final Results*. Accra, Ghana: Ghana Statistical Service.
- Goodfellow, T. (2013). Urban Planning in Africa and the Politics of Implementation: Contrasting Patterns of State Intervention in Kampala and Kigali. In B. Obrist, V. Arlt, & E. Macamo (Eds.), *Living the City in Africa. Processes of Invention and Intervention* (pp. 45-61). Zürich, Berlin: LIT Verlag.
- Goodman, M. K., Boykoff, M. T., & Evered, K. T. (2008). Contentious Geographies: Environmental Knowledge, Meaning, Scale. In Michael K. Goodman, Maxwell T. Boykoff and Kyle T. Evered (Ed.), *Contentious Geographies : Environmental Knowledge, Meaning, Scale (Ashgate Studies in Environmental Policy and Practice)* (pp. 1-23).
- Grischow, J. D. (2008). Rural 'Community', Chiefs and Social Capital: The Case of Southern Ghana. *Journal of Agrarian Change*, 8(1), 64-93.
- Harrison, P. (2006). On the edge of reason: Planning and urban futures in Africa. *Urban Studies*, 43(2), 319-335. doi:10.1080/00420980500418368
- Hetz, K. (2016). Contesting adaptation synergies: political realities in reconciling climate change adaptation with urban development in Johannesburg, South Africa: Regional Environmental Change. *Regional Environmental Change*, 16(4), 1-12. doi:10.1007/s10113-015-0840-z
- Hetz, K., & Bruns, A. (2014). Urban planning lock-in: implications for the realization of adaptive options towards climate change risks. *Water International*, 39(6), 884-900.
- Hinkel, J. (2011). "Indicators of vulnerability and adaptive capacity": Towards a clarification of the science-policy interface. *Global Environmental Change*, 21(1), 198-208. doi:10.1016/j.gloenvcha.2010.08.002
- Kelman, I., Gaillard, J. C., & Mercer, J. (2015). Climate Change's Role in Disaster Risk Reduction's Future: Beyond Vulnerability and Resilience. *International Journal of Disaster Risk Science*, 21-27. doi:10.1007/s13753-015-0038-5
- Khan, S., & Crozier, M. J. (2009). *'Hazardscape': A holistic Approach to Assess Tipping Points in Humanitarian Crises*. Submitted to: Annual Summer Academy on Social Vulnerability: "Tipping Points in Humanitarian Crises" Hohenkammer, Munich, Germany 26 July - 01 August 2009. Munich, Germany.
- Lund, C. (2006). Twilight Institutions: Public Authority and Local Politics in Africa. *Development and Change*, 37(4), 685-705. doi:10.1111/j.1467-7660.2006.00497.x
- Lund, C. (2008). *Local politics and the dynamics of property in Africa*. New York: Cambridge University Press.
- Macamo, E. (2013). Living Effervescence: The Social in African Urban Settings. In B. Obrist, V. Arlt, & E. Macamo (Eds.), *Living the City in Africa. Processes of Invention and Intervention* (pp. 291-297). Zürich, Berlin: LIT Verlag.
- Mayntz, R., & Scharpf, F. W. (1995). Der Ansatz des akteurszentrierten Institutionalismus. In R. Mayntz & F. W. Scharpf (Eds.), *Schriften des Max-Planck-Instituts für Gesellschaftsforschung. Gesellschaftliche Selbstregulierung und politische Steuerung* (pp. 39-72). Frankfurt am Main / New York: Campus Verlag.
- McFarlane, C. (2011). Assemblage and critical urbanism. *City*, 15(2), 204-224. doi:10.1080/13604813.2011.568715
- McGranahan, G., Balk, D., & Anderson, B. (2007). The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. *Environment and Urbanization*, 19(1), 17-37. doi:10.1177/0956247807076960
- Modern Ghana News (2013). Incoming floods: NADMO in Gh¢186m debt, International donors fed up, April 30. *Modern Ghana News*.
- Moser, C., & Dilling, L. (2013). Communicating climate change: closing the science-action gap. In J. S. Dryzek, R. B. Norgaard, & D. Schlosberg (Eds.), *Oxford handbook of climate change and society* (1st ed., pp. 161-174). Oxford: Oxford Univ. Press.
- Müller-Mahn, D. (2005). Von „Naturkatastrophen“ zu „Complex Emergencies“ - Die Entwicklung integrativer Forschungsansätze im Dialog mit der Praxis. In D. Müller-Mahn & U. Wardenga (Eds.), *forum ifl. Möglichkeiten und Grenzen integrativer Forschungsansätze in Physischer Geographie und Humangeographie* (pp. 69-78). Leipzig: Leibniz-Institut für Länderkunde.
- Müller-Mahn, D., & Everts, J. (2013). Riskscape: The spatial dimension of risk. In D. Müller-Mahn (Ed.), *Earthscan risk in society series. The spatial dimension of risk. How geography shapes the emergence of riskscape* (pp. 22-36). London: Routledge.
- Mustafa, D. (2005). The Production of an Urban Hazardscape in Pakistan: Modernity, Vulnerability, and the Range of Choice. *Annals of the Association of American Geographers*, 95(3), 566-586. doi:10.1111/j.1467-8306.2005.00475.x
- Næss, L. O., Bang, G., Eriksen, S., & Vevatne, J. (2005). Institutional adaptation to climate change: Flood responses at the municipal level in Norway. *Global Environmental Change*, 15(2), 125-138. doi:10.1016/j.gloenvcha.2004.10.003
- Alice Newton, Tim J.B. Carruthers, & John Icely. (2012). The coastal syndromes and hotspots on the coast. *Estuarine, Coastal and Shelf Science*, 96, 39-47.

- Oteng-Ababio, M., Owusu, K., & Appeaning Addo, K. (2011). The vulnerable state of the Ghana coast: The case of Faana-Bortianor. *Jàmba: Journal of Disaster Risk Studies*, 3(2), 429–442.
- Oteng-Ababio, M. (2013a). 'Prevention is better than cure': Assessing Ghana's preparedness (capacity) for disaster management. *Jàmba: Journal of Disaster Risk Studies*, 5(2), 75. Retrieved from <http://dx.doi.org/10.4102/jamba.v5i2.75>
- Oteng-Ababio, M. (2013b). Unscripted (in)justice: exposure to ecological hazards in metropolitan Accra. *Environment and Planning A*, 45(5), 1199–1218. doi:10.1068/a45256
- Owusu, G., Oteng-Ababio, M., & Afuto-Kotey, R. L. (2012). Conflicts and governance of landfills in a developing country city, Accra. *Landscape and Urban Planning*, 104(1), 105–113. *Landscape and Urban Planning*, 104(105-113).
- Parnell, S., & Pieterse, E. (2015). Translational Global Praxis: Rethinking Methods and Modes of African Urban Research. *International Journal of Urban and Regional Research*, n.p. doi:10.1111/1468-2427.12278
- Parnell, S., & Robinson, J. (2013). (Re)theorizing Cities from the Global South: Looking Beyond Neoliberalism. *Urban Geography*, 33(4), 593–617. doi:10.2747/0272-3638.33.4.593
- Pelling, M. (2011). *Adaptation to climate change: From resilience to transformation*. London, New York: Routledge.
- Pelling, M., & High, C. (2005). Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change*, 15(4), 308–319. doi:10.1016/j.gloenvcha.2005.02.001
- Pelling, M., High, C., Dearing, J., & Smith, D. (2008). Shadow spaces for social learning: a relational understanding of adaptive capacity to climate change within organisations. *Environment and Planning A*, 40(4), 867–884. doi:10.1068/a39148
- Pelling, M., & Wisner, B. (Eds.). (2012). *Disaster risk reduction: Cases from urban Africa*: Routledge.
- Pieterse, J. N. (2000). After Post-Development. *Third World Quarterly*, 21(2), 175–191. Retrieved from <http://www.jstor.org/stable/3993415>
- Ranganathan, M. (2014). 'Mafias' in the Waterscape: Urban Informality and Everyday Public Authority in Bangalore. *Water Alternatives*, 7, 89–105.
- Revi, a., Satterthwaite, D., Aragon-Durand, F., Corfee-Morlot, J., Kiunsi, R. B. R., Pelling, M., & Roberts, D. (2014). Towards transformative adaptation in cities: the IPCC's Fifth Assessment. *Environment and Urbanization*, 26(1), 11–28.
- Rijke, J., Brown, R., Zevenbergen, C., Ashley, R., Farrelly, M., Morison, P., & van Herk, S. (2012). Fit-for-purpose governance: A framework to make adaptive governance operational. *Environmental Science & Policy*, 22, 73–84. doi:10.1016/j.envsci.2012.06.010
- Smith, K., Barrett, C. B., & Box, P. W. (2000). Participatory Risk Mapping for Targeting Research and Assistance: With an Example from East African Pastoralists. *World Development*, 28(11), 1945–1959. doi:10.1016/S0305-750X(00)00053-X
- Smith Asante, E. (2016, June 1). A year after the June 3 twin disaster. *Graphic online*. Retrieved from <http://www.graphic.com.gh/features/features/a-year-after-the-june-3-twin-disaster.html>
- Stoler, J., Fink, G., Weeks, J. R., Otoo, R. A., Ampofo, J. A., & Hill, A. G. (2012). When urban taps run dry: sachet water consumption and health effects in low income neighborhoods of Accra, Ghana. *Health & place*, 18(2), 250–262. doi:10.1016/j.healthplace.2011.09.020
- Stow, D. a., Weeks, J. R., Shih, H.-c., Coulter, L. L., Johnson, H., Tsai, Y.-H., . . . Mensah, F. (2016). Inter-regional pattern of urbanization in southern Ghana in the first decade of the new millennium. *Applied Geography*, 71, 32–43. doi:10.1016/j.apgeog.2016.04.006
- Terkenli, T. S. (2001). Towards a theory of the landscape: the Aegean landscape as a cultural image. *Landscape and Urban Planning*, 57, 197–208.
- Tyroller, L. (2016). *Changing Socio-Ecological Dynamics in an African Peri-Urban Wetland* (Water Power Working Paper Series No. 7). Trier. Retrieved from http://www.waterpower.science/uploads/5/3/1/1/53111533/7_tyroller-larissa_changing-socio-ecological-dynamics.pdf
- Ubink, J. M., & Amanor, K. S. (Eds.). (2008). *Contesting Land and Custom in Ghana: State, Chief and the Citizen (AUP - Law, Governance, and Development R)*. Leiden: Leiden University Press.
- Ubink, J. M., & Quan, J. F. (2008). How to combine tradition and modernity?: Regulating customary land management in Ghana. *Land Use Policy*, 25(2), 198–213. doi:10.1016/j.landusepol.2007.06.002
- United Nations Development Programme Ghana (UNDP). (2012). *Community Resilience through Early Warning: CREW*. Project Document. Accra, Ghana.
- UNDP (2014). World Urbanization Prospects, the 2014 revision. Growth rates of urban agglomerations by size class. UNDP Population Division, accessed July 13, 2015, <http://esa.un.org/unpd/wup/Maps/CityGrowth/CityGrowth.aspx>
- Wamsler, C. (2006). Mainstreaming Risk Reduction in Urban Planning and Housing: A Challenge for International Aid Organisations. *Disasters*, 30(2), 151–177. doi:10.1111/j.0361-3666.2006.00313.x
- Watson, V. (2009). Seeing from the South: Refocusing Urban Planning on the Globe's Central Urban Issues. *Urban Studies*, 46(11), 2259–2275. doi:10.1177/0042098009342598
- Wesselink, A., Warner, J., & Kok, M. (2013). You gain some funding, you lose some freedom: The ironies of flood protection in Limburg (The Netherlands). *Environmental Science & Policy*, 30, 113–125. doi:10.1016/j.envsci.2012.10.018
- Wisner, B. (1988). *Power and Need in Africa: : basic human needs and development policies*. London: Earthscan.
- Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *At risk: Natural hazards people's vulnerability and disasters* (2. ed). Oxon, New York, NY: Routledge.

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I. Appendix I: Core publications submitted

I.1 Article A: Institutional bricolage and the production of vulnerability to floods in an urbanising delta in Accra

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This paper has been published in the International Journal of Disaster Risk Reduction. It can be cited as: Frick-Trzebitzky, F., Baghel, R., & Bruns, A. (2017). Institutional bricolage and the production of vulnerability to floods in an urbanising delta in Accra. *International Journal of Disaster Risk Reduction*, 26, 57–68. DOI 10.1016/j.ijdr.2017.09.030.

Submitted: 21.12.2016; resubmitted: 13.06.2017; published online first: 23.09.2017

Abstract

The boundary between formal and informal urban development tends to be particularly blurred in African cities. The Densu Delta in western Greater Accra is a prime example where buildings have been erected outside formally regulated urban development, in an ecologically precarious site. As a result, more and more people and structures are exposed to inundation, coastal erosion and flooding, but they also develop creative strategies to cope with the risks and vulnerabilities related with these hazards. The role of institutions, understood as co-produced arrangements between people, towards shaping the distribution of vulnerability to flood risk has been assessed for two localities in the Densu Delta. The article combines qualitative data from interviews and field observations with quantitative spatial data monitoring urbanisation in Greater Accra. Institutional as well as bio-physical dynamics in space and time that shape the riskscape of urban flooding in the Densu Delta are revealed. They expose a highly diverse landscape of vulnerability to flooding that cannot be explained solely by the material environment. Instead, tinkering, re-invention and transformation of twilight institutions is found to shape the distribution of vulnerability. The insights gained are of particular relevance to disaster risk reduction in rapidly urbanising areas in the Global South.

Highlights

- Vulnerability to floods is shaped by institutional, biophysical and social dynamics
- Bricolage of institutions of varying degrees of formality alters vulnerability

- Precarious land ownership fosters wetland encroachment and heightens vulnerability
- Examination of practices key to addressing the spatial dimension of vulnerability
- Disaster response must consider institutional, ecological, structural, social dynamics

Keywords:

Urban floods, Sub-Saharan Africa, informal institutions, riskscape, urbanisation

1.1.1 Introduction

Many African cities are currently undergoing rapid urbanisation and Accra is a good example of this, since it is one of the largest cities in West Africa, and projected to be growing at 4.59 % in the current decade (United Nations Human Settlements Programme, 2014). Urbanisation in African cities is shaped by current and historical governmental planning practices as well as by traditional land ownership systems, private development interests, direct foreign investment and migration. The interaction of these drivers creates hazard-prone areas in settlements facing an increase in the risk of natural disasters such as flooding. Or, to put it differently, riskscapes are a product of material and social processes of urban change that play out dynamically in rapidly urbanising spaces for which the Densu Delta serves as our case-study. The case is of particular relevance as a wetland in the most rapidly urbanising area of Greater Accra in the 21st century (Stow et al., 2016). Here, the spatial distribution of flood risk is mediated by a bricolage of formal and informal institutions, or what we call “twilight institutions”, namely institutions acting between state and society (Lund, 2006), and shapes both exposure and susceptibility to floods.

The aim of this paper is to scrutinise more closely the process by which material and institutional dynamics interact to shape the landscape of social vulnerability in the Densu Delta. By social vulnerability we mean the combined exposure to hazards and access to opportunities to prepare for and cope with hazard impacts (see Wisner et al., 2004). Conceptually we build upon and advance the concept of riskscapes to study how bricolage of “twilight institutions” produces a landscape of differentiated vulnerability. Building on Müller-Mahn and Everts (2013) and Mustafa (2005), we understand riskscapes as the landscapes of risk co-produced in social and material processes. We place special emphasis on identifying the dynamic interactions among material and institutional processes, which go on to create the reality of people at risk of floods.

Studying riskscapes of flooding in an African urban context is of particular relevance as urban seasonal flooding tends to be overlooked in national and international disaster databases, and is generally not the prime risk the urban poor are facing (Pelling and Wisner, 2012). As a consequence, urban flood risk tends not to be addressed in areas where the urban poor settle, making urban poor settlers particularly vulnerable to the effects of flooding (Huq et al., 2007). Case study approaches to urban flooding and other disaster risk from various regions of the world such as Asia, Sub-Saharan Africa, the Caribbean and Europe (e.g.

Aßheuer et al., 2012; Braun and Nsorfon, 2013; Chang et al., 2013; Morrow, 1999; Pelling, 1997; Pelling, 1999; Walker and Burningham, 2011) have offered insights into the relative vulnerability of different social groups. We attempt to supplement this work through the present case in order to bring out both the common and the contrasting factors in vulnerability and risk, with a focus on institutional dynamics.

1.1.2 Riskscape and urban flooding

In our analysis of flooding in Accra, we build upon the concept of ‘riskscape’ proposed by Müller-Mahn and Everts in 2013, to describe both the processes that produce risks, and their spatial distribution. In our frame of reference we also include prior formulations such as the integrative concept of ‘hazardscape’ to understand the actual reality of urban flooding in the comparable setting of Rawalpindi/Islamabad in Pakistan (Mustafa, 2005). The hazardscape concept deals with the social structural basis of vulnerability as well as the role of institutions in shaping flood risk: “[T]he experience of hazards is not just a function of the material geographies of vulnerability but also of how those hazardous geographies are viewed, constructed, and reproduced by the expert/technocratic discourses about them” (Mustafa, 2005: 566).

Both these concepts draw upon the established idea of landscape and both point to the fact that human relations with the environment are mediated through a process of social construction, but at the same time also deal with the material reality of that biophysical environment. As actor groups interacting in space and time perceive risks differently, Müller-Mahn and Everts (2013) argue that riskscape are plural in nature. Thus, the riskscape in the present case is produced through materialised biophysical processes combined with power relations and perceptions to shape the distribution of risk, and it interacts with riskscape of other hazards (water security, domestic fire, etc.).

Understanding patterns of vulnerability and risk involves assessing their multiple dimensions to include bio-physical dynamics as well as social relations and capacities (Adger and Brown, 2009; Cutter, 1996). Spatial and temporal patterns of flood risk – a function of hazard, exposure and susceptibility – are changing rapidly in urban areas, and pose a challenge to risk reduction. Reducing urban vulnerability is riddled with complexities which Barroca et al. (2006) have summarised as the complexity of the hazard itself, the complexity of elements at risk, and the complexity of relations between elements at risk. Corresponding to these complexities, an Action Aid study (2006) shows that urban floods in Africa primarily occur as the result of multiple interacting social and environmental processes that are poorly monitored. Secondly, they affect slum dwellers with particular severity due to their often precarious locations and lack of basic infrastructure. Among these, migrant settlers, indigenous groups, women, children, and other groups are particularly vulnerable (Abdallah Imam and Tamimu, 2015; Adelekan et al., 2015). Finally, in Accra, local flood risk is increasing because disaster risk reduction approaches are top-down and lack local enforcement, while local collective action strategies are neglected in policy design (Frick-Trzebitzky and Bruns, 2017). Further, gaps persist between knowledge and action on disaster

risk (Gaillard and Mercer, 2013), and thus practice is an equally important factor in the distribution of risk that deserves further attention.

Given the relevance of social and institutional dynamics in urban risk context that have not been adequately addressed in analyses of riskscapes we pay special attention to the role of practices and institutions with respect to urban flooding in the Densu Delta. Institutions are understood to be co-produced “arrangements between people which are reproduced and regulated across time and space and which are subject to constant processes of evolution and change” (Clever, 2012: 8, and also Hall et al., 2013). The importance of institutions in shaping social practices and communal action is well-established (Ostrom, 1986, 1990). Twilight institutions are “institutions [which] operate in the twilight between state and society, between public and private” (Lund, 2006: 686). We consider twilight institutions particularly relevant to our analysis of flooding in Accra because here both governmental and customary authorities, as well as private institutions shape land and water governance (Frick, 2016).

Social practice related to floods offers a broad spectrum of *bricolage* – both epistemological and institutional. Building upon the notion of *bricolage* proposed by Lévi-Strauss (1962), Lanzara (1998: 26–27) proposed the concept of “institutional bricolage” to highlight the fact that institutions are produced through a process of tinkering (French: *bricolage*) that describes “the recombination and reshuffling of pre-existing available components or other institutional materials that happen to be at hand and that, even when depleted, can serve new purposes”. Cleaver (2001: 29), used the term “institutional bricolage” to suggest that “mechanisms for resource management and collective action are borrowed or constructed from existing institutions, styles of thinking and sanctioned social relationships”. As we discuss below, there is a long history of tinkering, reinvention and transformation of traditional and non-traditional; formal and informal and what we describe broadly as “twilight” institutions (Lund, 2006) which aim to address flood risk in the Densu Delta. We extend the concept of riskscape by stressing the role of actors, institutions and biophysical elements in shaping the spatial and temporal dynamics of vulnerability.

1.1.3 Research design

The Densu Delta is a flood-prone wetland in the coastal urban fringe of Accra, the growing capital of Ghana on the Atlantic coast (Amoako and Boamah, 2014). The delta was chosen as a case of a rapidly urbanising site where multiple factors of environmental change interact in a dynamic context of institutional diversity, exposing settlers to a range of risks. Despite delta areas being prone to flooding, urbanisation has been strong in such areas in Africa and elsewhere (Seto, 2011). In the absence of space for settlement accessible to the urban poor, the rapid growth comes with the urbanisation of river deltas, namely the Korle lagoon in the city centre, Sakumono lagoon East of Accra, and the Densu delta West of the city. These particularly flood-prone areas are home to large informal settlements particularly vulnerable to hazards, such as Old Fadama with around 80.000 people in the Korle lagoon (Owusu, 2013). Floods in Accra have led to casualties, the displacement of thousands of people and

costs of more than 1 million US Dollars each year between 2003 and 2012 (Amoako and Boamah, 2014).

While peri-urban growth concentrated on Eastern areas of Accra before 2000 and was halted by the natural barrier of the wetland in the Densu Delta (Doan and Oduro, 2012), the area has been the hotspot of Accra's urban expansion between 2000 and 2014 (Atlas of Urban Expansion, 2016). The Densu Delta expands into Ga South district West of Accra, where population has increased by 860160 inhabitants at faster rates (83%) than in Accra Metropolitan Area (Stow et al., 2016: 36). Coastal localities in the delta are also exposed to a particularly high rate of coastal erosion. In Glefe, for instance, a loss of more than one meter per year has been measured between 2005 and 2011 (Amoani et al., 2012; Appeaning Addo and Adeyemi, 2013). In consequence, an increasing number of people and structures are exposed to flooding each year. However, residents in the absence of accessible land for settlement rather tend to cope with the change than retreating or migrating, as Oteng-Ababio et al. found for the coastal settlement Faana-Bortianor West of Glefe (Oteng-Ababio et al., 2011).

The case is also unique in the diversity of social groups and institutions interacting on an area of less than six thousand hectares, ranging from one of Accra's poorest settlements to settlements of wealthy migrants; from indigenous fishermen and authorities to international companies and agreements. Downstream of the Weija dam, the river Densu meanders through the Densu Delta wetland, which is protected as a Ramsar site under the international convention for the protection of water birds. As a result of ongoing encroachment, the former wetland boundaries along the surrounding coastline and streets at the time of its declaration as a Ramsar site of 5892 hectares in 1998 (Wildlife Department, 1998) are no longer visible on the ground. The enforcement of planning regulation that forbids development in the delta is challenged by multiple responsibilities as the area falls under the aegis of various local authorities, and also by conflicts over land ownership (Abbey, 2013; Barry and Danso, 2014). The presence of multiple institutions of different degrees of formality, with national governmental, indigenous, international and commercial authorities and agencies involved in land use governance is characteristic of African cities more generally (Lund, 2006). In choosing a site where diverse institutions interact in a dynamic context of multiple risks we aim to provide insights on the role of twilight institutions in riskscape that apply to urbanising wetlands in Accra and elsewhere.

To understand dynamics of vulnerability and how they are produced we first assessed the material manifestation of risk and social vulnerability in space. We then assessed practices that link institutions to the spatial manifestation of social vulnerability in the case study area. We did so in identifying practices that have an effect on the spatial or temporal dimension of vulnerability to flooding, identifying institutions that guide each practice, specifying spatial and temporal linkages, and identifying the actors involved. In a third step, we identified instances of institutional bricolage in the twilight institutions identified, based on narrative accounts of the institutions' development over time. The purpose of the analysis was to identify twilight institutions and understand how these institutional practices shape the material riskscape.

Within the Densu Delta, two localities have been surveyed in detail: Tetegu and Glefe (see Figure 2). Primary data on urban change and flood risk was collected in field visits between April and July 2014, in January 2015, and between July and November 2015 during rainy and dry seasons. Over that period of time 41 qualitative interviews with residents, key stakeholders, and experts were held. In addition field observations and transect walks including land use mapping were conducted. Secondary data sets used were the national census of 2010 on housing in Tetegu, publically available Google Earth satellite images and Google Maps, the Accra Structure Plan (“Vision 2010” Town and Country Planning Department, 1991), and baseline data for flood risk and urbanisation maps.

Encroachment in the Densu Delta was mapped from historical satellite imaging from 2009 to 2016 as provided by Google Earth, by tracking the outlines of built-up environment, including construction sites. Flood hazard maps were digitised from assessments provided by the CSIR Water Research Institute, Accra. Mean daily water levels and water flows of the Densu River upstream of the Weija dam, and mean monthly rainfall in Accra were assessed from datasets provided by the Ghana Hydrometeorological Department as indicators of seasonal flood dynamics. Susceptibility was assessed through socio-economic indicators from the 2010 housing census for Tetegu and Glefe, two localities in the delta. Qualitative interviews with local stakeholders were assessed in their spatial contexts by locating selected quotes on risk and adaptive capacity on a map.

1.1.4 Risk patterns in the Densu Delta

Flood hazard and coastal erosion

Hazard maps based on elevation and run-off modelling reveal the entire wetland area to be a highly flood-prone area (see Figure 2). Water levels and water flows of the Densu River upstream and the rainfall in Accra indicate seasonal variability of water discharge into the delta, with the highest levels in June/July and October (Figure 1). Although the data would appear to show that there is no significant increase in water levels and that rainfall that might sufficiently explain the increase in the damage caused by flooding in Accra, as stated in literature (e.g. Amoako and Boamah, 2014) and in interviews⁴, actual discharge flows very likely differ from this pattern due to structural modifications, namely the Weija dam, roads and gutters, and to the increase of built-up area and subsequent soil sealing. There is currently no data available measuring water flows downstream of the Weija dam⁵.

⁴ E.g. Hydrological Services Department, 29.05.2014

⁵ Hydrological Services Department, 27.05.2014

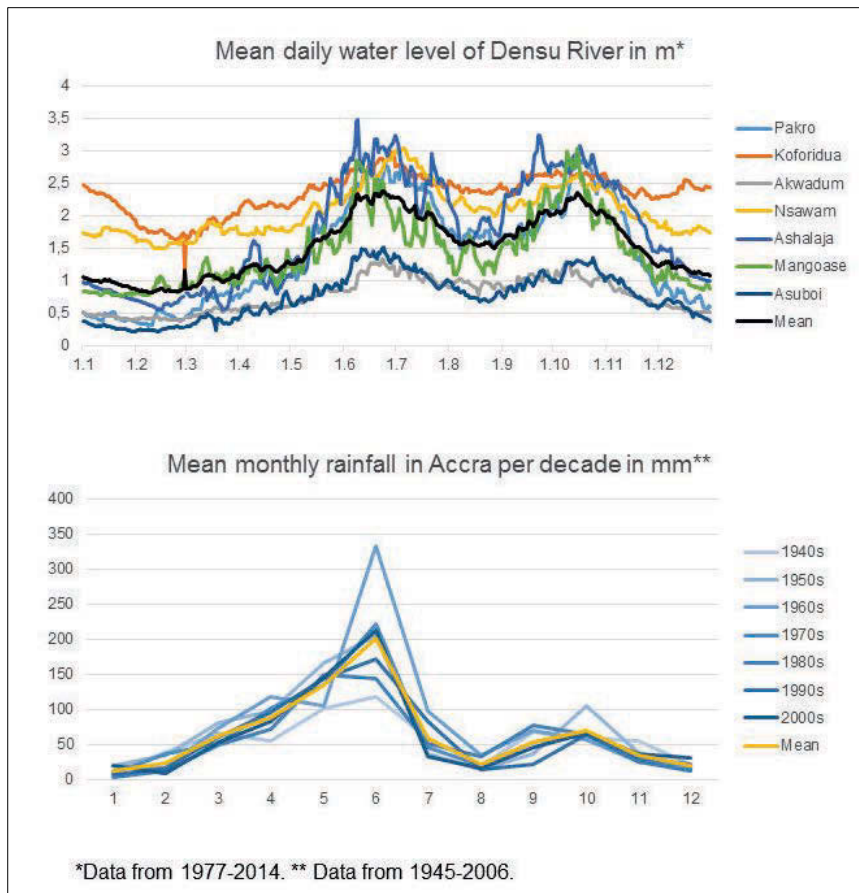
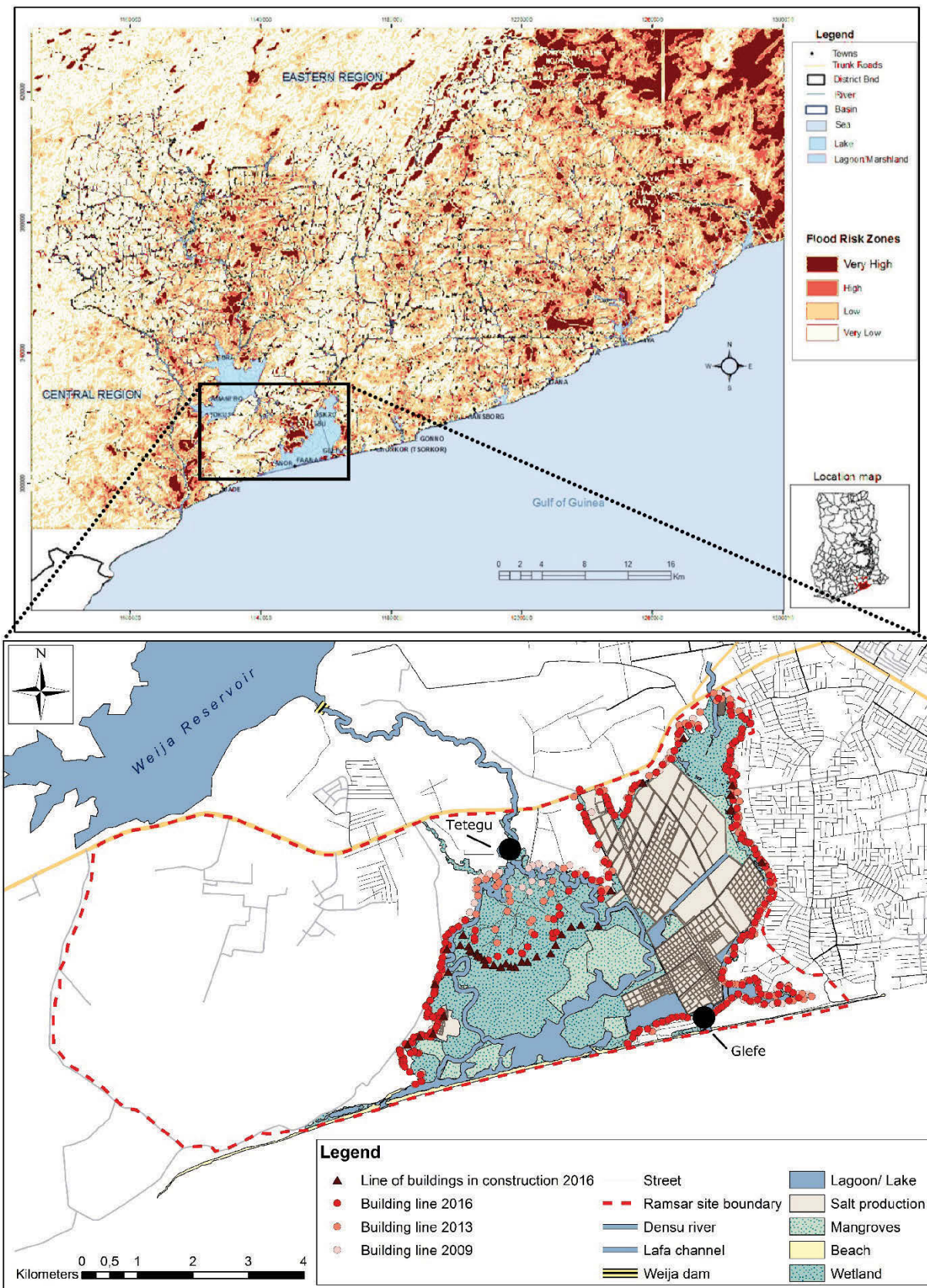


Figure IA.1 Mean daily water level of Densu river and mean monthly rainfall in Accra. Own design based on data from Ghana Hydrological Services Department. Daily water level is shown for the average over the measuring period from 1977-2014 at different measuring stations along the river, and for the mean across all stations (above). Monthly rainfall is shown by the mean per decade between 1945 and 2006

Encroachment and urbanisation

The continuous spreading of roads and built-up environment in Tetegu and densification in Glefe reveal a dynamic pattern of exposure in the Densu Delta (Figure 2).



Design: Christel Weable, Larissa Tyroller, Tobias Faust, Fanny Frick-Trzebitzky based on data from WRI CSIR Ghana (above), Google Earth© and own data (below)

Figure IA.2 Flood risk in Greater Accra (above) and land use in the Densu delta. Streets and construction sites in the wetland indicate ongoing encroachment (below). Source: WRI CSIR Ghana (above) / own design (below)

Social vulnerability

Comparison of socio-economic indicators from Tetegu and Glefe highlights differences in housing conditions (Figure 3), and environmental sanitation (Figure 4) that combine to produce an uneven pattern of social vulnerability in the delta. The data suggests more susceptible housing conditions in Tetegu, where mud is the main construction material, as compared to Glefe. Similarly, a greater share of the population of Tetegu is exposed to poor environmental sanitation conditions that raise susceptibility to flood-related effects such as the spreading of water-related diseases.

However, the dynamic encroachment that can be observed after 2009 (see Figure 2) indicates that while there are more buildings exposed to flooding, there is a growing number of concrete houses less likely to be washed away than mud structures, particularly in Tetegu. The rapid spatial expansion of the locality, as well as changes in housing conditions, thus imply a rearrangement of relative social vulnerability in the Densu Delta. This shift is amplified by the densification of the built-up area in Glefe which means not only that more people are exposed to flooding, but also face additional threats such as the more rapid spread of disease⁶ which may further impact their vulnerability.

⁶ NADMO 27.06.2014 (interview)

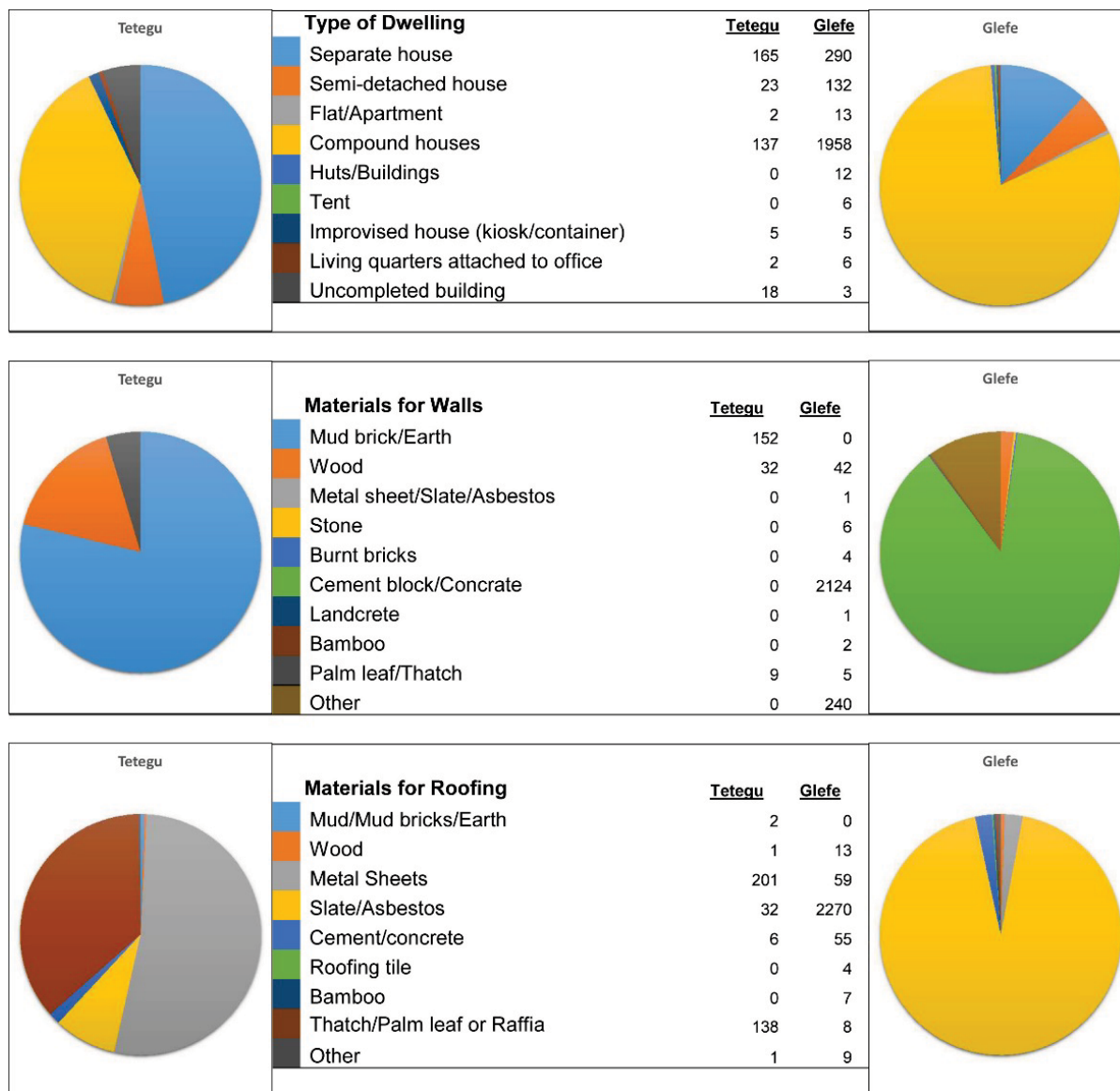


Figure IA.3 Housing conditions in Tetegu and Glefe. Source: own design based on Ghana Statistical Services census data from 2010.

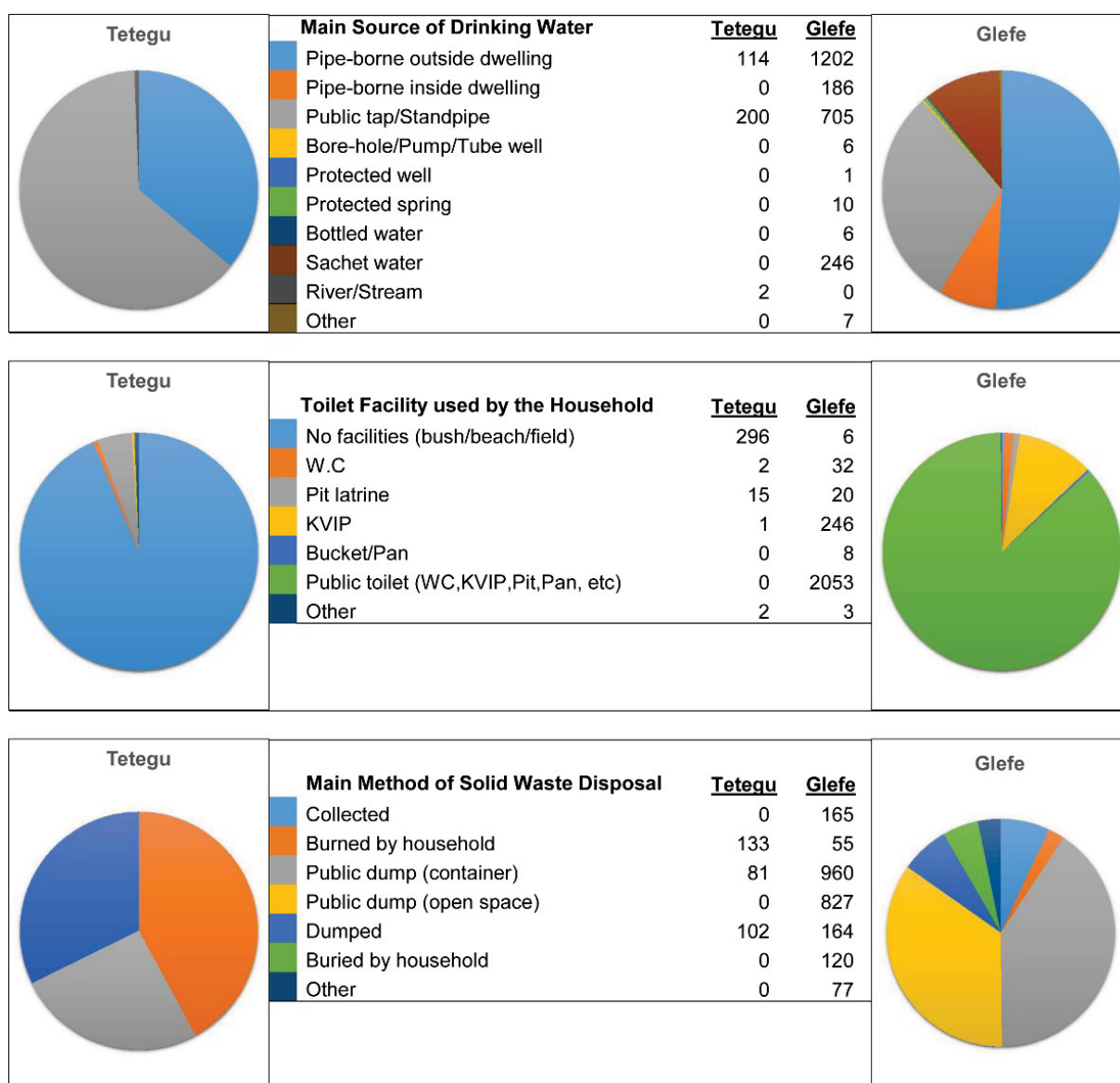


Figure IA.4 environmental sanitation conditions in Tetegu and Glefe. Source: own design based on Ghana Statistical Services census data from 2010.

Localised manifestations of social vulnerability within the Densu Delta are changing over time as quotes from interviews in Tetegu illustrate:

In former days of our forefathers all houses were built with mud so when floods came houses would collapse. But since we changed mud for blocks we just move our belongings, we take them to the upper land. But nowadays things have improved so it is a long time [since] this has happened. (Assembly man⁷ of Oblogo-Tetegu, 21.05.2014)

Not all the places are flooded. We have some places which are a bit higher so we all go there and we sit together (...) for about three, four days. Then [the flooding] goes down and we all go back to our homes (...). So it is now about getting to 20 years (...) we have not experienced [flooding] again. (Tetegu Assemblyman candidate, 21.05.2014)

⁷ Elected representative of a locality, the smallest entity in local government

A month later, the same resident reported that

many houses were flooded. The mud houses collapsed. (Tetegu Assemblyman candidate, 28.06.2014 on flooding in June 2014)

Linkages between the social fabric, vulnerability and security are expressed in quotes from Glefe.

Here is a peaceful community but when the rain start to come then it turns to war, they start to fight with each other because someone doesn't want rain to pass his house. So we, the community chairman⁸ and assemblyman, we have to lead and break people's houses so that the water can pass. Every year we have to enter into the water and break way out (...). Some people block the waterway and when they block it will be dangerous for others. (Chairman of Community Development Association Glefe, 07.05.2014)

Depending on the time of the day, especially when most men are at work, the burden of dealing with floods falls solely upon women, who “suffer a lot” from flooding (Queen Mother of Glefe, 07.05.2014).

These quotations expose differing vulnerability within localities which are paralleled by varying perceptions of risk and vulnerability. Interviews with settlers and key stakeholders for instance reveal different assessments of knee-high inundations as a threatening risk or a bearable burden, and report flood depths ranging between ankle or knee depths and roof height. With regard to the frequency of flooding occurring, experiences vary between several times per year (every time it rains) and once in 20 years. Similarly, reports on the duration of a typical flood vary between several days (in Tetegu) and several months (in Glefe). In other words, the perception of risk arising from flooding in the Densu Delta both with regard to the perceived likelihood of floods occurring, and to the perceived impact of flood events differs between the residents of the case study area in question.

Housing, water infrastructure and land conversion are physical materialities shaping the distribution of vulnerability. As encroachment continues, more people, houses and infrastructure are located in the flood-prone area of the delta (Figure 2). Bio-physical vulnerability further increases with the loss of mangroves, which buffer flooding naturally, and with the soil-sealing in adjacent areas through which the area for natural infiltration is reduced, and surface runoff enhanced. Although social vulnerability is generally higher in Glefe than in Tetegu, vulnerability within either locality differs depending on socio-economic status, housing conditions, etc.

The assessment of biophysical and social vulnerability factors in the Densu Delta reveals a highly dynamic landscape of risk. Spatial and temporal risk patterns are shaped by social arrangements (practices and institutions) as much as by water flows, as shown in table 1. All in all, the spatio-temporal configuration of a riskscape is revealed to be a product of material, social and institutional processes.

⁸ Here: chairman of a non-governmental community development association

1.1.5 Twilight institutions in the Densu Delta riskscape

The results show that twilight institutions in the form of strategies for coping with flooding and other risks, for developing and maintaining safe and comfortable housing, and for generating income configure the spatial extent of flood risk and vulnerability. By digging individual drains for excess water to flow away, residents channel water to other plots, increasing other residents' exposure. Extracting beach sand is a cheap way for developers to obtain construction materials, and for locals to generate income. At the same time the practice expedites coastal erosion and enhances the risk of coastal flooding for nearby settlers, and is therefore prohibited by state law and denounced by community group representatives, although it is in practice rarely prosecuted⁹. Another example of twilight institutions is the formation of residents' associations that lobby governmental authorities to provide basic infrastructure and services that contravene planning regulations, and provide these structures and services in the meantime. Importantly, twilight institutions have temporal effects. An example is the way that work sharing and daily routines in families imply that women and children are more susceptible to flooding during daytime while most men have left the area to go to work. The results show a heterogeneity of social and biophysical elements (actors, infrastructure, ecosystems, etc.) engaged in the bricolage of twilight institutions that has spatial and temporal effects on the distribution of vulnerability. Table 1 gives an overview of these elements' interaction in practices and related institutions and actors, and their spatial and temporal effects on the distribution of flood risk. It is sorted by key types of biophysical elements identified, namely infrastructure, land, and risk.

Table 1 Practices and related institutions, actors, and their spatial and temporal effects in the Densu Delta riskscape (Own design based on fieldwork).

No	Practice	Institution	Link to spatial risk pattern	Link to temporal pattern	Actors involved
Infrastructure					
1	Dam gates opened when water level in the Weija reservoir exceeds 50 ft) and generally after warning residents.	Arrangement between GWCL and Tetegu community representatives to reduce dam openings and alerting residents	Delta flooding linked to rainfall in upstream Eastern region Sites downstream of the dam less exposed to regular inundation than upstream; low risk perception among downstream residents which spurs further encroachment	Delta flooding from the Densu River concentrated on several days annually, generally in rainy season during periods of heavy rainfall along the Densu River, floods are anticipated.	GWCL
2	Salt is produced from sea water through evaporation. Water is pumped from the sea into the salt pans, an overflow of lagoon water into the pans is prevented by dams around the production site.		Excess water in Glefe cannot flow into the sea, thereby exacerbating flooding in the area; encroachment into the delta is halted by the salt production site, and mangroves on the production site	Blockages result in floods and inundations in Glefe taking longer to recede – up to 2 months; future of nature conservation (Ramsar site) in the delta depends on future land use on the land owned by Panbros Salt Ltd.	Panbros Salt Ltd
3	Inappropriate waste disposal: open gutters, natural streams, streets	Waste collection not performed because dumpsites are lacking / existing ones full, and because	Drainage channels blocked and runoff water polluted –low elevation coastal areas most affected, particularly where	While riverine flooding in the delta entails a time lag between rainfall in the Eastern Region and flood	Residents in Accra + the delta/ adjacent localities

⁹ E.g. Glefe representative, 26.05.2014; EPA officer, 28.01.2015; also Borges et al.

		residents are not prepared to pay for waste services; common belief that 'waste will be washed away'	discharge ways are obstructed (e.g. Glefe). Waste in water ways causes waterway blockage by Panbros.	events, flooding caused by local rainfall occurs immediately without time to prepare. Increased velocity of water discharge flows.	
4	Drainage is not designed and/ or constructed as technically required		Backwaters induce flooding in areas with drains		Different authorities in charge of drainage construction at different levels: AMA; urban roads department, feeder roads department; NADMO
5	Resident groups pressure government for installation of infrastructure and permits	Resident groups take collective action in community development	Initiative effective in Tetegu: permits granted and consequently infrastructure (gutters) installed for parts of the community, not effective in Glefe until media got involved; in both localities the gutters installed only benefit some areas – those where most influential people/ those with longest residency live. Time lags between development and infrastructure provision differ between Tetegu and Glefe.	Infrastructure follows development. Time lag between housing and infrastructure development depends on community representatives' power to influence governmental action; Tetegu house owners' association ceased to exist after initial goals had been reached; is being revived in context of increased risk from traffic accidents and armed robbery	Local government, residents' associations
6	Electricity connections are often illegally constructed	Infrastructure installed following pressure from community groups is along main roads only, and has created a source for irregular connections. Electricity is cut off during flooding to prevent electrocution	In areas without formal electricity connection, risks of fire and electrocution are high. The risk of electrocution is particularly high in flooded areas/ areas of stagnant water	During flooding, there is a heightened risk of electrocution // no electricity	
7	River water is used for washing and cooking when pipe water is cut off	Water and electricity supply in Accra are rationed and follow a schedule that is frequently adjusted to supply/demand situations	When surface runoff (from flooding) carrying pollutants is discharged into the river, water-related diseases are spread easily	Vulnerability (here: susceptibility to disruption of water supply) and effects of flooding vary over time depending on the reliability of service provision	Residents, basic service providers (GWCL, electricity)
8	Poor environmental protection	Formal waste collection performed by contractors; district assemblies provide insufficient facilities; both formal and informal waste collection services too expensive for residents; people build in and discharge into vulnerable ecosystems	Flood waters carry pollutants which enhance flood-related risks in flooded areas; natural infiltration and filtration processes are disturbed and natural flood retention areas lost	After flood waters have receded, effects persist in the form of diseases and ecosystem degradation	Waste collection providers, residents, EPA, Wildlife Division, district assemblies

		against regulations to enhance individual living standard			
Land					
9	Reclamation of land from sea / lagoon	(Self-proclaimed) custodians of land sell plots to new settlers,	New settlers settle at particularly exposed sites in Glefe	Increasing number of residents and properties exposed to flooding; new residents arriving in the dry season unaware of the exposure of their plots by the lagoon	Traditional authorities, representatives acting as custodians of land
10	Chiefs of the Sempe stool from Wiaboman have taken Panbros land to court over the embankment/their land use and have won. They subsequently sold the land and moved to Sempe communities within Accra (Chorkor) themselves.	Chiefs have considerable power in land negotiations in both customary and statutory law/court. Chiefs/proclaimed chiefs in Glefe are not taking action	Chiefs of the Sempe stool which owns the coastal strip between Chorkor (in Accra) and Bortianor (at the Western side of the Densu Delta) are keen on renegotiating land ownership as with the receding coast, coastal plots are continually being lost. The selling of land and emigration of customary owners encourages migrant settlement on the most exposed sites. Migrants not familiar with the flood risk		Chiefs, Sempe stool, migrants, statutory court, Panbros
11	Sand is mined at Glefe beach for various construction uses	Governmental and local residents' environmental protection regulations are being ignored/dismissed	Houses and structures within the locality and at the lagoon side are protected from flooding /less exposed, whereas those at the beach are at increased risk from coastal erosion	Sand extraction contributes to an ongoing process of coastal erosion	Local residents, developers, residents' association, EPA
12	Ramsar site management guidelines for wetland conservation not implemented	Collaboration between Wildlife Division, Panbros Salt Industry, communities and district assemblies challenged by politically derived decision making that prefers visible quick interventions over long term solutions, and by competitive land market	Wetlands receding, mangroves dying, natural processes of infiltration and cleansing disturbed		Wildlife Division; developers/residents
13	Fishing in the Densu Delta	Artisanal freshwater fishing is a main land use and source of livelihood in the Densu Delta	Residents in fishing communities have no fear of flooding/ water	Fishermen look forward to dam opening (and subsequent flooding) as the water carries fish	Fishermen
14	Buildings erected against planning regulations, without permits, and demolition of haphazardly erected structures rarely put into practice.	Traditional custodians (chiefs) hold right to allocate plots in context of land litigation among chiefs; guards protect property/land to be taken from other title holders; corruption	Exposure enhanced as people settle on hazardous sites due to lack of basic infrastructure in 'informal' settlements.	Development exceeds planning capacities;. Distribution of exposure constantly shifting as basic gutters are installed in settlements after some time, at times inducing a shift of water flows	MMDAs, neighbourhood associations, traditional leaders/ their representatives

		in local authorities		(exposure) to other places	
15	Buildings erected in waterways		Waters diverted, inundations shifted between neighbours	Water cannot discharge, therefore floods take longer to recede; temporal diversion until structures on waterways are demolished	
16	Grounds around houses paved	Ideal of 'beautification' by sealed open spaces	Area of infiltration reduced, increased surface runoff leads to flooding on sealed grounds	Higher velocity of surface runoff and in streams, exposure increases as urbanisation is ongoing	Settlers/ residents
Risk					
17	Creating passageways to channel off water from flooded houses	Resident associations, assembly man's 'boys' and other community volunteers help and rescue affected households.	Flood water is diverted to adjacent plots and streets		Community volunteers and assembly man/ his staff
18	Buildings are erected without demarcation		Buildings in Glefe are too dense for emergency vehicles to pass; fires spread easily		
19	Temporary relocation to higher ground	Staying with other people (relatives) during flood events	The option of temporary relocation reduces people's susceptibility and creates an incentive to settle in regularly flooded places	Flooding - the necessity of temporal relocation is accepted as a periodically reoccurring condition of living on the Densu Delta. Perception of repetitiveness differs greatly between perennial and once in 20 years.	Residents, their relatives
20	NADMO has shifted from emergency relief to prevention approaches but continues to provide emergency relief on the ground as floods are not prevented. Emergency relief items (blankets, food, etc.) reportedly come in late and do not correspond to the needs of those affected	Prevention is mainly understood as (top-down) education on flood risk; education is mostly provided to queen mothers and school children as multipliers; residents expect governmental assistance in case of flooding in form of monetary assistance	Emergency relief without effective prevention tends to reinforce vulnerability patterns as background vulnerability and socio-economic effects from flooding are not addressed	Time lags between flood events and relief enhance vulnerability of those affected; sensitisation, education and awareness activities enable anticipation of flooding and its effects	NADMO, also Red Cross
21	Residents gather at a central spot during flooding	Emergency gathering spots and emergency shelters are erected on sites considered to be relatively safe. The sites are prevented from being sold off and developed by community groups against chiefs' interests (Glefe case)	Land speculation and ongoing development endanger/reduce safe spots' capacities to protect residents		Neighbourhood associations; Chiefs as custodians of land
22	Early warning	Through radio, announcements		Anticipation of flooding	

In the following subsections linkages between practices and institutions and their effects on the spatial pattern of vulnerability are identified and illustrated with examples (5.1), and how institutional dynamics create dynamic riskscape in the Densu delta is explained (5.1).

Practices shaping the landscape of vulnerability

Practices shaping the distribution of flood risk interact in such a way that adaptation of some increases the vulnerability of others. In Tetegu for example, the rapid development of middle and high income housing in the area has given the community's land owners association considerable power in negotiations on infrastructure (row 5) and dam management (row 1). Anticipating the property taxes to be gained from the community, the municipality granted building permits to all houses in the community in 2010, paving the way for infrastructure development by governmental authorities. Downstream of New Tetegu, however, residents are exposed to the disposal waters discharged into the Densu River from said gutters, and their coping capacity has become reduced.

Sand extraction at the beachside in Glefe leads to an increased risk of shoreline erosion, while residents further inside the locality and on reclaimed land in the lagoon use the material to reduce their exposure to flooding. Gutters have been installed in Glefe and the most exposed buildings were demolished by city authorities in December 2014/ January 2015, following media pressure initiated by the assembly man. Whether this measure is effective remains to be seen, since according to an engineers' assessment, the construction of open gutters in an area which is at or below sea level would not reduce the risk of flooding¹⁰. A few households have constructed individual drains which end abruptly on the main (and only) street, creating ponds of waste water. Again, these individual measures enhance the vulnerability of others as ponds of stagnant water facilitate the spreading of water-transmitted and water-borne diseases (such as malaria and cholera).

The examples from Tetegu and Glefe illustrate the interaction of actors, practice and institutions in shaping the distribution of risk. They also show how multiple institutions that are not directly targeted at flood risk governance are involved. As formally designed arrangements – namely, urban planning, waste collection – are only partially implemented, complementary informal arrangements have emerged. Residents of Tetegu have come up with strategies to cope with the lack of infrastructure by forming resident groups to dig drains and negotiate with government and GWCL. As a result, all houses were granted building permits subsequent to their construction. The issue of permits facilitated connections to public infrastructure. Dam openings were reduced to a minimum. In Glefe, negotiations with local government for drainage infrastructure in the informally erected settlement were successful after the media became involved. These two examples demonstrate the piecing together of twilight institutions that can be both 'formal' and 'informal' at the same time.

Looking at practices that shape the spatial and temporal dimensions of flood risk enables identifying institutions, including those that are not explicitly targeted at flood risk reduction. Figure 5 explains how practices and institutions interact with biophysical elements to shape

¹⁰ Hydrological Services Department, 19.05.2014

patterns of vulnerability to flooding in the Densu Delta by means of the example of the way the Weija dam is managed.

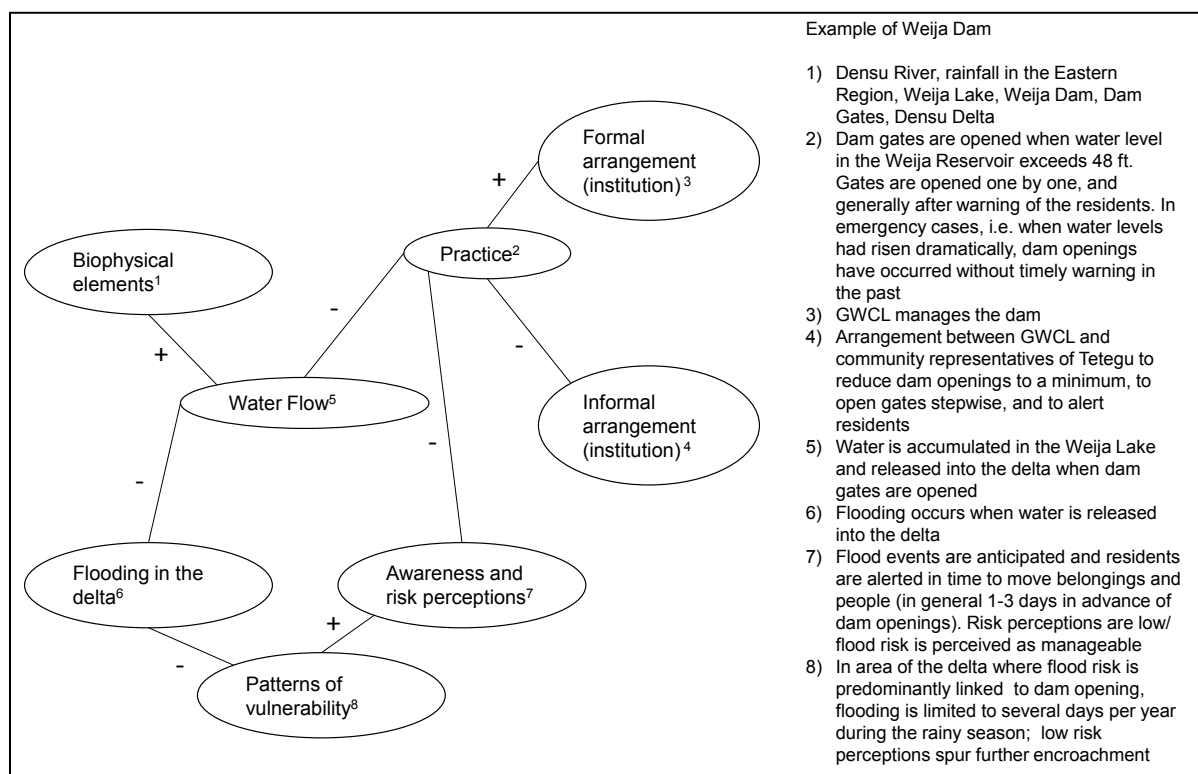


Figure IA.5 Elements of the Densu delta riskscape linked by institutions. (+) indicates links that strengthen, (-) those that weaken the subsequent element's contribution to vulnerability. Own design based on Table 1

The assessment of practice-institution-actor relations and their spatial and temporal effects shows that practices influence spatial and temporal dynamics at all scales. They expose unintended consequences of institutions/ arrangements between actors with shifting interests. For example, Ramsar site management involves the coordination of land use by communities, authorities and industry (salt production), but has become ineffective in the light of accelerating economic and political returns from land development that have led leaders to ignore traditional and governmental regulations. The residents' association in Tetegu has ceased to exist after the initial interests of basic infrastructure and services, including flood risk reduction, had been met – although not for downstream residents (see above). It is now being revived as new risks (armed robbery and traffic accidents) have become a concern for those who initially benefitted from the association's achievements. Institutions thus tend to have a contradictory role, reducing risk through some practices while enhancing it through others, depending on the spatial and temporal scales at stake.

Infrastructure plays an important role in spatial and temporal interactions, by physically diverting water flows, and as a symbol of legitimacy – and power. Examples are the Weija dam openings, the river wall in Tetegu, gutters, dams around salt pans, housing infrastructure and the outfall of the lagoon. Similarly, land is a key factor shaping the pattern of vulnerability as access to land defines who settles where. Figure 6 illustrates how institutions

which possess different degrees of formality become patched together in bricolage within the context of land use governance.

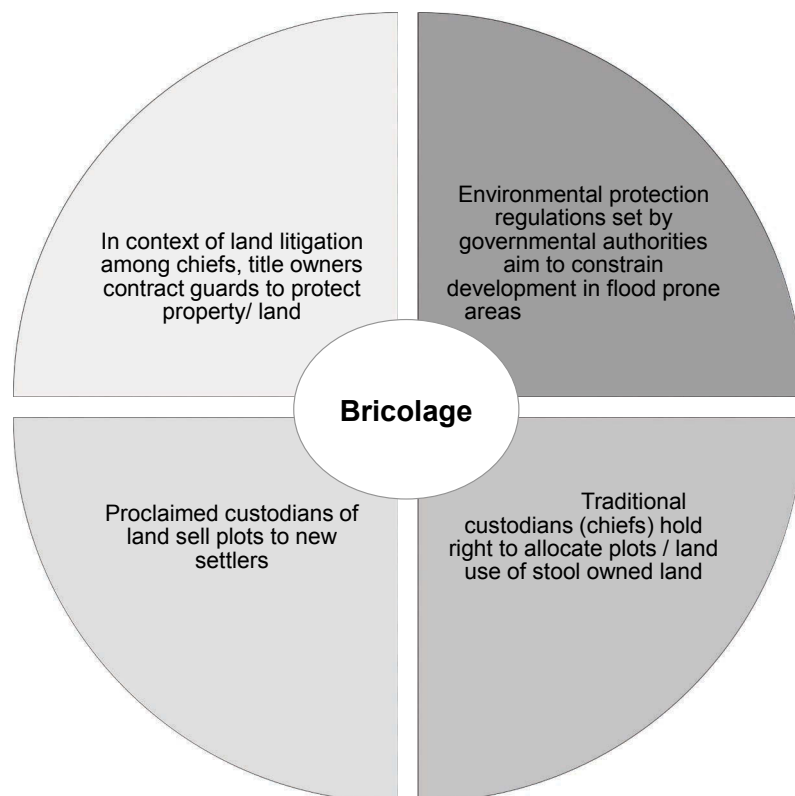


Figure IA.6 Institutional bricolage in the context of land governance in the Densu delta. Land tenure in Ghana can be governmental, private or stool-owned, meaning that it is to be held in trust by a traditional chief for the constituents of his chiefly office (stool) under formal regulations (Barry and Danso, 2014). The darkness of the quadrants increases with the degree of the respective institution's formality. Source: own design

The finding that the distribution of vulnerability is shaped by twilight institutions built around infrastructure, land use management and ownership, and flood risk reduction, shows that the practices producing the Densu Delta riskscape are embedded in a diverse institutional landscape of customary rules, governmental regulations, and market mechanisms, which are patched together in institutional bricolage. It implies that not only local, immediate stakeholders, but also distant actors shape the riskscape as they design institutions that impact local practice. Furthermore, it implies that the relationships of institutions and actors are in constant change.

Practices guided by twilight institutions manifest power relations in the spatial pattern of vulnerability, as the following example illustrates (see row 17 in Table 1): creating passageways to channel off water from flooded houses is a practice that draws on local institutions, namely resident associations, assembly man's 'boys' and other community volunteers. The assembly man's 'boys' are not officially his staff but paid by the assembly man from his salary to assist in community work (in Glefe). The actors involved hold the power to decide who is alleviated (first) from the burden of a flooded house, and whose plot is put at further risk.

Institutional dynamics: tinkering, transformation and re-invention

In the previous sections we have seen how the diversity of twilight institutions in interplay with bio-physical processes in the Densu Delta shape spatially and temporally differentiated

vulnerability to flood risk. The instances discussed above and listed in detail (Table 1) reveal the mechanisms by which bricolage takes place, namely by tinkering, transformation, and reinvention. The tinkering of institutions is particularly visible in the combination of local government structures, informal employment, and voluntary resident groups in emergency flood relief in Glefe. Similarly, the local assembly member referred to both governmental structures and media pressure in order to enhance preparedness for flood events in the locality. The transformation of institutions is particularly visible in Tetegu, where government regulations on building permits have been transformed from a hard, restrictive, authoritative institution into a negotiable, enabling arrangement in infrastructure development. Conversely, the house owners' association has transformed from a loose, informal group of neighbours into a core component in the formalised arrangement for managing infrastructure beyond the locality's boundaries (i.e. of the Weija dam). The association also serves as an example of the re-invention of institutions, as it had ceased to exist after its initial purpose (provision of basic infrastructure) had been met, and has been revived in light of new security concerns that are linked to growing affluence in the locality.

The results show that institutions influence the distribution of flood risk by legitimising the practices of actors with diverse and shifting interests. Infrastructure and land use which mediate spatial and temporal dynamics of flood risk are bones of contention around which key institutions are formed. Formal arrangements for such concerns (namely infrastructure provision, land use planning and flood risk reduction) are often not implemented effectively. For instance, unclear ownership and authority over land use management and speculation trigger constant encroachment into the delta regardless of formal planning and regulations. In response to this haphazard development, demolitions have become a common instrument of environmental and urban planning regulation enforcement. EPA, NADMO and Town and Country Planning can solely monitor violations of regulations which they report to the MMDA, which has the mandate of carrying out demolitions. MMDAs however lack the capacity and means to effect demolitions¹¹ against the resistance of inhabitants¹¹. Sustainable practices in resource use are detailed in Ramsar site management regulations, as well as in customary fishing tradition. They are however not being implemented, with very few exceptions (Tyroller, 2016).

Linked to the shifting interests and priorities of actors engaging in institutional bricolage are different perceptions and experiences of risk. Depending whether access to land for development, affordable housing, maintenance of fishery as a source of livelihoods, habitat conservation, environmental health or community development is the main issue of concern, actors experience different aspects of the riskscape of flooding and its interaction with other riskscape. Panbros Salt Industries, Wildlife Division and the Planning Department for instance experience risks to their activities primarily from encroachment into the Densu delta wetlands. Fishermen's main concern in Tetegu is water quality, not quantity. Accordingly, institutions play different roles in shaping these actors' practices. The cross-sectoral stakeholder roundtable to manage encroachment is of relevance to Panbros Salt Industries and Wildlife Division, but not to community representatives and residents. In Tetegu, the

¹¹ NADMO officer at AMA, 19.05.2014; UNDP Ghana officer, 23.01.2015

house owners' association has formed, disassembled and re-established around risks of property rights, environmental health, street accidents and armed robbery. Particularly this latter example (row 5 in Table 1) highlights the role of risk perceptions in the transformation of institutions.

Here we show that the outcome of institutional dynamics shaped by bricolage is an uneven, dynamic riskscape of flooding in the Densu Delta. In Tetegu, the network of streets and pathways is constantly expanding on the ground and has partly been paved by local government. Official regional planning documents continue, however, to demarcate the area as 'protected' for nature conservation and natural flood retention. Home-owners have come up with multiple strategies to reduce the impact of annual flooding. At the same time the story of bottom-up urbanisation in Tetegu illustrates that social innovation is not stable, and can be limited in creating a liveable urban environment that is safe for all. In Glefe, the recent construction of gutters along the main road is benefitting the core settlement, but also enhancing exposure of residents at the shoreline. These are mostly migrants and 'the poor', who lack resources to reduce their susceptibility. As a consequence, disputes among residents over discharge water flows are likely to continue.

1.1.6 Conclusion

In this paper we have discussed the way in which biophysical, institutional and social elements interact to shape flood risk in the rapidly urbanising and ecologically sensitive Densu delta. The most striking insight is the dramatic differentiation of vulnerability of local people, which is not apparent if the spatial distribution of risk is seen purely in terms of location within the material environment. Even where risk can be spatially quantified, vulnerability to floods differs according to gender, class, property rights, and institutional dynamics, as our examples and list of actor-institution-practice interaction in section 5.1 have revealed. In section 5.2 we have also described the difficulties of identifying clearly defined institutions or institutional functions. Instead the actual response to floods emerges in the form of a bricolage of institutions, spread across a spectrum possessing varied degrees of formality, few of which have an exclusive focus on flood risk. An examination of everyday experiences and practices also offers useful insights into the difference between perceived and actual risk. This needs to be redressed through education regarding actual risk and by fine-tuning disaster response to social differences.

The findings highlight the plurality in risk perception and experience that transform institutions. As twilight institutions transform around various risks of different relevance to different actors, they shape not only the riskscape of flooding, but a range of interacting riskscapes. 'The riskscape' is in fact a combination of riskscapes (of flooding, crime, water security...). Institutions' roles in these vary as different social groups face different riskscapes. The plurality of riskscapes interacting has been stressed by Müller-Mahn and Everts (2013) in their example from Eastern Africa. Our findings contribute to an understanding of how the interaction between riskscapes is shaped by twilight institutions and their interaction with risk.

Our findings also point to the importance of examining everyday experiences and practices in understanding and reducing vulnerability. Further, we also need to give due recognition to the institutional bricolage that exists in practice and acknowledge the limitations of policies directed solely at formal institutions. An inadequate understanding of conditions on the ground can render invisible not only vulnerability, but even entire categories of people at risk, thereby exacerbating policy failure rather than reducing disaster risk (Baghel, 2014). Future research should address gaps in our understanding of disaster risk, especially in rapidly urbanising areas in the global south, such as those in Africa, where the interactions of institutional, biophysical and social elements in the context of disasters continue to be poorly understood.

Acknowledgements

This research has been (partly) funded by the German Federal Ministry of Education and Research (BMBF) under the (project funding) reference number 01 LN 1316 A, and by the Heinrich Böll Stiftung under the funding reference number P105800. We are grateful for the kind support our research has received from our partners at the University of Ghana and in the case study area. We especially thank Arabella Fraser, Mark Pelling and three anonymous reviewers for their thoughtful comments on earlier drafts of this article. We thank the student assistants of the Governance and Sustainability Lab for their support.

1.1.7 References

- Abbey, E.E. (2013) Bortianor youth protest sale of land. *Daily Graphic Ghana*, 24 October.
- Abdallah Imam, H; H. Tamimu (2015) 'Life beyond the Walls of my Hometown': Social Safety Networks as a Coping Strategy for Northern Migrants in Accra. *Asian Journal of Social sciences and Management Studies* 2.1, 25–43.
- Action Aid (2006) *Climate change, urban flooding and the rights of the urban poor in Africa. Key findings from six African cities*. URL http://www.actionaid.org/sites/files/actionaid/climate_change_urban_flooding_and_the_rights_of_the_urban_poor_in_africa.pdf (accessed 24 February 2015).
- Adelekan, I.O; C. Johnson; M. Manda; D. Matyas; B.U. Mberu; S. Parnell, et al. (2015) Disaster risk and its reduction: an agenda for urban Africa. *IDPR* 37.1, 33–43.
- Adger, N.W; K. Brown (2009) Vulnerability and resilience. In: N. Castree, D. Demeritt, D. Liverman and B. Rhoads (eds) *A Companion to Environmental Geography (Blackwell Companions to Geography)*: Wiley-Blackwell.
- Amoako, C; F.E. Boamah (2014) The three-dimensional causes of flooding in Accra, Ghana. *International Journal of Urban Sustainable Development*, 1–21.
- Amoani, K; K. Appeaning Addo; W. Laryea (2012) Short-term shoreline evolution trend assessment: A case study in Glefe, Ghana. *Jàmá: Journal of Disaster Risk Studies* 4.1, 1–7.
- Appeaning Addo, K; M. Adeyemi (2013) Assessing the impact of sea-level rise on a vulnerable coastal community in Accra, Ghana. *Jàmá: Journal of Disaster Risk Studies* 5.1, 1–8.
- Abheuer, T; I. Thiele-Eich; B. Braun (2012) Coping with the impacts of severe flood events in Dhaka's slums The role of social capital. *Erdkunde: Archiv für wissenschaftliche Geographie* 67.1, 21–35.
- Atlas of Urban Expansion (2016) *The City as a Unit of Analysis and the Universe of Cities. Accra*. URL www.atlasofurbanexpansion.org (accessed 25 April 2017).
- Baghel, R. (2014) *River Control in India: Spatial, Governmental and Subjective Dimensions*. Springer, Dordrecht, Heidelberg, New York & London.
- Barroca, B; P. Bernardara; J.M. Mouchel; G. Hubert (2006) Indicators for identification of urban flooding vulnerability. *Natural Hazards and Earth System Science* 6.4, 553–561.

- Barry, M; E.K. Danso (2014) Tenure security, land registration and customary tenure in a peri-urban Accra community. *Land Use Policy* 39, 358–365.
- Borges, P; C. Andrade; M.C. Freitas Sand Mining - the Case of Santa Barbara Beach, São Miguel (Azores, Portugal). *Journal of Coastal Research* 2002.36, 89–95.
- Braun, B; I.F. Nsorfon (2013) Überschwemmungen und Überleben in den Slums von Lagos und Dhaka. *Geographische Rundschau*.10, 20–27.
- Chang, L.-F; Karen C. Seto, Karen C; S.-L. Huang (2013) Climate Change, Urban Flood Vulnerability, and Responsibility in Taipei. In: C.G. Boone and M. Fragkias (eds) *Urbanization and Sustainability: Linking Urban Ecology, Environmental Justice and Global Environmental Change*: Springer Science & Business Media.
- Cleaver, F. (2001) Institutional Bricolage, Conflict and Cooperation in Usangu, Tanzania. *IDS Bulletin* 32.4, 26–35.
- Cleaver, F. (2012) *Development through bricolage. Rethinking institutions for natural resource management*. Routledge, Abingdon, Oxon, New York, NY.
- Cutter, S.L. (1996) Vulnerability to environmental hazards. *Progress in Human Geography* 20.4, 529.
- Doan, P; C.Y. Oduro (2012) Patterns of Population Growth in Peri-Urban Accra, Ghana. *International Journal of Urban and Regional Research* 36.6, 1306–1325.
- Frick, F. (2016) Travelling Through the Densu Delta: Location, Place and Space in the Waterscape. In: J. Niewöhner, A. Bruns, P. Hostert, T. Krueger, J.Ø. Nielsen, H. Haberl, et al. (eds) *Land Use Competition*: Springer International Publishing, Cham.
- Frick-Trzebitzky, F; A. Bruns (2017) Disparities in the Implementation Gap: Adaptation to Flood Risk in the Densu Delta, Accra, Ghana. *Journal of Environmental Policy & Planning* in press.
- Gaillard, J.C; J. Mercer (2013) From knowledge to action Bridging gaps in disaster risk reduction. *Progress in Human Geography* 37.1, 93–114.
- Ghana Statistical Service (2012) *2010 Population & Housing Census. Summary Report of Final Results*. Ghana Statistical Service, Accra, Ghana.
- Hall, K; F. Cleaver; T. Franks; F. Maganga (2013) Critical institutionalism: a synthesis and exploration of key themes. *Environment, Politics and Development Working Paper Series*.63.
- Huq, S; S. Kovats; H. Reid; D. Satterthwaite (2007) Editorial: Reducing risks to cities from disasters and climate change. *Environment and Urbanization* 19.1, 3–15.
- Lanzara, G.F. (1998) Self-Destructive Processes in Institution Building and Some Modest Countervailing Mechanisms. *European Journal of Political Research* 33.1, 1–39.
- Lévi-Strauss, C. (1962) *La pensée sauvage*. Plon, Paris.
- Lund, C. (2006) Twilight Institutions: Public Authority and Local Politics in Africa. *Development and Change* 37.4, 685–705.
- Morrow, B.H. (1999) Identifying and mapping community vulnerability. *Disasters* 23.1, 1–18.
- Müller-Mahn, D; J. Everts (2013) Risksapes The spatial dimension of risk. In: D. Müller-Mahn (ed.) *The spatial dimension of risk: How geography shapes the emergence of risksapes*: Routledge, London.
- Mustafa, D. (2005) The Production of an Urban Hazardscape in Pakistan Modernity, Vulnerability, and the Range of Choice. *Annals of the Association of American Geographers* 95.3, 566–586.
- Ostrom, E. (1986) An agenda for the study of institutions. *Public Choice* 48, 3–25.
- Ostrom, E. (1990) *Governing the commons: the evolution of institutions for collective action*.
- Oteng-Ababio, M; K. Owusu; K. Appeaning Addo (2011) The vulnerable state of the Ghana coast: The case of Faana-Bortianor. *Jàmbá: Journal of Disaster Risk Studies* 3.2, 429–442.
- Owusu, M. (2013) Community-managed reconstruction after the 2012 fire in Old Fadama, Ghana. *Environment and Urbanization* 25.1, 243–248.
- Pelling, M. (1997) What determines vulnerability to floods; a case study in Georgetown, Guyana. *Environment and Urbanization* 9.1, 203–226.
- Pelling, M. (1999) The political ecology of flood hazard in urban Guyana. *Geoforum* 30, 249–261.
- Pelling, M; B. Wisner (2012) *Disaster risk reduction: Cases from urban Africa*. Routledge.
- Seto, K.C. (2011) Exploring the dynamics of migration to mega-delta cities in Asia and Africa Contemporary drivers and future scenarios. *Global Environmental Change* 21, S94-S107.
- Stow, D.a; J.R. Weeks; H.-c. Shih; L.L. Coulter; H. Johnson; Y.-H. Tsai, et al. (2016) Inter-regional pattern of urbanization in southern Ghana in the first decade of the new millennium. *Applied Geography* 71, 32–43.

- Town and Country Planning Department (TCP) (1991) *Structure Plan 2010. Accra Planning and Development Programme*, Accra, Ghana.
- Tyroller, L. (2016) *Changing Socio-Ecological Dynamics in an African Peri-Urban Wetland*, Trier.
- United Nations Human Settlements Programme (UN-Habitat) (2014) *The State of African Cities 2014. Re-imagining sustainable urban transitions*, Nairobi.
- Walker, G; K. Burningham (2011) Flood risk, vulnerability and environmental justice Evidence and evaluation of inequality in a UK context. *Critical Social Policy* 31.2, 216–240.
- Wildlife Department (1998) *Ramsar Wetlands Information Sheet*, Accra, Ghana (accessed 17 January 2015).
- Wisner, B; P. Blaikie; T. Cannon; I. Davis (2004) *At risk. Natural hazards people's vulnerability and disasters*. Routledge, Oxon, New York, NY.

I.2 Article B: Disparities in the Implementation Gap: Adaptation to Flood Risk in the Densu Delta, Accra, Ghana

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This paper has been published online first in the Journal of Environmental Policy & Planning and can be cited as: Fanny Frick-Trzebitzky & Antje Bruns (2017): Disparities in the implementation gap: adaptation to flood risk in the Densu Delta, Accra, Ghana, Journal of Environmental Policy & Planning. DOI: 10.1080/1523908X.2017.1343136

Received 04 Feb 2015, Accepted 08 Jun 2017, Published online: 07 Jul 2017

Abstract

While the need for adaptation in response to the effects of global environmental change impacts in cities has been widely recognised, implementation of appropriate strategies and measures to curb them remains a challenge. In the Densu Delta, west of Accra, multiple phenomena of global environmental change interact together, making adaptation a key strategy for dealing with the increased risk of urban flooding. Implementation of existing policies, however, is scarce. Here we analyse policy arguments concerning strategies to reduce and adapt to urban flooding in key policy documents and contrast them with practitioners' experiences of implementation in the Densu Delta. Two general mismatches in argumentation are identified that reflect the implementation gap in adaptation to flooding in the Densu Delta. These are a disconnected presentation of the causes, consequences, and strategies in policy arguments, and the concealing of undisclosed premises. Undisclosed premises are shown not to speak to the conditions of implementation practice. Consequences for overcoming the implementation gaps are sketched out. The paper contributes to understanding of the implementation gap in adaptation to urban flood risk by applying a lens of argument to environmental policy analysis in an African context.

Key words

Urban disaster risk, environmental policy discourse, implementation gap, local knowledge and practices

1.2.1 Introduction

Adaptation is considered a particularly effective approach when addressing climate change and disaster risk in cities where development exceeds planning capacities in their pace and scale. In such growing cities, static, technocratic solutions for risk reduction are difficult to implement (Huq, Kovats, Reid, & Satterthwaite, 2007). The superposition of population growth, environmental degradation and a deceleration in economic growth is a major challenge particularly in African cities (Parnell & Walawege, 2011), that requires governments and urban dwellers adapt to complex and uncertain conditions of socioeconomic and environmental change. Urban flooding is one of the major risks African cities are increasingly facing as a result of multiple socio-economic and environmental changes (Bhattacharya & Lamond, 2011). Factors enhancing risk in African cities include the interaction of multiple hazards and vulnerabilities, poor attention to basic infrastructure, insufficient mainstreaming of disaster risk reduction in urban planning, low capacity of local governments and uncoordinated decentralisation of responsibilities (Adelekan et al., 2015; Benouar et al., 2012; Bhattacharya & Lamond, 2011).

While the need for adaptation as a response to the effects of global environmental change in cities has been widely recognised, active implementation of respective strategies and measures remains a challenge (e.g. Corfee-Morlot, Cochran, Hallegatte, & Teasdale, 2011). Adaptation measures that have been proposed in academic research would address risk factors such as those that have been identified for African cities. However, they are not mirrored in the practice of urban adaptation and risk management. Other measures that have been identified are not suited to the context of African cities, since “global technical knowledge” (Benouar et al., 2012, p. 196) tends to ignore both the interaction of multiple risks and vulnerabilities that is strong in African cities (Benouar et al., 2012; Huq et al., 2007), and the legacy of local urban planning practice (Hetz & Bruns, 2014). The aim of this research is to identify mismatches between designed policy and implementation practice in an African city, in order to demarcate some room for manoeuvre towards overcoming the implementation gap. Adaptation to flood risk in Accra, the capital city on the coast of Ghana, is taken as an example.

With a population of four million (as of 2010; Ghana Statistical Service, 2012), Greater Accra is a prime example of a growing medium sized African city where urban flooding is increasingly forcing residents to adapt to its associated risks (Douglas et al., 2008). In 2011, large floods affecting Accra and other regions of the country created a momentum for the development of policies on disaster risk reduction and climate change. However, they show little impact on the ground (Amoako & Boamah, 2014). Policies addressing urban flood risk such as the National Disaster Management Plan appear to be ineffective, as flood events keep reoccurring (Modern Ghana News, 2013; Oteng-Ababio, 2013). In the Densu Delta, west of Accra, multiple phenomena of global environmental change interact, making adaptation a key strategy for dealing with the increased risks of urban flooding. This need is recognised among researchers and decision-makers alike who pushed the protection of the delta as a Ramsar site, and planned to keep the area free from urban development. At the same time, urbanisation in the delta continues, making strategic adaptation from a city planning

perspective almost impossible to implement. Residents, meanwhile, develop adaptive strategies at household level (Oteng-Ababio, Owusu, & Appeaning Addo, 2011).

The implementation gap in adaptation to flood risk in Accra has been attributed to the disintegration of measures targeted at water resource management, urban planning, and climate change (Amoako & Boamah, 2014), and also to limited attention to indigenous knowledge and differing vulnerability (Aboagye, 2012; Codjoe, Owusu, & Burkett, 2014). The role of underlying assumptions has not, however, been analysed in this context. Environmental policy argumentation can be understood as the contestation over definitions of an environmental problem and its solutions. Policy arguments link statements as premises and conclusions. Analysis of policy arguments thus exposes underlying assumptions on causal relations (Felgenhauer, 2009; Fischer & Gottweis, 2013). Here we analyse policy arguments on strategies for reducing and adapting to urban flooding in key policy documents and contrast them with practitioners' experiences of implementation in the Densu Delta. The aim is to identify mismatches in argumentation that widen the implementation gap in adaptation to flooding in the Densu Delta. The paper contributes to understanding of the implementation gap in adaptation to urban flood risk by applying an argumentation lens to environmental policy analysis in an African context.

1.2.2 Analysing the Implementation Gap

This section gives an overview of the factors shaping the implementation gap in adaptation to urban flood risk, as identified in the literature. The relevance of environmental policy discourse and argument analysis to further understanding the implementation gap is discussed and an analytical framework presented.

The Implementation Gap in Adaptation and Disaster Risk Reduction

The gap between what is known about and what is being done to counter the risks associated with climate change has increasingly become the subject of adaptation and risk research over the past 20 years (Moser & Dilling, 2013; Vogel, Moser, Kasperson, & Dabelko, 2007). This gap has been analysed in terms of both the policy context of adaptation to climate change, and that of disaster risk reduction. Both research fields are relevant to understanding the implementation gap in adaptation to urban flood risk, as climate change is one of several factors contributing to urban flood risk, and typical measures for disaster risk reduction such as drainage infrastructure are key in shaping (urban) adaptation options.

The implementation gap in adaptation to climate change is not the result of a simple gap in the flow of information but of communication insensitive to the audience's context, belief systems and world views (Gaillard & Mercer, 2013; Moser & Dilling, 2013). For instance, decision-makers' attitudes towards uncertainty in risk predictions are shaped by their experience of uncertainties in policy-making processes and broader conditions. Moreover, their individual underlying values, cognition, decision-making, and institutionally embedded behaviour shape their attitudes (Moser, 2005). Similarly, context-specific experiences and conditions are poorly considered in policies on disaster risk reduction as a result of

disintegrated processes of policy formulation at international and national levels and their implementation at the local level. Consequently actors on the local level are confronted with policies that are difficult to implement because they fail to recognise local communities' vulnerabilities and capacities (Gaillard & Mercer, 2013). In addition, disaster risk has historically been addressed by a different community of research and policy-making to urban development, whereas the two arenas are closely linked in local practice, particularly in the context of adaptation to urban flood risk (Bull-Kamanga et al., 2003).

Environmental Policy Discourse and Argument Analysis

Environmental issues such as adaptation to climate change and urban disaster risk reduction are characterised by high complexity and uncertainty. Dealing with these issues in policy therefore involves continual adjustment of knowledge and meaning. Particularly in the context of 'wicked problems' such as environmental change, competing narratives that create knowledge and meaning are contested (Fairclough, 2013; Fischer & Gottweis, 2013). The way in which knowledge is being constructed and used in policies addressing environmental issues is therefore key to understanding implementation gaps.

The argumentative turn in policy analysis (Fischer & Forester, 1993) initiated a focus on construction of knowledge in policy analysis from different perspectives. Building predominantly on the work of Hajer (1993), environmental policy discourse analysis looks at how actors, discourses and meanings interact in the construction of environmental problems and their solutions. Drawing on a wide range of approaches to discourse analysis case studies have shown how powerful narratives determine what environmental issues are created and dealt with, and how (Feindt & Oels, 2005). Power relations are exposed, for instance where hegemonic global environmental discourses have rendered local environmental problems illegible to decision-makers, and thus ungovernable (Adger, Benjaminsen, Brown, & Svarstad, 2001; Keil & Debbané, 2005).

Following a more normative understanding of policy as deliberative action, the process of contestation over knowledge and meaning in policy is analysed as practical argumentation (Fairclough, 2013; Fischer & Forester, 1993; Fischer & Gottweis, 2013). The underlying concept here is that decision-makers confronted with a situation choose options based on their knowledge of possible actions and intended and unintended consequences (Fairclough, 2016). Discourse and argumentation are interlinked as ideological discourse shapes premises, arguments and actors involved in argumentation (Fairclough, 2016; Fischer & Gottweis, 2013).

Flood policy research has pointed to differences in knowledge and discourse between sectors and levels, and to power relations as key factors challenging active response to urban flooding. Large flood events have triggered changes in hegemonic policy discourse in the Netherlands and in Norway, shifting from a technocratic understanding of flood risk reduction towards adaptation (Næss, Bang, Eriksen, & Veatne, 2005; Wesselink, Warner, & Kok, 2013). In implementation of the respective policies however, institutional settings, power relations and decision makers' world views have contributed to continual focus on technical measures rather than adaptive approaches using 'soft solutions' such as integrated

land use planning, ecosystem conservation and coastal retreat (Næss et al., 2005; Næss, Norland, Lafferty, & Aall, 2006). The examples illustrate argumentation in adaptation. Arguments anticipating integrated adaptive ‘soft solutions’ to flood risk were contested by local decision-makers’ arguments that support technocratic ‘hard solutions’. Arguing that such solutions create wealth from land use whereas adaptive land management giving more space to flood water doesn’t, flood prone areas near Oslo have been developed despite initial concerns about flood risk (Næss et al., 2005).

Argument analysis is concerned with the evaluation of arguments exchanged in making decisions. A policy argument can be understood to be “a complex blend of factual statements, interpretations, opinions and evaluations” (Fischer & Gottweis, 2013, p. 429). Policy argument analysis teases out the premises that lead to a conclusion (Fischer, 2003, p. 181). Evaluating arguments, moreover, tests their validity and consistency (Brun & Betz, 2016; Fairclough, 2016). The exchange of arguments plays a particularly large role in deliberative action when faced with uncertainty and risk, where knowledge about potential actions and their consequences is incomplete (Fairclough, 2016), just as in flood risk governance.

The role of discourse in argumentation has been analysed from different perspectives (Fairclough, 2016; Fischer & Gottweis, 2013). Here we focus on the effects of policy arguments made in policy documents on implementation practice. The purpose is to understand the role of argumentation in the implementation gap. This is done by evaluating policy arguments on strategies targeting flood risk based on decision makers’ experiences of implementation in the case study area.

Argument Analysis in Adaptation to Urban Flood Risk

Basing our definition on the analytical frameworks for argument analysis as developed by Brun & Betz (2016) and Fairclough (2016) we define argument as a set of statements that are linked as premises and conclusions. Hence statements are segments of argumentative text passages that can be identified as a premise or conclusion in the reconstruction of an argument (Brun & Betz, 2016). A practical policy argument links statements on conditions (such as flood risk) and goals (such as risk reduction) to possible actions or strategies (such as adaptation). It moreover builds on underlying assumptions about causal relations, for instance between actions and intended and unintended consequences that are not always made explicit (Brun & Betz, 2016). Premises on goals, conditions, activities and effects are combined in policy arguments (Fairclough, 2016)¹².

Arguments on strategies for reducing flood risk are traced here in policy publications¹³. The focus of the analysis is on evaluation of the coherence of arguments on flood risk and adaptation across policy document groups. Experiences of implementation gaps in adaptation to flood risk in the Densu Delta serve as a basis for testing the validity of premises of policy

¹² See supplemental material for a visualisation of the structure of practical reasoning.

¹³ A note of caution: the analysis of arguments in formal policy documents looks at the outcome of argumentation only and doesn’t show who is engaged in argumentation in what way. Consequently only dominant arguments are revealed.

arguments. This contrasting of policy arguments with decision makers' experiences shows where policy arguments are unrelated to local conditions and thus the implementation gap becomes widened. The question guiding this research is: how are arguments on strategies in flood risk policy documents linked to implementation experiences in adaptation to flood risk in the Densu Delta?

1.2.3 Methods

The research design follows a case-study approach to explore and understand the implementation gap in the field of flood risk governance. The geographical and content-related limitation is necessary to allowing a qualitative approach to investigating the role of arguments in the implementation gap. Selection of the case study area was information-oriented. The Densu Delta west of Accra was selected as an extreme case of multiple implementation gaps in adaptation to flood risk in a dynamic context of high uncertainty in urban environmental change. At the same time the case can be considered to be critical in implementation of adaptation to urban flooding in rapidly urbanising African coastal areas because several adaptation policies addressing urban flooding are in place, and multiple environmental risks and vulnerabilities affect the area and its settlers (Benouar et al., 2012; Bhattacharya & Lamond, 2011; Flyvbjerg, 2006).

Case Study Area

At the core of the case study area lies the Densu Delta Wetland. Settlements here are exposed to severe annual flooding and coastal inundation (Amoani, Appeaning Addo, & Laryea, 2012; Appeaning Addo & Adeyemi, 2013; Oteng-Ababio et al., 2011). Flooding results from shoreline recession, relative sea level rise and the eventual spilling of nearby Weija dam (Appeaning Addo, 2013). Glefe, one of the poorest neighbourhoods of Accra, is located in the area. Its settlers are particularly vulnerable to flood risk. Ongoing encroachment of wetlands without sufficient drainage and sanitation infrastructure exposes an increasing number of people to flooding and associated risks (Adank et al., 2011). The encroachment defies current land use regulations that designate the area as a green space for nature conservation.

Policy Documents

Policy documents were selected as the corpus of the argument analysis. Interviews were conducted with key decision makers engaged in policy design and implementation. In addition to interview partners' reports, field observations were made to identify implementation gaps.

Policy documents were selected when 'adaptation' appeared in the title or content of a policy document (as identified through a web search), and when referred to as relevant to adaptation to climate change and flood risk reduction by interviewees or policy documents explicitly targeting adaptation to climate change (N=18). They were further grouped by their level of outreach under 'international conventions and frameworks' (N=3), 'national policy

frameworks' (N=4), 'national policies' (N=2), 'national action plans' (N=6), and 'donor projects' (N=2).

Pre-coding of selected documents exposed causes and effects, and corresponding strategies as the main elements of arguments on flooding. Respective statements were encoded from the full text corpus using MAXQDA software. Argumentative passages were identified from the encoded material. Codes were continuously refined and sorted throughout the encoding process and segments supporting the same argument grouped. Encoded text segments consist of half and full sentences and passages up to and including whole paragraphs that make up a statement within an argumentative passage, or a full argument, depending on the structure and style of the document analysed. Arguments on selected strategies were reconstructed from the statements identified following the method described by (Brun & Betz, 2016) by which unclear statements are refined, unnecessary information eliminated, and implicit assumptions identified. Consistency of premises and conclusions was assessed.

Interviews and Field Observations

The analysis of implementation gaps draws on interviews conducted with twelve decision-makers in urban planning and disaster risk reduction in Accra, and on field observations. Field research in Accra was conducted from April to June 2014 and in January 2015.

Interview partners were selected by relevance of position in key institutions concerned with the implementation of adaptation policy in Accra, as stated in policy documents and in interviews. The interviews analysed here are a selection of a larger set of interviews (N=65) on flood risk in Accra and the Densu Delta conducted with key decision-makers at different levels. Out of this set, those interviews with the greatest relevance to the research question were selected for the analysis of implementation gaps. The respective interview partners hold leading positions in eight government authorities, two international development organisations, and two private companies concerned with implementation of environmental regulation and urban development (see supplemental material for a list of interviews). Semi-structured interviews lasting 30 to 90 minutes addressed causes, consequences and strategies of flooding in Accra and the Densu Delta. Site visits and transect walks served to identify implementation gaps and refine interview questions accordingly. Developed areas in the Densu Delta were mapped in transect walks and compared with official maps.

Interviews were assessed in a qualitative content analysis based on inductive category development (Mayring, 2010). Categories were derived from in vivo-coding of a pre-selection of interviews and used for in-depth analysis of the full material using MAXQDA software. Implementation gaps and their causes were identified from interview partners' reports of implementation practice, as well as from comparison of strategies as described in policy documents, strategies described by interview partners, and the spatial extent of urban development in the Densu Delta. The role of arguments in the implementation gap was identified by testing the validity of premises in policy arguments on implementation practice (Fairclough, 2016).

1.2.4 Disparities and the Implementation Gap in the Densu Delta

The findings show that a separate discussion of causes, consequences and strategies, blue-printing of arguments and underlying assumptions unrelated to local conditions shape disparities between different groups of policy documents, and disparities between policy documents and implementation practice. These patterns in arguments broaden the implementation gap, as we discuss in this section.

Disparities in Policy

Two patterns can be observed from comparison of statements and analysis of arguments in policy documents. These are that firstly, conclusions on strategies for reducing flood risk are drawn independently of the causes and consequences described. Secondly, a tendency to blue-print arguments from international frameworks to national policy and action plans in sectoral context. The two patterns are discussed here based on selected topics of argumentation, namely infrastructure, knowledge and differential vulnerability. Prior to the discussion, the document groups are introduced briefly.

Table I.2.1 Policy documents relevant for adaptation to flooding by document groups

International Frameworks and Conventions	Policy and	Donor Projects	National Frameworks	Policy	National Policies	Action Plans
United Nations Framework Convention on Climate Change (UNFCCC) (United Nations, 1992)		CREW Community resilience through early warning (CREW) (United Nations Development Programme Ghana, 2012)	Ghana National Climate Change Policy (Ministry of Environment, Science, Technology and Innovation, 2013b)	(NCCP) (Ministry of Environment, Science, Technology and Innovation, 2013b)	National Water Policy (NWP) (Ministry of Water Resources, Works and Housing, 2007)	Ghana Plan of Action on Disaster Risk Reduction and Adaptation to Climate Change (National Disaster Management Organisation, 2011)
Hyogo Framework for Action (HFA) (United Nations International Strategy for Disaster Reduction, 2005)		Africa Adaptation Programme in Ghana (AAP) (UN Africa Adaptation Programme, 2013)	National Urban Policy Framework (NUP) (Ministry of Local Government and Rural Development, 2012b)		Riparian Buffer Zone Policy (Ministry of Water Resources, Works and Housing, 2011)	NCCAS National Climate Change Adaptation Strategy (Ministry of Environment, Science, Technology and Innovation, 2013a)
Ramsar Convention on Wetlands (United Nations Educational, Scientific and Cultural Organization, 1971; 1994)			Ghana Shared Growth and Development Agenda 2010-2013 (GSGDA) (National Development Planning Commission, 2010)		National Land Policy (NLP) (Ministry of Land and Forestry, 1999)	NDMP National Disaster Management Plan (National Disaster Management Organisation, 2010)
						Accra Structure Plan 2010 (Town and Country Planning Department, 1991)
						Ghana National Climate Change Policy Action Plan (Ministry of Environment, Science, Technology and Innovation, 2015)
						National Urban Policy Framework Action Plan (Ministry of Local Government and Rural Development, 2012a)

Policy documents relevant to adaptation to flooding in the case study area include international frameworks and conventions, national policy frameworks, national policies and action plans (see Table 1 and supplemental material). As key international policy frameworks, the Hyogo Framework for Action on Disaster Risk Reduction (HFA) and the United Nations Framework Convention on Climate Change (UNFCCC, ratified by Ghana in 1994) have shaped adaptation planning in Ghana. To comply with the HFA and UNFCCC, national policies and action plans targeting adaptation to climate change have been designed by the government of Ghana, assisted by UNDP. Flooding is addressed in national policies and action plans as an incidence of the effects of climate change anticipated for Ghana. Further documents relevant though not directly engaging with adaptation are the international Ramsar Convention on Wetland Conservation, the Accra Structure Plan, and others.

Table 2 gives an overview of statements on causes, consequences, and strategies related to key topics in urban flooding identified by document group. The following analysis refers to these topics¹⁴.

Table 1 Statements on causes, consequences and strategies related to key topics in urban flooding identified by document group. Dark shading indicates a statement (row) has been coded within the respective document group (column). IPFC = International Policy Framework or Convention; DP = Donor Project; NDF = National Policy Framework; NP = National Policy; AP = Action Plan

Knowledge					
Strategies to address flood risk	IPFC	DP	NDF	NP	AP
Adaptive capacity includes indigenous knowledge / cultural factors					
Education, training, awareness on CC/DRR is key to DRR					
CCA and DRR requires knowledge, data and research on CC/ DR					
Vulnerability					
Strategies to address flood risk	IPFC	DP	NDF	NP	AP
Vulnerable groups need priority attention in DRR					
Impacts of flooding					
Residents of informal settlements are particularly exposed					
Vulnerability/ adaptive capacity depends on socio-economic resources					
Migrants are particularly exposed					
Elderly, disabled people, children are particularly vulnerable/exposed					
Women are particularly vulnerable/exposed					
The poor are particularly vulnerable/exposed					
Infrastructure					
Strategies to address flood risk	IPFC	DP	NDF	NP	AP
Structural DR protection has adverse impacts					
Structural and non-structural measures mitigate impacts from floods					
Infrastructure and services will mitigate floods and their effects					
Proper planning, design, maintenance of drainage systems					
Effects of flooding					
Floods cause loss/ disruption of infrastructure					
Causes of floods					
Lack of infrastructure exacerbates flood risk					
Poor maintenance and design of drainage creates floods					

¹⁴ The full list of statements is presented in the supplemental material.

Undisclosed premises. Comparison of statements made in the policy documents shows that conclusions on strategies are not linked to statements on causes and consequences. This is particularly evident from arguments about knowledge. While international frameworks focus on knowledge dissemination and coordination, national documents state a need for knowledge and data generation. Neither at international nor at national level is an explicit link between lack of data, knowledge and technology and adverse effects of flooding made. Hence the assumption that more knowledge is needed that underlies knowledge-related strategies is not derived explicitly from a statement on lacking knowledge as a cause or consequence of flooding.

This “missing link” results from the absence of explicit premises on which conclusions are drawn. Causes, consequences and strategies are presented in separate sections and statements include implicit premises, concealing assumptions about causal relations. For example, in the NDMP, various types of strategies are defined, such as “the pre-disaster phase constitutes measures taken to prevent man-made disasters and minimise the effects of natural ones”. Corresponding measures such as “Identification of hazards or emergency situations that may degenerate into disasters” are listed (National Disaster Management Organisation, 2010, p. 3). Implicit premises that can be identified here are:

[Man-made disasters ought to be prevented and the effects of natural ones minimised.]

[Man-made disasters can be fully prevented.]

[Hazards and emergency situations are identifiable.]

[Flooding is predictable.]

[Knowledge and information on a situation of risk lead to better preparation.]

The corresponding argument is, respectively:

Because knowledge and information on hazards and emergency situations lead to better preparation in the pre-disaster phase, such situations ought to be identified in order to prevent man-made disasters and minimise the effects of natural ones.

Looking at arguments about knowledge across all document groups as another example, the general argument on the need for knowledge in adaptation to and reduction of flood risk put forward by all documents is:

Social and environmental change contribute to enhanced risk of flooding, which has adverse effects on people’s lives and urban and national development. Better understanding of the processes that create flood risk and vulnerability allows risk and vulnerability reduction. Therefore knowledge, data and information on the processes that contribute to flood risk are needed.

The linking statement that ‘better understanding is needed’, however, is stated on different grounds, explicitly or implicitly. Consequently, different premises and conclusions support the general argument, including:

- Existing knowledge and technology needs to be shared *because knowledge and technology are not equally available across the world, and availability does not correspond to the global distribution of flood risk*
- Existing knowledge needs to be documented because developing strategies of disaster risk and vulnerability strategy from existing (indigenous) knowledge is cheaper than importing it from abroad *or developing new knowledge, and the cheaper option is the preferable one.*
- New data needs to be collected and research conducted to provide the information and knowledge needed to reduce risk and vulnerability *because key information and knowledge are lacking which could reduce risk and vulnerability.*
- Existing technology needs to be applied to yield the data / information needed to reduce risk and vulnerability
- New technology needs to be developed to be able to generate data needed for reducing risk and vulnerability *because existing technology is not accurate enough.*

The different premises lead to different conclusions on knowledge-related strategies in the various document groups. International policy frameworks stress the need to “Promote and support dialogue, exchange of information and coordination” (United Nations International Strategy for Disaster Reduction, 2005, p. 12; similar wording is used in the UNFCCC). By contrast, national policies focus on the need to “increase knowledge and strengthen capacity at all levels” (Ministry of Environment, Science, Technology and Innovation, 2013, p. 18), generate data and “apply appropriate technologies to provide the necessary information for detection and early warning systems for floods” (Ministry of Water Resources, Works and Housing, 2007, p. 21), as well as on integrating indigenous and scientific knowledge. As the premises leading to the definition of these strategies are not disclosed, it is unclear whether the focus on knowledge generation at national level stems from a contextual understanding of causes and consequences of urban flood risk in Ghana.

Blue printing. As well as being built on different undisclosed premises, arguments tend to be developed within the context of sectoral policy context than from context-specific information and flood-event based analysis, as is shown by the example of arguments on the differential vulnerability of people to flood risk. The National Disaster Management Plan stresses the need to attend in particular to “women, children, the aged, the sick, the wounded and the physically handicapped” (NADMO, 2010, p. 8). This statement mirrors that of the international framework HFA (UNISDR, 2005, p. 11) where: “the poor, the elderly and the disabled and other populations affected by disasters” as well as children need particular attention in recovery schemes, vulnerability reduction and preparedness and contingency plans. Vulnerable groups identified in national policies are migrants, the elderly, the disabled, children, women, poor people as well as residents of informal settlements. However, “women and other vulnerable groups” (e.g. Riparian Buffer Zone Policy, Ministry of Water Resources, Works and Housing, 2011) are addressed without further specification. Hence several of the groups identified as being particularly vulnerable are not addressed specifically in strategies. By and large, although statements in national policy documents on flood

impacts may stress the differential vulnerability of people, strategies tend not to address these specifically, but rather seem to mirror statements in international documents.

The differences between statements on infrastructure suggest that arguments in policy frameworks on adaptation are being replaced in action plans by arguments supporting more technocratic approaches to risk management. This shift from adaptive approaches in policy frameworks to technocratic approaches in action plans is likely to contribute to a gap in the implementation of adaptation, as case studies from elsewhere have shown (Næss et al., 2005).

Disparities between Policy Documents and Implementation Practice

Implementation gaps exist in the context of land use management, drainage infrastructure design, environmental regulations and disaster risk prevention. The gaps are most noticeable in the ongoing urbanisation of the Densu Delta. Reclamation of the lagoon is a common practice, despite various policies on riparian buffer zones designed to constrain development in a zone of heightened flood risk along riverbanks. Parallel to the fact that spatial development plans are out-dated, administrative practices which undermine the policies designed to control urban development are a hindrance to implementation.

“You need to have land title certificate to be able to apply for a permit to build. But getting the land title certificate is almost impossible.” (NDPC, 22.1.2015)

As a result, building permits are rarely sought by settlers after land has been purchased from traditional authorities. The implementation gap in spatial planning and building regulations is also evidenced by the warnings seen throughout the delta painted on unauthorized buildings saying they have to be torn down.

In addition, lack of institutional capacity, coordination, and commitment cause inadequate drainage design when unqualified contractors are engaged and various authorities fail to coordinate drainage plans. This results in the creation of right-angled intersections which do not allow the water to flow away but give rise to backwater and eventually flooding at times of high discharge (Hydrological Service Department, 29 May 2014). Backing of environmental protection is weak in the current legal framework as well as in governmental authorities up to and including the presidential level (Environmental Protection Agency, 28.1.2015; MESTI, 28.1.2015). Moreover, the shift in disaster risk management from post-disaster recovery to risk prevention as promoted in the HFA and the NDMP has not been implemented on the ground (Wildlife Division, 04.07.2014). So repeated recovery operations after flood events further spur encroachment onto the wetland and prevent conservation of mangroves.

The decision makers' response to the observed implementation gaps is one of being resigned and denying of responsibility. A NADMO official at sub-metropolitan district level, for example, states:

We don't discourage settlers in Glefe. We don't want them to build another building there – but what they have done is ok.

Instead of pushing for the enforcement of current regulations that would mean the resettlement of thousands of people, the Town and Country Planning Department is revising the regulations:

“It’s not a matter of we cannot develop at a marshy area, it depends on the technology that you will use. But now the people have already developed so do we regularize it? So that is the critical situation, and I have advised our planning committee that there is a need for us to take a look at those things again. Instead of saying that we will not give them permit – already they are living [in the marshy area] and the assembly is also losing revenue in terms of property rate and what have you – so why don’t we look at the situation critically and maybe the drains if we have to construct to contain floods we do that and then issue a permit and charge them accordingly? So that will also form part of the review of the scheme that we will be doing.” (Town and Country Planning Department Accra, 28.05.2014)

This development places a significant constraint on implementation of Ramsar site management:

“The rate at which the encroachment is increasing and because the municipal authorities do not have proper layout planning schemes, it has become a challenge in those Ramsar sites which are in urban centres. Probably what we need to do is get a better planning scheme and strengthen the enforcement codes by municipal authorities so that these wetlands can be protected (...) But if we don’t get the necessary support then I am afraid in the future we have to desert the area and then remove it from the Ramsar list.” (Wildlife Division, 04.07.2014)

The Town and Country Planning Department’s response of issuing permits and formalising existing settlements undermines adaptation approaches through integrated spatial planning. Since the formalisation of and construction of drainage infrastructure creates incentives for further encroachment, fewer mangrove areas will exist to retain flood water, and more people will be exposed to flooding.

According to the key decision-makers interviewed, the implementation gaps observed are caused by limited government control over land use and ownership due to the tenure system, the speed of urban development and residents’ lack of trust, by a lack of capacities and resources in implementing agencies, by conflicting interests, and by a lack of judicial backing for environmental policies. Further causes can be identified from critical questioning of the premises in policy arguments based on the implementation practices identified. Again, we refer to the arguments on need for knowledge to test the validity of premises. We also touch briefly on premises that can be challenged in the context of infrastructure and land use planning, as well as differential vulnerability.

Contestation of the need for knowledge. Decision-makers support the premise that knowledge is needed to reduce flood risk: water flow data has been monitored by the Hydrological Services Department but data records have not been stored, and the data records available are unreliable, and so key data needed for modelling the likelihood of flooding in the Densu Delta is unavailable. New data series are now being recorded by the Water Research Institute that will allow water flow modelling in the future (Water Research Institute, 10.07.2014;

Hydrological Services Department, 29.05.2014). The example supports the conclusion that data generation is needed with existing technology.

However, implementation gaps also indicate that increased knowledge would not necessarily improve implementation. Instead, settlers in the Densu Delta develop their own, informal strategies to cope with flooding, and they continue to encroach on the delta. Those in charge of implementation either resign themselves to it or deny responsibility. Even though data on encroachment may not be recorded systematically, the fact that the Densu Delta is being encroached upon is well known, as are the consequences of flooding to which people are exposed to. Still regulations that would reduce exposure are not enforced. Similarly, the shift from relief to prevention in disaster risk management is stated both in the NDMP and among decision-makers concerned with its implementation, but not implemented on the ground (Wildlife Division, 4.7.2014).

The premise that documentation of indigenous knowledge contributes to flood risk reduction is supported by decision-makers acknowledgement of how important such knowledge is to the anticipation of and preparation for flood events (MESTI, 28.1.2015). At the same time power relations and interests between the state and traditional structures competing in control over land are currently constraining land use based adaptation. Chiefs in the Densu Delta have played a counterproductive role in flood risk reduction as they have encouraged encroachment in the delta and wetlands.

“The (...) challenge is the fact that the area the land belongs to the people (...) although it is protected it has not been acquired by government (...). We are trying to adopt a management approach that will seek the support of all stakeholders. But because the area is close to the urban centre, the economic value of the land keeps increasing and it will be difficult for you to convince a chief who owns the land to leave mangroves in the area as compared to selling off the land to a developer (...)” (Wildlive Division, 4.7.2014)

These instances of contestation over land use between state and traditional authorities challenge the premise that indigenous knowledge is easily available and that documentation will be of use for improved adaptation strategies in a land speculation setting. Moreover, traditional and scientific knowledge cannot be separated as neatly as the respective argument presented in policy documents suggest. Rather,

“most of our current [traditional] chiefs are well-educated people. They speak the local dialect in official functions for purposes of tradition but they are lawyers, doctors. We must bring all the stakeholders together to have the synergy and complementarity in addressing our challenges because we have governance pluralism. We have the classical Westminster governance president. But development is on the ground and who controls the ground, is the traditional authority.” (MESTI, 28.1.2015)

Hence the dichotomy of ‘indigenous’ versus ‘scientific’ knowledge implied in the argument stating the need for the documentation of indigenous knowledge is exposed as false by policy practice.

Competing interests. Here we have presented practices of policy implementation in the Densu Delta that challenge premises in policy arguments. Many other premises implied in policy arguments, such as the lack of coordination or of information exchange are confirmed by implementation gaps evidenced in the Densu Delta. Other premises, relating to vulnerability and infrastructure, can be challenged given the Densu Delta example. Individuals influential in the informally settled Densu Delta (above all, the traditional chiefs) hold power, economic resources, and access to higher education, and belong to a strong social network. These factors reduce their vulnerability to flooding since they allow to preparation for flood events and cope with the aftermath.

Critical questioning of the more explicit premises in policy argument based on implementation practice has led to the identification of one underlying assumption that does not reflect implementation practice: this is the premise that sustainable development and risk reduction are goals shared among decision makers and traditional authorities. Both in the interaction of government and traditional authorities, and between governmental agencies, it is power relations, competing interests, and a lack of political backing that become exposed as the underlying causes of the implementation gap. These issues are not discussed in policy documents.

1.2.5 Discussion

The disparities between policy arguments on adaptation to flood risk and actual implementation expose four major hindrances to overcoming the implementation gap.

Firstly, due to the separate presentation of the causes, consequences and strategies and what is implicitly assumed about causal relations, strategies are presented in a generalised way that does not reflect site specific prerequisites and conditions for successful implementation. This is the case even though context-specific limitations and conditions have been presented, for instance, with regard to the differential vulnerability within informally settled areas. According to decision makers' experiences, influential individuals in the informally settled Densu Delta – above all the traditional chiefs – hold social capital, power, economic resources and access to higher education, all factors which can reduce vulnerability (Pelling & High, 2005). In addressing 'people living in informal settlements' as a particularly vulnerable group, strategies posited in policy documents appear to fail to include those most in need. They are moreover difficult to implement in a context where most buildings have been erected without permits and are thus 'informal'.

Secondly, both in policy documents and among decision makers, the common argument is that knowledge needs to be generated and shared in order to develop and implement adequate strategies. Integration of 'bottom up' knowledge is understood as documenting indigenous knowledge (through research) so that it can be considered as part of strategy development. However, this case study shows that practitioners hold key knowledge on power relations and political interests that hinder the implementation of adaptation strategies. Leaders of indigenous groups, by contrast, have been hindering adaptation in the Densu Delta whilst competing for land control, rather than sharing their knowledge. As traditional chiefs are also

academics and key players in the real estate market, classifying their knowledge as ‘indigenous’ potentially hinders integration of alternative, local adaptation knowledge.

Thirdly, comparison of the arguments in policies suggests a combination of blue-printing from international frameworks and conventions, and from strategies developed in a narrow sectoral context, either of which is likely not to address local context. As a result, the broad scope of strategies with nuclear causal context provides little information to actors making implementation decisions, strategies are not implemented, and actors concerned with implementation in the Densu Delta just resign themselves to this. This creates a cycle of non-action, since the less implementable the policy, the greater the non-compliance, the greater the risk, and the greater the need for short-term coping strategies.

Fourthly and last, power relations become evident in disparities between differential vulnerability and apparent ignoring of decision-makers’ experiences in policy design. These are, for one, local power relations, as referred to by key decision makers involved in policy implementation in the Densu Delta (within authorities, between authorities, between governmental agencies and traditional leaders/chiefs), and these relations are also implicit in the influence of arguments in international policy frameworks on urban environmental policy.

Overcoming these hindrances in the implementation gap would therefore involve a more coherent presentation of causal relations in policy documents, and stakeholder engagement based on a cautious definition of local knowledge in the selection of strategies, along with attention paid to power relations in practical argumentation. The findings call for alternative ways of eliciting knowledge from stakeholders, rather than focussing on data and scientific producing knowledge as proposed in the documents analysed.

1.2.6 Conclusions

Analyses of policy documents and implementation gaps as reported by key decision-makers have shown disparities between arguments on causes, effects and strategies between various levels of policy outreach, and also between policy documents and practical implementation. The findings from comparison of the arguments in policy documents suggest that disparity is rooted in a culture where blue-printing strategies from policy frameworks developed at higher levels is acceptable. The findings from the interviews with decision-makers suggest that disparities are, furthermore, rooted in a hierarchy of sector interests and competition over land control among state and traditional authorities. Both disparities are related to a dichotomous understanding of what constitutes knowledge.

The blue-printing of policy strategies and overriding of competing interests in implementation have been identified as barriers in implementation (Adger, 2001). Dominant arguments in policy tend to mirror global environmental change and development discourse rather than local experience and every day practises, and are therefore a barrier to developing locally fitting, situated policies (Keil & Debbané, 2005). What is surprising about the findings in our case is that although these barriers were known, they have not been addressed

in this context where adaptation policies are new, adaptation to flood risk is high on the national agenda of urban development, and where the role of local, indigenous knowledge is widely acknowledged. Our findings from the Densu Delta case show that patterns in practical argumentation encourage blue-printing and hinder integration of knowledge from implementation practice.

National policies are unable to address local conditions. However, the case study does show that as a result of unclear causal relations, decision-makers lack the information needed to evaluate the strategies proposed based on their specific goals and conditions. Thus we argue that if premises in arguments were made more transparent and proposed strategies more clearly linked to causes and effects, decision-makers could better judge what the options of action are, which strategies to implement, and in what way. The way arguments are constructed and presented in policy documents reproduces disparities, and consequently also widens the implementation gap.

Our findings, moreover, demonstrate how important it is both to critically rethink the modes by which broad concepts are transferred into policy formulation, and to think up new ways of crossing boundaries between formal and informal practices of knowledge production, particularly in rapidly urbanising areas. As Hinkel (2011) and O'Brien (2013) have stressed, the implementation gap in environmental governance can only be overcome by new ways of framing problems. In line with these findings, ours suggest that the reiterated call for data and knowledge production on flood risk in Accra made in policy documents as well as among decision-makers should be replaced by a call to elicit knowledge using a revised framing of the problems and a new definition of knowledge.

Implementation gaps in coastal governance are linked to a dualistic understanding of 'scientific' and 'local' knowledge in the science-policy interface, as (Nurse-Bray et al., 2014) have shown for Australia. In the Densu Delta case we see the duality mirrored in policy arguments in their distinguishing between 'indigenous' and 'scientific' knowledge. While close collaboration between academia, government, and civil society – including 'indigenous groups' – in policy design is being pushed by the Government of Ghana, the challenge of integrating 'practical' with 'scientific' knowledge persists notwithstanding. The resigned attitude of decision-makers concerned with implementation of policies for natural conservation and disaster risk reduction in the Densu Delta is also a reaction to a policy context that allows formal integration of local knowledge, but without practical implications. This is unlikely to change as long as underlying assumptions relevant to contextualising a strategy are undisclosed, and hierarchies between (global) scientific and (local) practical knowledge persist. Understanding flood risk as co-produced in science and policy highlights the role of social context and learning in risk governance and may contribute to more implementable policies (Scolobig & Pelling, 2015).

Here we have assessed the practical function of arguments in implementation practice. The structure of arguments on key topics relevant for implementation in the Densu Delta, namely knowledge and data, infrastructure and vulnerability was identified as decisive in the implementation gap. As arguments are shaped by discourse, the results hint to an important

role of global environmental discourses such as “vulnerability” (Bankoff, 2001), or “technocratic managerialism”, (Mustafa, 2005). Furthermore, the false dichotomy of indigenous versus scientific knowledge is discursively constructed (Nurse-Bray et al., 2014). Further research should look into processes of co-production of knowledge and discourse to identify ways of integrating local knowledge into policy argumentation in a context of high informality and multiple effects from global environmental change.

Acknowledgements

The authors would like to thank Samuel Agyei-Mensah, Chris Gordon, Ernest Olerthey, Martin Oteng-Ababio, Kofi Owusu and Mark Pelling for their advice and/or support of the research in Accra. The authors would in particular like to thank Peter Feindt, Sebastian Mehling, three anonymous reviewers and the participants at the ‘Discourse, Power and Environmental Policy’ workshop in Freiburg for their helpful comments on earlier drafts of this article.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This research has been partly funded by the German Federal Ministry for Education and Research (BMBF) under the (project funding) reference number 01 LN 1316 A and by the Heinrich-Böll-Foundation under the funding reference number P105800.

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I.2.7 References

- Aboagye, D. C. (2012). Living with Familiar Hazards: Flood Experiences and Human Vulnerability in Accra, Ghana. *Articulo - Journal of Urban Research Briefings*, 48(12), n/a-n/a. doi:10.1029/2012WR012335
- Adank, M., Darteh, B., Moriarty, P., Osei-tutu, H., van Rooijen, D., & Assan, D. (2011). *Towards integrated urban water management in the Greater Accra Metropolitan Area: Current status and strategic directions for the future*. Accra, Ghana: SWITCH/RCN Ghana. Retrieved from <http://switchurbanwater.lboro.ac.uk/outputs>
- Adelekan, I. O., Johnson, C., Manda, M., Matyas, D., Mberu, B. U., Parnell, S., . . . Vivekananda, J. (2015). Disaster risk and its reduction: an agenda for urban Africa. *IDPR*, 37(1), 33–43.
- Adger, W. N. (2001). Scales of governance and environmental justice for adaptation and mitigation of climate change. *Journal of International Development*, 13, 921–931.
- Adger, W. N., Benjaminsen, T. A., Brown, K., & Svarstad, H. (2001). Advancing a political ecology of global environmental discourses. *Development and Change*, 32, 681–715.
- Amoako, C., & Boamah, F. E. (2014). The three-dimensional causes of flooding in Accra, Ghana. *International Journal of Urban Sustainable Development*, 1–21. doi:10.1080/19463138.2014.984720
- Amoani, K., Appeaning Addo, K., & Laryea, W. (2012). Short-term shoreline evolution trend assessment: A case study in Glefe, Ghana. *Jàmbá: Journal of Disaster Risk Studies*, 4(1), 1–7.
- Appeaning Addo, K., & Adeyemi, M. (2013). Assessing the impact of sea-level rise on a vulnerable coastal community in Accra, Ghana. *Jàmbá: Journal of Disaster Risk Studies*, 5(1), 1–8.
- Bankoff, G. (2001). Rendering the World Unsafe: ‘Vulnerability’ as Western Discourse. *Disasters*, 25(1), 19–35. doi:10.1111/1467-7717.00159
- Benouar, D., Diagne, K., Kiunsi, R., Songsore, J., Pelling, M., Pharoah, R., . . . Yitambe, A. (2012). Towards a Safer Urban Future: Conclusions and Recommendations. In M. Pelling & B. Wisner (Eds.), *Disaster risk reduction: Cases from urban Africa* (pp. 195–210). Routledge.
- Bhattacharya, N., & Lamond, J. (2011). A review of urban flood risk situation in African growing economies. In *Urban flood risk management approaches to enhance resilience of communities*. Graz, Austria: UFRIM.
- Brun, G., & Betz, G. (2016). Analysing Practical Argumentation. In S. O. Hansson & G. Hirsch Hadorn (Eds.), *Logic, argumentation & reasoning: Vol. 10. The argumentative turn in policy analysis. Reasoning about uncertainty* (pp. 39–77). [Cham]: Springer.
- Bull-Kamanga, L., Diagne, K., Lavell, A., Leon, E., Lerise, F., MacGregor, H., . . . Yitambe, A. (2003). From everyday hazards to disasters: the accumulation of risk in urban areas. *Environment and Urbanization*, 15(1), 193–204. doi:10.1177/095624780301500109
- Codjoe, S. N. A., Owusu, G., & Burkett, V. (2014). Perception, experience, and indigenous knowledge of climate change and variability: The case of Accra, a sub-Saharan African city. *Regional Environmental Change*, 14(1), 369–383. doi:10.1007/s10113-013-0500-0
- Corfee-Morlot, J., Cochran, I., Hallegatte, S., & Teasdale, P.-J. (2011). Multilevel risk governance and urban adaptation policy. *Climatic Change*, 104(1), 169–197. doi:10.1007/s10584-010-9980-9
- Douglas, I., Alam, K., Maghenda, M., McDonnell, Y., McLean, L., & Campbell, J. (2008). Unjust waters: climate change, flooding and the urban poor in Africa. *Environment and Urbanization*, 20(1), 187–205. doi:10.1177/0956247808089156
- Fairclough, I. (2016). Evaluating policy as argument: The public debate over the first UK austerity budget. *Critical Discourse Studies*, 13(1), 57–77. doi:10.1080/17405904.2015.1074595
- Fairclough, N. (2013). Critical discourse analysis and critical policy studies. *Critical Policy Studies*, 7(2), 177–197. doi:10.1080/19460171.2013.798239
- Feindt, P. H., & Oels, A. (2005). Does discourse matter? Discourse analysis in environmental policy making. *Journal of Environmental Policy & Planning*, 7(3), 161–173.
- Felgenhauer, T. (2009). Raumbezogenes Argumentieren: Theorie, Analysemethoden, Anwendungsbeispiele. In G. Glasze & A. Mattissek (Eds.), *Sozialtheorie. Handbuch Diskurs und Raum. Theorien und Methoden für die Humangeographie sowie die sozial- und kulturwissenschaftliche Raumforschung* (2nd ed.). Bielefeld: Transcript.

- Fischer, F. (2003). *Reframing Public Policy: Discursive Politics and Deliberative Practices*: Oxford University Press.
- Fischer, F., & Forester, J. (Eds.). (1993). *The argumentative turn in policy analysis and planning*. London: UCL.
- Fischer, F., & Gottweis, H. (2013). The argumentative turn in public policy revisited: Twenty years later. *Critical Policy Studies*, 7(4), 425–433. doi:10.1080/19460171.2013.851164
- Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, 12(2), 219–245. doi:10.1177/1077800405284363
- Gaillard, J. C., & Mercer, J. (2013). From knowledge to action: Bridging gaps in disaster risk reduction. *Progress in Human Geography*, 37(1), 93–114. doi:10.1177/0309132512446717
- Ghana Statistical Service. (2012). *2010 Population & Housing Census: Summary Report of Final Results*. Accra, Ghana: Ghana Statistical Service.
- Hajer, M. (1993). Discourse Coalitions and the Institutionalization of Practice: The Case of Acid Rain in Britain. In F. Fischer & J. Forester (Eds.), *The argumentative turn in policy analysis and planning* (pp. 43–76). Duke University Press.
- Hetz, K., & Bruns, A. (2014). Urban planning lock-in: implications for the realization of adaptive options towards climate change risks. *Water International*, 39(6), 884–900.
- Hinkel, J. (2011). “Indicators of vulnerability and adaptive capacity”: Towards a clarification of the science–policy interface. *Global Environmental Change*, 21(1), 198–208. doi:10.1016/j.gloenvcha.2010.08.002
- Huq, S., Kovats, S., Reid, H., & Satterthwaite, D. (2007). Editorial: Reducing risks to cities from disasters and climate change. *Environment and Urbanization*, 19(1), 3–15. doi:10.1177/0956247807078058
- Keil, R., & Debbané, A.-M. (2005). Scaling discourse analysis: Experiences from Hermanus, South Africa and Walvis Bay, Namibia. *Journal of Environmental Policy & Planning*, 7(3), 257–276. doi:10.1080/15239080500339786
- Mayring, P. (2010). *Qualitative Inhaltsanalyse* (12th ed.). Weinheim Basel: Beltz.
- Ministry of Environment, Science, Technology and Innovation (MESTI). (2013). *Ghana National Climate Change Adaptation Strategy (NCCAS)*. Accra: UNEP; UNDP CCDARE. Retrieved from: <http://www.ccdare.org>.
- Ministry of Environment, Science, Technology and Innovation (MESTI). (2013). *Ghana National Climate Change Policy*. Accra: Government of Ghana.
- Ministry of Land and Forestry. (1999). *National Land Policy*. Accra: Government of Ghana.
- Ministry of Local Government and Rural Development (MLGRD). (2012). *Ghana National Urban Policy Action Plan*. Accra: Government of Ghana.
- Ministry of Local Government and Rural Development (MLGRD). (2012). *National Urban Policy Framework*. Accra: Government of Ghana.
- Ministry of Water Resources, Works and Housing (MWRWH). (2007). *National Water Policy*. Accra, Ghana.
- Ministry of Water Resources, Works and Housing (MWRWH). (2011). *Riparian Buffer Zone Policy: For Managing Freshwater Bodies in Ghana*. Accra, Ghana.
- Modern Ghana News (2013). Incoming floods: NADMO in Gh¢186m debt, International donors fed up, April 30. *Modern Ghana News*.
- Moser, C., & Dilling, L. (2013). Communicating climate change: closing the science-action gap. In J. S. Dryzek, R. B. Norgaard, & D. Schlosberg (Eds.), *Oxford handbook of climate change and society* (1st ed., pp. 161–174). Oxford: Oxford Univ. Press.
- Moser, S. C. (2005). Impact assessments and policy responses to sea-level rise in three US states: An exploration of human-dimension uncertainties. *Global Environmental Change*, 15(4), 353–369. doi:10.1016/j.gloenvcha.2005.08.002
- Mustafa, D. (2005). The Production of an Urban Hazardscape in Pakistan: Modernity, Vulnerability, and the Range of Choice. *Annals of the Association of American Geographers*, 95(3), 566–586. doi:10.1111/j.1467-8306.2005.00475.x
- Næss, L. O., Bang, G., Eriksen, S., & Vevatne, J. (2005). Institutional adaptation to climate change: Flood responses at the municipal level in Norway. *Global Environmental Change*, 15(2), 125–138. doi:10.1016/j.gloenvcha.2004.10.003
- Næss, L. O., Norland, I. T., Lafferty, W. M., & Aall, C. (2006). Data and processes linking vulnerability assessment to adaptation decision-making on climate change in Norway. *Global Environmental Change*, 16(2), 221–233. doi:10.1016/j.gloenvcha.2006.01.007

- National Development Planning Commission (NDPC). (2010). *Ghana Shared Growth and Development Agenda (GSGDA), 2010-2013: Medium-Term National Development Policy Framework*. Accra: Government of Ghana.
- National Disaster Management Organisation (NADMO). (2010). *National Disaster Management Plan*. Accra, Ghana.
- National Disaster Management Organisation (NADMO). (2011). Ghana National Plan of Action on Disaster Risk. Accra, Ghana.
- Reduction and Climate Change Adaptation. Accra: Government of Ghana. Nursey-Bray, M. J., Vince, J., Scott, M., Haward, M., O'Toole, K., Smith, T., . . . Clarke, B. (2014). Science into policy?: Discourse, coastal management and knowledge. *Environmental Science & Policy*, 38, 107–119. doi:10.1016/j.envsci.2013.10.010
- O'Brien, K. (2013). Global environmental change III: Closing the gap between knowledge and action. *Progress in Human Geography*, 37(4), 587–596. doi:10.1177/0309132512469589
- Oteng-Ababio, M., Owusu, K., & Appeaning Addo, K. (2011). The vulnerable state of the Ghana coast: The case of Faana-Bortianor. *Jàmbá: Journal of Disaster Risk Studies*, 3(2), 429–442.
- Oteng-Ababio, M. (2013). 'Prevention is better than cure': Assessing Ghana's preparedness (capacity) for disaster management. *Jàmbá: Journal of Disaster Risk Studies*, 5(2), 75. Retrieved from <http://dx.doi.org/10.4102/jamba.v5i2.75>
- Parnell, S., & Walawege, R. (2011). Sub-Saharan African urbanisation and global environmental change. *Global Environmental Change*, 21S, 12–20. doi:10.1016/j.gloenvcha.2011.09.014
- Pelling, M., & High, C. (2005). Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change*, 15(4), 308–319. doi:10.1016/j.gloenvcha.2005.02.001
- Scolobig, A., & Pelling, M. (2015). The co-production of risk from a natural hazards perspective: Science and policy interaction for landslide risk management in Italy. *Natural Hazards*. Advance online publication. doi:10.1007/s11069-015-1702-1
- Town and Country Planning Department (TCP). (1991). *Structure Plan 2010: Accra Planning and Development Programme*. Accra: Government of Ghana.
- United Nations (UN). (1992). United Nations Framework Convention on Climate Change (UNFCCC) (No. 3). New York.
- UN Africa Adaptation Programme (AAP). (2013). Terminal Report. Retrieved from www.undp-aap.org, last accessed on 01.07.2017.
- United Nations Development Programme Ghana (UNDP). (2012). Community Resilience through Early Warning: CREW. Project Document. Accra: UNDP Ghana.
- United Nations Educational, Scientific and Cultural Organization (UNESCO). (1971; 1994). Convention on Wetlands of International Importance especially as Waterfowl Habitat. The Ramsar Convention on Wetlands. Retrieved from www.ramsar.org.
- United Nations International Strategy for Disaster Reduction (UNISDR). (2005). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*. Kobe, Hyogo, Japan. Retrieved from United Nations International Strategy for Disaster Reduction (UNISDR) website: www.unisdr.org/wcdr
- Vogel, C., Moser, S. C., Kaspersen, R. E., & Dabelko, G. D. (2007). Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships. *Global Environmental Change*, 17(3-4), 349–364. doi:10.1016/j.gloenvcha.2007.05.002
- Wesselink, A., Warner, J., & Kok, M. (2013). You gain some funding, you lose some freedom: The ironies of flood protection in Limburg (The Netherlands). *Environmental Science & Policy*, 30, 113–125. doi:10.1016/j.envsci.2012.10.018

1.2.8 Supplemental Material

Structure of practical reasoning in deliberative action

Figure 1 is a scheme of how premises on goals, conditions, activities and effects are combined in policy arguments and applied in deliberative decision-making.



Figure IB.1 Proposal for the structure of practical reasoning in deliberative activity types (Fairclough, 2015, p. 59)¹⁵

Policy documents relevant for adaptation to urban flood risk in the Densu Delta

Table 1 presents an overview of policies, frameworks and action plans relevant for adaptation to urban flood risk. These documents were selected for the analysis of framings in policy documents¹⁶. Strategy design for implementation of adaptation objectives as outlined by the Government of Ghana (GoG) in those frameworks and policies that explicitly address adaptation have been supported by international development assistance through the UNDP led Climate Change and Development – Adapting by Reducing Vulnerability (CCDARE) Programme for Sub-Saharan Africa, the African Adaptation Project (AAP, programme duration 2010-2012) and the Community Resilience through Early Warning (CREW, project duration 2012-2015) project for which specific adaptation measures were implemented in 10 pilot sites across Ghana.

¹⁵ Fairclough, I. (2015). Evaluating policy as argument: The public debate over the first UK austerity budget. *Critical Discourse Studies*, 13(1), 57–77.

¹⁶ The text corpus for analysis from policy documents and academic publications was further reduced by a keyword search for sections relevant to adaptation to flood risk. Key words were identified based on key issues (codes) identified in the analysis of interviews on adaptation to flood risk in the Densu Delta. The key words identified were tested in a trial lexical search in MAXQDA for their strength to select relevant sections of text, and adapted accordingly. The key words derived from the analysis of key stakeholder interviews were: buffer zone; desilt*; drain*; encroach*; flood*; green infrastructure; restoration; mangroves; relocat*; waterway; water flow; water level; wetland; Ramsar. The pages containing one or more of these key words were included in the analysis.

Table 2 Policy frameworks, policies, action plans and programs relevant for adaptation to climate change and related hazards in Accra

Title	Document Group	Publishing institution	Year of publication / implementation	planned duration of implementation	Strategies address adaptation ¹⁷
Ghana Plan of Action on Disaster Risk Reduction and Adaptation to Climate Change	Action Plan	NADMO	2011	2011-2015	Y
NCCAS National Climate Change Adaptation Strategy	Action Plan	UNDP		2010-2020	Y
NDMP National Disaster Management Plan	Action Plan	NADMO	2010		N
Accra Structure Plan 2010 ¹⁸	Action Plan	Town and Country Planning	1991	1991-2010	N
CREW Community resilience through early warning (CREW)	Donor Project	UNDP	2012	2012-2015	Y
AAP Africa Adaptation Programme in Ghana	Donor Project	UNDP	2010	2010-2012	Y
NCCP Ghana National Climate Change Policy and Action Programme for Implementation	Policy Framework/ Action Plan	MESTI	2015	2015-2020	Y
UNFCCC Convention	Framework Int'l Policy	UNFCCC	1992		Y
HFA Hyogo Framework for Action	Framework Int'l Policy	UNISDR	2005	2005-2015	Y
NUP National Urban Policy Framework and Action Plan	Framework/ Action Plan	MLGRD	2012		N
NLP National Land Policy	Policy	Ministry of Lands and Forestry	1999		N
Riparian Buffer Zone Policy	Policy	Water Resources Commission (WRC)	2011		N
GSGDA Ghana Shared Growth and Development Agenda 2010-2013 - Policy Frame	Policy Frame	GoG	2010	2010-2013	N
NWP National Water Policy	Policy Frame	MWRWH	2007		N
Ramsar Convention on Wetlands	International Convention	UNESCO	1971 (amended in 1982 and 1987)	1975 onwards	N

Two dates were influential in the development of policies on adaptation to flood risk in Ghana (as indicated by stakeholders and policy documents), namely 1994, the year in which Ghana signed the United Nations Framework Convention on Climate Change (UNFCCC), and 2007, when major flood events in Northern Ghana and Accra triggered the attention of governmental authorities and international donors to flood risk and climate change. Socio-economic drivers of flood risk, as well as socio-cultural factors in addressing flood risk are increasingly focused on both in academic articles and in policy documents after 1995. For instance economic and cultural resources are framed as a base of adaptive capacity in the arguments ‘adaptive capacity includes indigenous knowledge and cultural factors’, and ‘adaptive capacity is created from socio-economic resources’. Arguments on impacts do not appear until after 2007. Arguments on both causes and strategies after 2007 indicate a closer engagement with the legacy of past urban development planning and infrastructure design practice, in addition to the broader governance issues discussed from 1995 onwards. This is

¹⁷ To climate change and disaster risk

¹⁸ Not included in the analysis as only the map was available to the researchers without any accompanying text document

paralleled by an increased attention to urban flooding in academic research beyond Ghana (see figure 1). While adaptation to climate change (including flood risk) has been addressed by policies since before 1994 – at least at the international level – adaptive capacity has not been framed for the context of Ghana until after 2007.

Key stakeholders in adaptation to urban flooding in Accra

Table 3: List of key stakeholders involved in policy action on adaptation to flood risk in the Densu Delta interviewed

Date of Interview	Location of Interview	Position of Interviewee	Organisation
28.05.2014	Accra	Head officer	Town and Country Planning Accra
29.05.2014	Accra	Section head officer	Hydrological Services Department
04.07.2014	Accra	Section head officer	Wildlife Division
09.07.2014	Weija	Manager	Ghana Water Company Limited (GWCL)
20.01.2015	Accra	Section head officer	Lands Commission
20.01.2015	Accra	Head officer	Town and Country Planning
22.01.2015	Accra	Head officer	National Development Planning Commission (NDPC)
22.01.2015	Weija		Panbros Salt Industry Limited
23.01.2015	Accra	Section head officer	United Nations Development Programme (UNDP)
27.01.2015	Accra	Consultant	Ghana Netherlands WASH Programme (GNWP)
28.01.2015	Accra	Section head officer	Environmental Protection Agency (EPA)
28.01.2015	Accra	Head officer	Ministry of Environment, Science, Technology and Innovation (MESTI)

Statements on strategies, effects and causes of flooding

Table 4 Coded statements on strategies, impacts and causes of floods by document group. **IPFC = International Policy Framework or Convention; DP = Donor Project; NDF = National Policy Framework; NP = National Policy; AP = Action Plan**

Strategies to address flood risk	IPFC	DP	NDF	NP	AP
Structural DR protection has adverse impacts					
DRR and CCA efforts need to be shared across levels and sectors					
Alternative financial instruments needed to address DRR					
Mitigation, adaptation, preparedness reduce effects of disasters					
Structural and non-structural measures mitigate impacts from floods					
Adaptive capacity is created from socio-economic resources					
Adaptive capacity includes indigenous knowledge / cultural factors					
Migration and relocation are adaptive strategies					
Integrated planning and nat. res. man. enable CCA / DRR					
DRM /CCA requires coordination, capacity development and poverty reduction					
Vulnerable groups need priority attention in DRR					
Emergency response requires immediate coordinated action					
Infrastructure and services will mitigate floods and its impact					
Proper planning, design, maintenance of drainage systems					
Planning and regulation enforcement reduces DR					
CC and DR considerations need to be mainstreamed					
Education, training, awareness on CC/DRR is key to DRR					
CCA and DRR requires knowledge, data and research on CC/ DR					

Effects of flooding	IPFC	DP	NDF	NP	AP
Residents of informal settlements are particularly exposed					
Vulnerability/ adaptive capacity depends on socio-economic resources					
Migrants are particularly exposed					
Elderly, disabled, children are particularly vulnerable/exposed					
Women are particularly vulnerable/exposed					
The poor are particularly vulnerable/exposed					
Floods cause health and socioeconomic losses					
Floods disrupt ecosystem functioning					
Floods cause loss / disruption of houses/property / displacement					
Floods cause loss/ disruption of infrastructure					
Multiple hazards and vulnerabilities interact					
Disasters cause economic and human loss/constrain development					

Causes of floods/disasters/ coastal erosion	IPFC	DP	NDF	NP	AP
Lack of infrastructure exacerbates flood risk					
Poor maintenance and design of drainage creates floods					
Sea level rise enhances vulnerability to flood risk					
Climate change causes flood risk					
Population dynamics have caused environmental hazards					
(Unplanned) urban development causes disasters/ risks					
Poor governance contributes to flood risk					
Waste dumping along waterways creates flood risk					
Floods have natural and anthropogenic causes					
Natural processes cause flooding/ disaster/ coastal erosion					
Socio-economic challenges enhance vulnerability to floods					
Resource mismanagement and environmental degradation can exacerbate flood risk					

I.3 Article C: Crafting Adaptive Capacity: Institutional Bricolage in Adaptation to Urban Flooding in Greater Accra

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This paper has been published in the Journal Water Alternatives and can be cited as: Frick-Trzebitzky, F. (2017). Crafting adaptive capacity: institutional bricolage in adaptation to urban flooding in Greater Accra. *Water Alternatives*, 10(2), 625-647. Available online at: <http://www.water-alternatives.org/index.php/alldoc/articles/vol10/v10issue2/373-a10-2-23/file>

Received: 05.09.2016, accepted: 09.05.2017, published: 08.06.2017

Abstract

Institutional bricolage, which explains how institutions are actively crafted across different degrees of formality, and urban adaptation have been studied separately in the past. Linking critical institutionalism and adaptive capacity research, this article describes how institutional bricolage shapes the distribution of adaptive capacity in adaptation to urban flooding. The Densu delta in Greater Accra, Ghana, is taken as a case of a rapidly urbanising area in coastal West-Africa. Interviews and stakeholder mappings show that institutional bricolage shapes who is likely to adapt to urban flooding and who isn't, as well as where people are likely to adapt and where they are not. Interviews moreover provided evidence of the distribution of adaptive capacity in dynamic water governance contexts that are characteristic of urban areas particularly in Africa. The role of the traditional 'chief' is shown to be a dynamic institution that can contribute to or hinder adaptation to urban flooding, depending on his own world views and institutional context. Four new findings emerge. Firstly, key elements of bricolage foster the decisive role of chieftaincy structures in adaptation to urban flooding in the local context of a West-African city. Secondly, institutional bricolage exposes the role of culture in adaptive capacity. Thirdly, applying institutional bricolage in the setting of a rapidly urbanizing flood-prone area offers new perspectives on both institutions and adaptation in urban water and risk governance. Fourthly, a bricolage analysis enables incorporating different forms of knowledge towards transformative adaptation.

Keywords

Flood, transformative adaptation, critical institutionalism, urban water, African cities

1.3.1 Introduction

The mutual reproduction of urban flooding and poverty in African cities results from both disaster impacts exacerbating poverty, and poorly planned urban development creating floods (Bhattacharya and Lamond, 2011; Bicknell, Dodman, and Satterthwaite, 2009; Bull-Kamanga et al., 2003). Current strategies of cities and urban dwellers are limited to immediate adjustments with little or negative effects on future sensitivity and exposure to flooding (Bhattacharya and Lamond, 2011; Hetz, 2016). Reasons for this are low awareness of flood risk, other priorities, or more pressing risks, especially among the urban poor. As governments, non-governmental organisations and urban dwellers are faced with multiple acute risks that require urgent action, flooding tends to be overlooked, particularly in informal settlements where settlers are exposed to multiple risks (Benouar et al., 2012). In Accra, the dynamically growing coastal capital of Ghana, floods result from the interaction of urban development, rainfall intensity and poor management of surface water, and impacts from climate change and variability (Amoako and Boamah, 2014). The ability of urban dwellers to adapt to flooding is distributed unevenly among different social groups (Aboagye, 2012; Codjoe and Issah, 2015; Oteng-Ababio, Owusu, and Appeaning Addo, 2011). Understanding how differences in access to adaptation options are produced is key to overcoming inequalities and providing a safer urban environment particularly to the urban poor.

Adaptation is needed where risk reduction is impossible under conditions of rapid change and uncertainty. Whether adaptation occurs (or not: then vulnerability increases) depends on people's capacity to adapt. The ability to adjust practices and modify processes in response to experienced or perceived risk is referred to as adaptive capacity (Brooks, Neil Adger, and Mick Kelly, 2005). The term describes the option space of adaptation and depends on underlying social relations, networks, knowledge and institutional support as much as on more tangible resources such as financial means (Adger and Vincent, 2005; Juhola and Westerhoff, 2011; O'Brien, 2013). It also depends on culture as the underlying dynamic of risk perception and behaviour (Warner and Engel, 2014). Adaptive capacity is scale-dependent and nested as individuals' and communities' adaptive capacity is embedded in institutional context. Access to adaptive capacity therefore differs between social groups, locations and scales. It moreover shifts in time, also because adaptive action "drives scope for action, which in turn can foster or hinder future capacity to act" (Pelling, 2011), and can have unintended consequences for the distribution of adaptive capacity at different scales (Birkmann, 2011; Pelling, 2011). Anticipating implications of adaptive action for future adaptive capacity in coastal cities in Africa is particularly limited as knowledge and information on human-environmental interactions in the dynamic and diverse governance context of urban development in African coastal regions is currently scarce (Adelekan et al., 2015; Bruns and Frick, 2013; Parnell and Walawege, 2011).

Social networks and norms that create relations of trust, reciprocity and exchange are important components of people's adaptive capacity (Adger, 2003; Pelling and High, 2005). They have been analysed as underlying institutional factors in institutional learning and as social capital (Aßheuer, Thiele-Eich, and Braun, 2012; Pelling et al., 2008; Pelling and High,

2005). Social learning has also been identified as a factor of adaptive capacity in research on adaptation to floods in formal institutions such as governmental organisations, regulations and instruments (McFadden, Penning-Rowsell, and Tapsell, 2009; Næss et al., 2005; Pahl-Wostl et al., 2013). What institutional learning, social capital and flood risk literature have left open is the question of how navigation between different institutions takes place when boundaries of formality/informality are fuzzy, and institutions are dynamic. Addressing a dynamic and diverse institutional context is particularly relevant for adaptation in expanding urban areas, not only in Africa. In such areas a particularly large number of organisations, norms and legislations interact as cities grow across administrative and cultural boundaries, and become entangled in global networks (Adelekan et al., 2015; Grant, 2009).

'Institutional bricolage', the crafting of institutions beyond formal arrangements, is an analytical lens that was found to expose institutional adaptation in natural resource governance from a critical perspective (Cleaver, 2012; Nunan, Hara, and Onyango, 2015). From this perspective, institutions "include designed arrangements of varying degrees of publicness and formality (...), institutionalized interactions as embodied in kinship and social networks, relations of reciprocity and patronage and in norms and practices deeply embedded in habits and routines of everyday life" (Cleaver, 2012). Similar to actor-centred institutionalism (Mayntz and Scharpf, 1995) critical institutionalism stresses the key role of individual actors as agents who combine different governance modes, but it goes beyond this by stressing the fuzziness of the boundary between formal and informal institutions (Cleaver and De Koning, 2015). This is of particular relevance for institutional analysis in the African context where boundaries between the state, traditional authorities, private and informal sectors are particularly messy (Adelekan et al., 2015; Benjaminsen and Lund, 2002). Understanding how these institutions are navigated is key to understanding differences in adaptive capacity.

The contribution of this paper results from its original lens introducing critical institutionalism in adaptation research, and by applying the bricolage framework developed for institutional analysis in natural resource management to a context of urban flood risk. The potential of an institutional bricolage analysis for adaptation knowledge, i.e. describing how institutions are shaped across different degrees of formality, has been pointed out for instance by Nunan et al. (2015) because it stresses the adaptive nature of institutions resulting from more and less formal arrangements in natural resource management. Mainstream institutionalism,¹⁹ in comparison, explains institutional adaptation mainly through relatively formalized decision making processes.

In sum, studying adaptation to flooding in African urban areas is of particular relevance as it concerns a large number of people, many of whom live in low income settlements where the priority of other risks prevents them from actively creating adaptive capacity. Looking at adaptive capacity from a critical institutional perspective is very promising because of the institutional and legal plurality found in the African context. The Densu delta, located in the

¹⁹ Cleaver (2012) distinguishes between Mainstream Institutionalism that follows the ideas of institutional economics influenced by Elinor Ostrom, and Critical Institutionalism which adopts a wider definition of institutions, as for instance Benjaminsen and Lund (2002) do.

most dynamically urbanising part of Greater Accra, Ghana, and of the West-African coastal strip (Stow et al., 2016), is a case example of traditional, governmental and private institutions interacting in the alteration of a flood plain where people are increasingly forced to adapt to floods. Social relations shape discharge water flows, which in turn shape the distribution of flooding, exposure and adaptive capacity. Looking at the case through an institutional bricolage lens rather than adopting other potentially relevant approaches promises to be particularly insightful for understanding the distribution of adaptive capacity because (1) other critical approaches such as political ecology that explain uneven patterns focus on structures but do not explain dynamic practices and agency, (2) it builds on assumptions that apply to post-colonial cities, namely plurality in governance, and twilight institutions, and (3) the lens promises to complement the literature on which institutions shape adaptive capacity by how they change, and also on the role of actors in these dynamics.

The question guiding this research is: How does institutional bricolage shape the distribution of adaptive capacity in adaptation to flooding? By linking adaptive capacity and institutional bricolage, a contribution is made to both adaptation and critical institutionalism research. More specifically, novel insights are gained on the role of chieftaincy in adaptation in urban Ghana, on culture as a factor of adaptive capacity, on applying the institutional bricolage lens in an urban flood risk context, and on integrating different forms of knowledge in research on urban water and adaptive capacity.

1.3.2 Institutional bricolage: An analytical lens

The differential exposure of social groups to risk and vulnerability has been the object of political ecology research on risk pointing to the role of power and discourse in reproducing patterns of uneven risk (Cutter, Mitchell, and Scott, 2000; Wisner et al., 2004). Here uneven patterns are explained mainly by structural determinants such as capitalist relations between the powerful and the vulnerable (Ranganathan, 2015). However, the distribution of risk and vulnerability is also importantly shaped by actors as people actively shape their adaptive capacity (Pelling and High, 2005). Moreover, urban political ecology approaches tend to be based on narrow assumptions about capitalist relations, namely that the urban poor settle in the most hazardous areas. This does however not apply to post-colonial cities, where multiple institutions and agents shape who settles on hazardous sites, and who is most at risk (Collins, 2008, 2010; Ranganathan, 2015). A plurality of institutions that have been formalised in very different ways, such as traditional law, or religious norms define the option space people have in dealing with risk and vulnerability, and the relation between these institutions is reproduced in people's practices (von Benda-Beckmann, 2001). Culture plays an important role in shaping practices that constantly reconfigure conditions of risk and vulnerability (Krüger et al., 2015). Thus far, little attention has been paid to institutions that are not formalised, long-term arrangements in research on disaster risk. As non-formal, dynamic types of institutions play an important role in rapidly changing contexts, as is the case here, a 'critical', actor-centred approach to institutions appears most insightful to the present analysis.

Drawing on a broad range of case studies of natural resource management in Africa and Europe, Cleaver develops 'institutional bricolage' as an analytical frame for studying the messiness of institutions in natural resource governance. She builds on the work of Claude Lévi-Strauss, who first introduced the terminology of bricolage and bricoleurs in social sciences, and Mary Douglas, who advanced it to criticise rational choice views on institutions (Cleaver, 2012; Douglas, 1986; Johnson, 2012). Further drawing on Bourdieusian conceptualisations of structure-agency relations (Bourdieu, 1989; Bourdieu and Wacquant, 1992; McNay, 2000) and Foucaultian governmentality (Agrawal, 2005; Foucault, 1991), 'institutional bricolage' (Cleaver, 2012) or 'doing institutions' (Etzold et al., 2012) describes the mechanisms by which institutions are rearranged. For instance, traditions are invented, as has been described in detail by Hobsbawm (1983). Governmental symbols of legitimacy are copied into customary practices, for instance in land allocation by traditional rule makers (Earle, 2014).

Relations between different sets of rules are reproduced through the practices of actors confronted with a plurality of legal systems, defined for instance by government or religion (von Benda-Beckmann, 2002). Institutional bricolage draws on this understanding of institutional dynamics in legal pluralism by looking in particular at underlying mechanisms of power, authority and inequity that are invisible to the researcher of polycentricism in formal governance arrangements (Cleaver, 2012). Accordingly, Cleaver defines institutions as "arrangements between people which are reproduced and regularized across time and space and which are subject to constant processes of evolution and change" (Cleaver, 2012). In this view institutions of different degrees of formality and visibility shape and are shaped by actors who "consciously and non-consciously (...) assemble or reshape institutional arrangements, drawing on whatever materials and resources are available" (Cleaver and De Koning, 2015). The role of actor interactions between formal and informal arrangements has been stressed in actor-centred institutionalism (Mayntz and Scharpf, 1995). Critical institutionalism diverges from this view in stressing the fuzziness of the boundary between 'formal' and 'informal' and by aiming at overcoming the dichotomy in explaining how institutions form.

Cleaver describes the mechanisms by which institutions are patched together as five groups of 'key elements of bricolage'. The elements of bricolage that appear particularly relevant to adaptation to flooding in the Densu delta are identified from a literature review on case studies adopting critical and actor-centred institutional lenses. Land and water are key resources in the co-production of urban water (Ranganathan, 2014), and shape flood risk in the Densu delta (see section 2.2, also Frick, 2016). Adaptation to urban flooding includes the governance of 'resources' that are not 'natural', for instance safety, roads, open space and housing development. Hence case studies from urban, land and water governance are used to identify and illustrate key elements that will guide the analysis.

The piecing together of infrastructure, constant redefinition and renegotiation of the content and meaning of institutions and authoritative processes have been described in urban water governance by Schwartz et al. (2015). Naturalisation by analogy and authoritative process were identified as key elements of bricolage in managing land for reindeer herding in

Norway (Marin and Bjørklund, 2015). Koch (2011) and Gailing (2012) have applied actor-centred institutionalism to the governance of urban and cultural landscapes, respectively, and have identified personal relations of trust and power, ontologies, values, and traditions as invisible institutions that shape (in)formalisation of existing governance arrangements. Etzold et al. (2012) highlight the dynamics of institutions and the role of actors within their relational context of power in open space governance in two Asian cities.

Based on these case studies, three 'elements of bricolage' as described by Cleaver appear particularly relevant for the present case. The first element, 'authoritative processes and their unequal outcomes', explains how institutions are formed by power relations and individuals whose actions benefit some more than others. Small scale providers of water supply in Maputo, for instance, rely on diverse authoritative resources such as social status, relations of kinship, and financial resources to navigate between the formal and informal institutions regulating the market. The outcome is highly uneven access to water provisioning in the city (Schwartz et al., 2015). The second element, 'naturalisation, leakage of meaning and invention of traditions', summarizes different modes by which symbols or acts are borrowed from existing institutions to legitimize new arrangements. This is illustrated by Sami herders in Finland who adopted the framing of 'commons' as articulated by government in order to legitimise land use practices that diverge from traditional land use management (Marin and Bjørklund, 2015). A third element, 'moral rationality' explains that institutional arrangements are partly the result of belief systems and world views that guide actors' ways of doing things. An illustration is provided in the description of hospital guards in Dhaka who tolerate street vendors at night acknowledging their poverty and need for livelihood strategies, while removing them during daytime under surveillance by formal authorities (Etzold et al., 2012). While Cleaver stresses the role of value systems that define what is 'good' and what is 'bad', here the element is defined more broadly to include world views shaping what is considered acceptable (risk) and what is not. The element is therefore termed 'belief systems and world views' for the purpose of this paper. While culture, defined as "constantly changing and shifting configuration of social practices (...) inscribed into society" (Bankoff et al., 2015), is a cross-cutting aspect of institutional bricolage, particularly the analysis of beliefs, perceptions and priorities contributes to an understanding of culture shaping risk (Bankoff et al., 2015).

Understanding adaptive capacity implies looking at how and where adaptation has occurred because adaptive capacity is scale- and place-specific, and indicators are difficult to transfer (Adger and Vincent, 2005). As indicators of adaptive capacity are unknown for the case study area, the role of bricolage in shaping adaptive capacity cannot be assessed directly. Understanding the role of institutional bricolage in adaptive capacity requires the assessment of where and how bricolage has shaped adaptation in the past. Analytical steps required prior to assessing the role of institutional bricolage in shaping adaptive capacity are therefore the identification of institutions involved in adaptation, and of the enabling or hindering role of institutional bricolage in adaptation in the case study area. Looking at adaptation as part of assessing adaptive capacity is all the more important as adaptive action shapes future capacity to act (Pelling, 2011). Here institutions are defined as socially legitimized arrangements

between people. They are being patched together through 'elements of bricolage', by which social arrangements become legitimized and thus institutionalized, which distinguishes them from purely instrumental and provisional conventions (Cleaver, 2012; Diaz-Bone, 2012; Douglas, 1986). The three elements of bricolage identified above as relevant for adaptation to flooding are traced in coping and adaptation strategies developed by organisations, households and community groups. Finally, key factors of adaptive capacity that shape adaptation options in the Densu delta are identified through a bricolage lens. In summary, the analytical questions are:

1. Which institutions are involved in the creation and mitigation of, and adaptation to, floods in the Densu delta?
2. How do 'leakage of meaning and invention of tradition', 'authoritative process and unequal outcomes', and 'belief systems and world views' act as key elements of bricolage in adaptation to flooding in the Densu delta?
3. What are the key factors of adaptive capacity shaped by institutional bricolage?

1.3.3 Methodology

Methods and data

The three analytical questions are addressed with data from expert interviews, stakeholder interviews, field observations, and document analysis. Institutional mapping based on interviews, documents and observations served to identify institutions involved in the creation and mitigation of, and adaptation to, floods (1). The role of the three elements of bricolage was identified from institutional practices through interviews and observations (2). Factors of adaptive capacity were identified from interviews and contrasted with the processes of bricolage identified (3).

66 semi-structured interviews were conducted in Accra in January 2014, May to July 2014, and January 2015. During the time of data collection, the Densu delta flooded in June 2014, following the spillage of the Weija Dam. Expert interviews (N=32) were conducted, in English, at the workplaces of the interviewees. The experts interviewed represent decision makers in the fields of urban planning and disaster risk reduction at sub-metropolitan district, district, city, country, and cross-national levels in government, non-governmental and donor organisations. Key stakeholder (N=24) and street (N=10) interviews in the Densu delta were conducted in English, Ga, Twi and Ewe, and took place on streets and in front of the homes of the interviewees. Key stakeholders represent opinion leaders and heads of formal and informal community groups. Experts and key stakeholders were identified based on literature as well as on information given in interviews (snowball sampling). Interviewees for street interviews were selected by convenience at different sites across the delta to represent different levels of bio-physical exposure.

All interviews followed a thematic structure of causes and consequences of urban flooding in Accra and the case study area, strategies for coping, adaptation and risk reduction and

collaboration. Photographs and maps of the case study area were used to illicit responses. Further methods of data collection and validation include site visits accompanied by stakeholders, transect walks, participatory observation at decision makers' meetings, and informal conversations with local researchers. Where possible the interviews were recorded and the interview material transcribed. All interviews were coded using MAXQDA software (VERBI Software GmbH, 2012) in a cyclical approach (c.f. Saldaña, 2013) to identify institutions, capacities, practices and risks, and relations between these elements from the qualitative interview material (see also Frick-Trzebitzky, Baghel, and Bruns, forthcoming). Off-the record informal conversations, meetings and observations were collected as field notes. Relations between institutions were mapped based on a document analysis, expert and key stakeholder interviews. Limitations may arise from the small sample of street interviews as it is not representative of the total population potentially affected by flooding, cultural and language barriers. Due to the multitude of languages spoken in the case study area the researcher had to rely on translations of an interpreter, particularly in street interviews.

Introduction to the case study area

Accra, a growing coastal city of approx. 4.3 million inhabitants as of 2014 (a projection based on the latest census from 2010, Atlas of Urban Expansion, 2016) has been affected by flooding almost every year between 2000 and 2012, with no flood events recorded in 2002 and 2006. During this period, the loss of 83 lives, 178,750 displacements and an estimated economic cost of US\$43.71 million have been recorded as impacts from flooding (Amoako and Boamah, 2014). Localised flooding in Accra occurs predominantly in May to July and September to November as a consequence of extreme rainfall and run-off discharge, and in August to October as a consequence of tidal waves (NADMO, 2010). Dam openings causing flooding in the Densu delta have occurred one to seven times per year for periods of two to 65 days between 1998 and 2007 (Kuma and Ashley, 2008). Further causes and consequences of flooding in Accra result from the interaction of unplanned urban development, lack of adequate drainage and waste infrastructure and services, as well as coastal erosion and sea level rise (Amoako and Boamah, 2014; Karley, 2009). Large parts of the built-up area are low-lying and therefore particularly prone to flooding. These areas coincide with low-income settlements (Amoako and Boamah, 2014), and within these marginalized groups are most vulnerable to impacts from flooding (Aboagye, 2012). It has been estimated that 366,823 people are living in informal settlements on flood prone sites in Accra (Amoako and Boamah, 2014). As the capital of an emerging economy, Accra is an example of a medium-size growing coastal city that is entangled in global market and migration flows (Grant, 2009) and thus serves as a case not only for African cities but of growing cities in flood-prone areas around the world (Güneralp, Güneralp, and Liu, 2015).

The Densu delta west of Accra (Figure 1) is among the most flood-exposed areas in the city (Amoako and Boamah, 2014). It is located in what has been the most dynamically urbanising area of Greater Accra in the 21st century (Stow et al., 2016). The protected wetland is being encroached on from all sides, leading to the loss of natural flood retention space. Sedimentation in the Densu River and subsequent overspill of the Weija reservoir north of

the wetlands is causing more and more flooding in the Delta (Kuma and Ashley, 2008). High pollution levels of river and lagoon waters from upstream agriculture, industrial and domestic waste disposal imply that floods are associated with health risks and environmental degradation (Denutsui et al., 2012; Osei et al., 2010; Osei et al., 2011). Knowledge on adaptive capacity in the Densu delta is limited to vulnerability and coping capacity assessments in selected localities (Amoako and Boamah, 2014; Amoani, Appeaning Addo, and Laryea, 2012; Appeaning Addo, 2013; Oteng-Ababio, Owusu, and Appeaning Addo, 2011), with no explicit mentioning of the role of institutions. As the Densu delta expands beyond the boundaries of the Accra Metropolitan Area (AMA), land use is managed by the respective authorities in AMA and Ga South District. In addition, land is owned and governed by various traditional authorities who have increasingly fought over land ownership claims in the context of increased urbanisation pressures (Barry and Danso, 2014). Litigation, land and successor disputes have been part of the Ghanaian chieftaincy system in recent years, and the governmental supervision of customary land transactions is barely put in practice (Ubink and Quan, 2008).

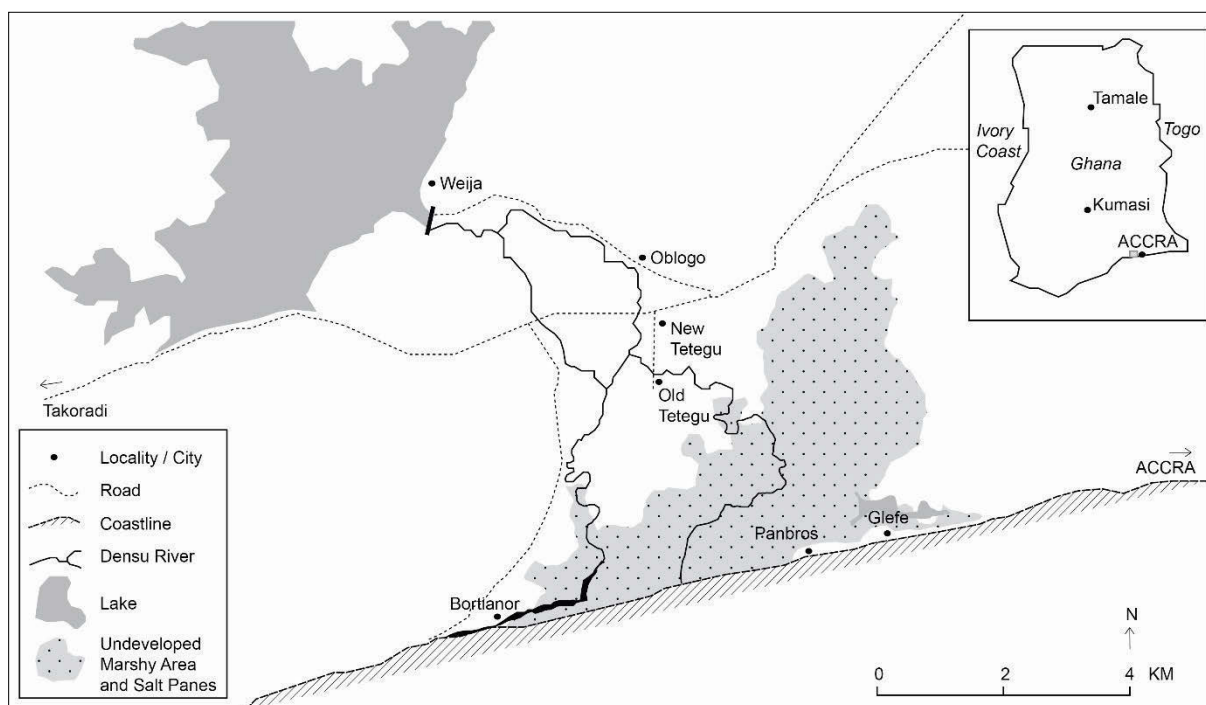


Figure IC.1. The Densu delta. Own design based on (Osei et al., 2010) and (Google Maps/Google Earth, 2016). A prior version has been published in Frick (2016).

1.3.4 Institutions in adaptation to flooding

Designed governmental and non-governmental arrangements

Designed regulations, rules and norms on disaster, water and land management are arrangements legitimized as institutions by governmental agencies, traditional authorities, and non-state organisations. Among governmental organisations, the National Disaster Management Organisation (NADMO) is particularly relevant as it was established in 1996 under Act 517 with the mandate to "manage disasters and similar emergencies in the country"

(Government of Ghana, 1996). The organisation operates through separate headquarters at national and regional levels, and officers based at district level and constituency government offices. Disaster Volunteer Groups (DVGs) assist in implementing NADMO's activities at local level. Following a focus on emergency relief, the organisation shifted its focus to prevention in 2013 due to increasing costs of emergency relief operations and reluctance of international donor agencies to continuously fund these.²⁰ NADMO collaborates with numerous national and international, governmental and non-governmental authorities and organisations in its operations. Flood prevention measures involve close collaboration with agencies responsible for drainage construction (namely: Hydrological Services Department for storm drains, Urban Roads Department and Feeder Roads Department for drains along roads), for urban planning (Town and Country Planning Division), conservation of wetlands (EPA) and implementation of land use planning and environmental protection (Municipal, Metropolitan and District Assemblies, MMDAs). NADMO moreover collaborates with UN Agencies, the NGO World Vision, Ghana Hydro-Meteorological Services Department, the Ministry of Water Resources Works and Housing (MWRWH), Ghana Health, Ghana Armed Forces, Fire Service, Ghana Police, Ghana Communications, and Universities for consultancy and in technical committees. Key governmental agencies engaged in urban development and risk management as indicated in Figure 2 operate at national, district, and constituency levels.

Although not directly engaged in risk and hazard reduction, the traditional chieftaincy system is a crucial component of flood risk management in the Densu delta, and Ghana more generally, because chiefs act as custodians of land and as such take key decisions on land use. Traditional chiefs and the respective stool hierarchies are designed institutions that are formally recognized by the Regional House of Chiefs. Land is family-owned in the Densu delta. Hierarchies of state and traditional authorities governing land use in the Densu delta and the respective legal systems are shown in Figure 3 taking two localities as examples. The figure shows the levels of hierarchy in both the statutory and the customary legal systems relevant to land and water governance in the case study area (namely, Glefe and Tetegu). Shades of grey indicate hierarchical levels from Municipal and metropolitan district (region in customary law; dark grey) to locality and family (light grey).

²⁰ Where not stated otherwise, sources for the findings presented in this and the following section are the interviews conducted for this research as indicated in 'Methods and data' (p. 139).

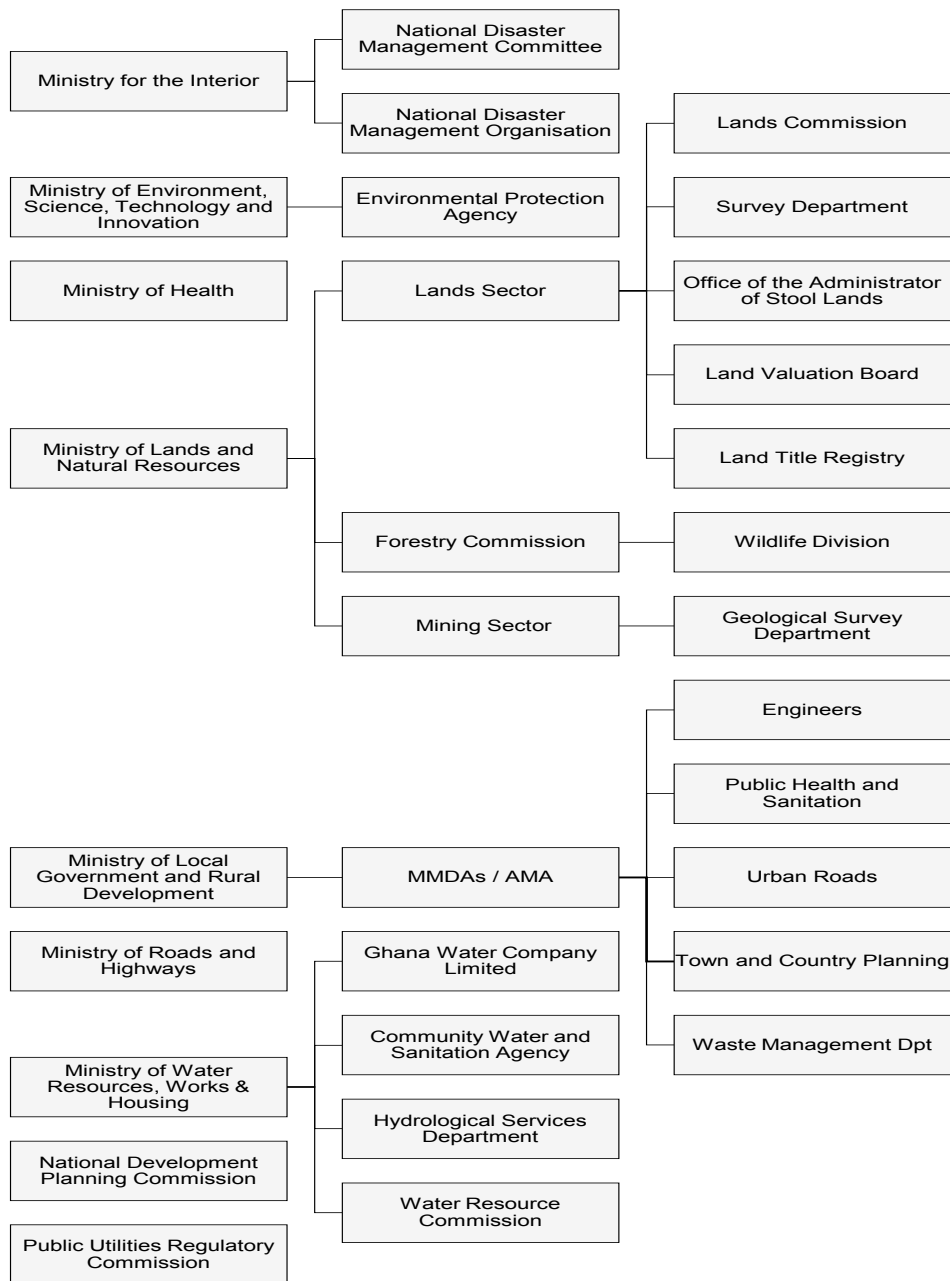


Figure IC.2. Government Agencies involved in flood risk management in Ghana. Own design based on governmental documents and interviews. Responsibility for policy design increases from right to left, and for implementation from left to right.

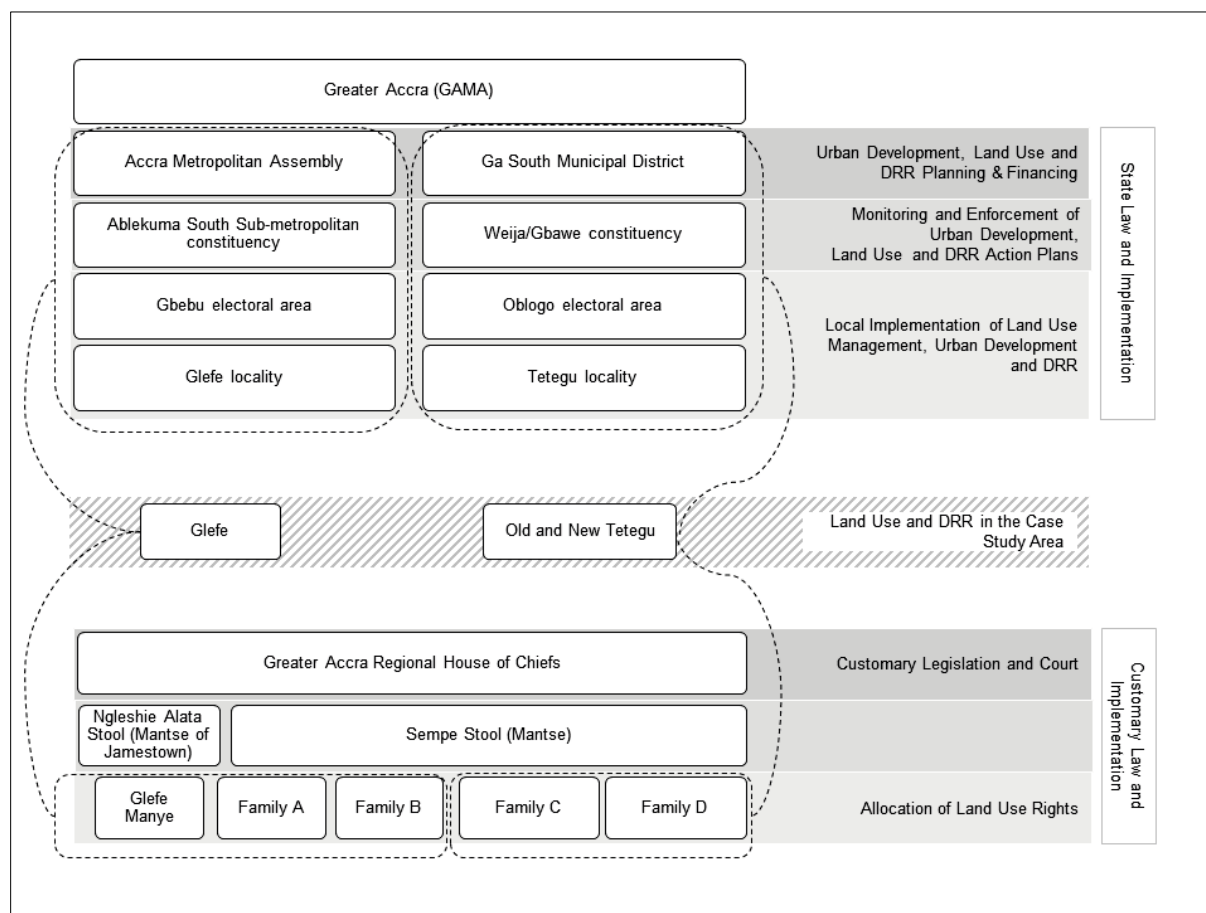


Figure IC.3. Hierarchical organisation of state and chiefly authority over land use and disaster risk reduction (DRR) management in the case study area. Own design.

Policies, regulations and by-laws anticipate the integration of environmental management, urban development planning and disaster risk reduction in planning.²¹ In the aftermath of major flooding in November 2011, the National Disaster Management Organisation (NADMO), together with the Environmental Protection Agency (EPA), UNDP and the University of Ghana, pushed for an integration of adaptation to climate change and disaster risk reduction in national and urban development planning. This shaped the formulation of key national action plans and policies, including the Ghana National Action Plan of Disaster Risk Reduction and Climate Change Adaptation (NADMO, 2011), the National Urban Policy Action Plan (MLGRD, 2012), and the National Climate Change Policy (MESTI, 2013). Several by-laws have been drafted to enforce urban development that is in line with flood risk reduction and adaptation to climate change in Accra.

The ultimate authority to monitor compliance with planning regulations and codes is the municipal, metropolitan or district assembly (MMDA). New buildings are, however, constantly erected in areas that are to be kept free from development under formal regulations, namely the Accra Structure Plan (TCP, 1991) and the Ramsar site management plan. Among experts, the lack of enforcement of environmental and planning regulations is

²¹ Both state and customary legislation are considered part of Ghanaian law according to the constitution. As indicated earlier however, customary law is not publically available in written form (except for case law), and is subject to change and local interpretation; see Ubink (2008).

considered the result of ignorance, lack of capacity and conflicting interests in MMDAs and among assembly members, poor coordination of donor activities, as well as of the lack of legal and political backing of environmental protection at national level. The Ministry of Environment, Science, Technology and Innovation (MESTI) is currently pushing for a national law to support environmental protection; however, presidential support is limited in the face of the National Growth Strategy. In the meantime, residents and the EPA attempt to push for environmental planning enforcement by suing AMA for tolerating or supporting violations.

The apparent incoherence of governmental institutions to manage flooding in Accra results in a limited impact of these institutions on the ground. According to NADMO officers at AMA and Ga South district and Ablekuma South constituency, flood risk in the Densu delta is caused by choked gutters from waste disposal, poorly developed and maintained drainage systems, building on waterways and reclamation of lagoon land in the area that floods when the Weija dam has to be spilt. The dam was constructed to supply Accra as well as agricultural lands with water. As agricultural lands have been converted to urban use however, no water is currently extracted for irrigation. Lacking both capacity and permission to extract larger quantities for supply to Accra, GWCL releases water from the reservoir more frequently during the rainy season to prevent the dam from bursting.

The Town and Country Planning Department at AMA level is responsible for designing and implementing a planning scheme for urban development which includes the provision of drains along roads, as well as buffer zones along water streams. The current scheme demarcates the Densu delta as a green belt in which urban development is to be prevented in order to protect natural drain for runoff in the delta (TCP, 1991). Enforcing implementation of land use and building regulations by demolishing structures that block waterways is the mandate of district governments to which NADMO reports any violations. However, the government has been unable to control the sale of stool-owned²² land by local chiefs and started tolerating established settlements in the area by issuing permits, constructing drains and collecting revenues. A revision of the planning scheme was underway at time of the research (ibid). The wetlands of the Densu delta are also protected under the international Ramsar convention and National Law LI 1659 as a habitat for migratory bird species following the national non-governmental initiative 'Save the Seashore Birds' supported by the UK based Royal Society for the Protection of Birds 1990s. Today the site is managed by the Wildlife Division of the Forestry Commission in collaboration with Panbros Salt Industries, a private company that owns large parts of the land in the protected area's core zone. However, in the face of ongoing deterioration of the wetland and little political support of environmental protection, it is likely that the Densu delta will soon be removed from the list of Ramsar sites. NADMO activities are limited to the construction of drains, education and awareness activities, and emergency relief.

²² A 'stool' signifies the chiefly office in Akan-speaking Ghana, referring to the furniture on which chiefs sit while in office (Berry, 2008).

As governmental arrangements for flood prevention by land use planning in the Densu delta have limited effect on the ground, alternative arrangements have been designed. The private sector is present in formal arrangements for flood risk management through contractors for waste management, GWCL and Panbros Salt Industries, as well as through companies distributing relief items after floods hit²³. Chiefs, assembly members, Panbros Salt Industries, NADMO and Wildlife Division are informed by GWCL ahead of a planned spillage of the Weija dam, which is operated by the company. This public-private partnership is effective in reducing the immediate impacts from flooding. However, it also undermines adaptation as the arrangement contributes to low risk perceptions and consequently to further encroachment. Moreover, it benefits some areas and actors more than others, and therefore adds to uneven access to adaptive capacity, as I will discuss below. Further alternative arrangements include humanitarian aid organisations such as the Red Cross, and the non-governmental organisation World Vision, with whom NADMO cooperates. However, their engagement in the Densu delta is limited as NGO activities tend to target the allegedly more vulnerable rural communities. Ghana Red Cross activities are constrained by a lack of resources and bureaucratic procedures that create time lags in the provision of emergency response. The Red Cross member residing in Glefe did not inform the organisation when the June 2014 flood hit. This may hint to the lack of adaptive capacity and poor suitability of bureaucratic practices in big international NGOs stated for Accra in the context of water provision (Morinville and Harris, 2014). Local, community-driven NGOs that work towards reducing the vulnerability of the urban poor, such as the Ghana Federation of the Urban Poor, are not active in the Densu delta.

Neighbourhood associations and other arrangements

Embedded institutions that contribute to adaptation to flooding in the Densu delta can be identified from the adaptation strategies found. Similar to the strategies of designed institutions (see previous section), adaptive strategies in socially embedded institutions, visible at individual level and in community groups, involve both intentional adaptation to flooding and less targeted improvement of background conditions. Fishermen in particular benefit from increased catch due to flood water and have developed successful strategies to cope with reoccurring floods. Residents tend to accept flooding as part of normal life and claim to feel safe from future flooding, even when interviewed shortly after the locality was flooded for several days in June 2014, as illustrated by the following quote of a Tetegu elder, recorded one week after the waters had receded from Tetegu:

Many houses were flooded. The mud houses collapsed. Many people were affected, they asked other people to stay with them until they could go back to their houses. (...) The normal spilling doesn't affect anyone. This was an accidental spillage. (...) A flood like this last occurred more than ten years ago. So we are not going to experience anything like this again (Tetegu Elder, 2014).

The traditional houses in the Densu delta are mud huts that reportedly easily collapse during floods. They have largely been replaced by concrete houses which now dominate the built up

²³ For instance after the flood-fire disaster in 2015; Andoh (2015)

area in and around the Densu delta. To prevent these houses from regular flooding up to approximately knee-height, they are built on strong basements of sand and concrete. Where building grounds are particularly prone to inundation, plots are filled with gravel, sand or solid waste prior to housing construction. Next to the preventive filling of land and raising of houses, the grounds of compounds are also filled temporarily with gravel and sand during the rainy season to prevent flood waters from entering houses. Individual waterways to discharge water are also constructed by individuals and neighbourhood associations both permanently as a preventive measure, and temporarily to divert flood water. Further strategies during times of flooding include the placement of stepping stones, navigating the streets by canoe, raising furniture and storing valuables under the roof, as well as temporal relocation of valuables and people to relatives.

The strategies taken at household level are primarily targeted at reducing the immediate exposure of people and valuables to flood water. Several of them involve the diversion of exposure and vulnerability to neighbours, e.g. when flood water is diverted, to other parts of the community, e.g. by mining sand for filling from the built-up coastal shore, or to the future as savings are spent on short-term strategies. Embedded institutions that can be identified from these strategies are professional traditions, conventions in housing construction practice, and personal relations of trust and reciprocity among relatives. In addition to these, neighbourhood associations are embedded institutions that become apparent from collective adaptation strategies, as described below.

Institutional arrangements to outbalance counterproductive on and off site consequences of households' (mal-) adaptation have had mixed results in the Densu delta. After settlers in Tetegu had discharged their water onto adjacent plots at the beginning of the informal development of middle and high income houses, a house owners' association was formed to collectively organise the installation of drainage, as well as further basic infrastructure, such as roads and water supply. A prerequisite for public infrastructure provision would be the authorisation of the settlement. The value of the members' properties was a decisive factor in the association's lobbying of local government as the municipality would benefit from authorising the settlement in the form of property taxes. Consequently, the association succeeded in obtaining building permits for the houses already erected in 2010 (see also Frick, 2016). Members of the association and the community's chief successfully pushed for the adjustment of dam gate openings and early warning by GWCL, which led to chiefs and assembly members being considered in dam gate management (see subsection above). The events reveal the formation of a community group and the formalisation of urban land use through building permits – though not primarily targeted at the reduction of flood risk – as important steps towards a process of adaptation to environmental and crime risks. At the same time the formalisation and subsequent adaptation process is spurring continuous development into the Densu delta. As a consequence of reduced natural retention space, regular flooding increases in frequency. More and more people are exposed as the population in the delta increases.

Community associations have similarly been formed in the deprived locality of Glefe to foster development in collaboration with the local assembly member. Their activities are

constrained by lack of political support and collaboration of an enterprise. In the absence of a drainage system, a few households have constructed individual drains which end abruptly in the only street, creating ponds of waste water. In light of the poor sanitary conditions in the community, government officials describe the community as 'the new Sodom and Gomorrha' – referring to the colloquial name of the allegedly most deprived informal settlement of Accra. Dredging the lagoon has been proposed as an interim solution to facilitate drainage of run-off water into the lagoon. However, the project was dropped following a political change in Parliament. In the meantime, the assembly member continued negotiations with Panbros Salt Industries, whose operations interfere with the discharge system of the Sakumo lagoon due to the layout of the salt panes. Panbros has altered the lagoon outfall to prevent pollution of water pumped into salt panes from waste dumped at Glefe. As a consequence, water from the lagoon does not flow off and easily creates floods. The community association finally succeeded in pressuring the government to install gutters and carry out demolitions of exposed houses by drawing media attention to the extreme exposure and vulnerability of Glefe during heavy flooding in June 2014. Whether this measure is effective remains to be seen as according to engineers' assessment, the construction of open gutters in the extremely low lying area is unlikely to reduce flood risk if the lagoon is not dredged. This may indicate that the process of bricolage has led to the government implementing a measure for flood risk reduction that experts consider to have little effect.

In sum, several embedded institutions, understood as socially legitimate arrangements between people that are not regulated through formal documents and authorities, can be identified from the adaptive strategies applied in the Densu delta. These are neighbourhood associations and community groups, professional traditions, conventions in housing construction practice, the insurance system of extended families, and value and belief systems that make residents accept perennial flooding as part of daily life. Personal relations of trust, reciprocity, status and political affiliation are key resources that enable actors to engage with these institutions. Embedded institutions are used not only to replace and complement ineffective institutions, but are also merged with these to form new arrangements in adaptation to flooding.

1.3.5 Powerful and inventive bricoleurs and the challenge of collaboration

Struggles in the formalisation of infrastructure

Authoritative processes reproduce relations of power (Clever, 2012). In the Densu delta case, these processes and relations become most visible in attempts to formalize infrastructure. In Glefe, for example, contestations over lagoon outfalls between community representatives, Panbros Salt Industries and NADMO, respectively, are the expression of competition over the power to control the water flow among actors linked by uneven relations of dependence. This power game took a new turn when Glefe's assembly member succeeded in pressuring the state for constructing drains through media reports. In spite of openly questioning the legitimacy of 'chiefs' selling land in both localities, the chiefs' practical power to control land allocation is unchallenged, including by National Government

authorities. The analysis of designed institutions in adaptation to flooding in the Densu delta in the previous section reveals that authoritative processes shape decision making in state organisations where environmental governance receives little support from central government. Its implementation has even been hindered by the presidential office in the past.

The observed authoritative processes have unequal outcomes. In Tetegu, the association's achievements benefit large parts of the locality, except the less affluent fishermen of Old Tetegu. The latter are by contrast exposed to increased contamination of the Densu, as a result of drains discharging into the river which they use for cleaning and cooking. Newly constructed houses further downstream of Tetegu are being squatted or rented out to construction workers or land guards. These tenants are likely to have little capacity to cope with the impacts from flooding. Authoritative processes and unequal outcomes moreover shape individual adaptive strategies and maladaptation. Sand for filling foundations and compounds in Glefe is mined at the sea coast and carried across the settlement to protect houses by the lagoon against flooding, while huts located at the coast are increasingly exposed to erosion. Self-constructed drains divert water flows from individual houses in Glefe but discharge onto streets and compounds, triggering conflict among neighbours.

Leakage of meaning from one institution to another is particularly evident in the allocation of land. The title 'chief' is used by individuals under a 'stool' as a resource of legitimacy for selling land plots, particularly to new migrants. As chiefs are traditionally responsible for land use management and plot allocation, new migrants are often unaware of conflicting regulations or ownership claims. Moreover, plots are sold with allegedly official documents, combining symbols of legitimacy from state and customary rules. Coupled to the leakage of meaning in land allocation is the reinvention of tradition, particularly with regard to 'drinks', which have been redefined. There used to be a custom of giving a chief a bottle of schnapps in return for a land allocation. Nowadays a significant sum of cash referred to as 'drinks' is handed to the chiefs for the same purpose. The result of institutional bricolage in land allocation is, for the time being, an ever increasing number of buildings situated and people living in flood prone areas, as well as the reduction of natural wetland, both of which increase exposure to flood risk and vulnerability in the Densu delta. Finally, belief systems and world views shape the perceived need to adapt, as illustrated by the quote from the Tetegu resident on p. 146, describing a recent flood as a singular event caused by management failure, unlikely to reoccur. Here and among fishermen in Oblogo and Tetegu, occasional flooding occurring once a decade is considered as an acceptable and manageable part of daily life.

In particular, the uneven outcomes of authoritative processes in adaptive strategies show that bricolage can both trigger and hinder adaptation. The above analysis only sets out how bricolage influences the extent to which those capable of adapting do in fact take adaptive action. How do elements of bricolage shape the distribution of adaptive capacities, understood here as the ability to adjust practices and processes to reduce impacts from flooding in the Densu delta?

Policy design, enforcement and collaboration

Key factors of adaptive capacity referred to in interviews are legislation and policy design, enforcement of regulations and political will, collaboration and coordination. The distribution of these factors in the Densu delta and within organisations is uneven. Collaboration among different actors facilitated the negotiation for infrastructure in Tetegu whereas it failed in Glefe. The different mandates of key authorities give overarching power to control exposure of people to flood risk in the Densu delta to the Town and Country Planning Department, whereas the NADMOs role is reduced to advising and providing relief – although this contradicts the organisations' 'prevention pays' strategy. An uneven distribution can also be observed for factors mentioned in interviews that refer to social capital and institutional learning, namely human and financial resources, learning, knowledge and awareness, data management and monitoring, and background conditions. These factors of adaptive capacity are not discussed here because they have been analysed in depth elsewhere (Abheuer et al., 2012; Pelling et al., 2008; Pelling and High, 2005).

Authoritative processes, belief systems, and world views shape the uneven distribution of factors of adaptive capacity. The combination of these elements signals that power relations and culture are influential. Legislation and policies are currently designed based on politicians' interests and by international conventions that influence the world view of UN representatives and researchers engaged in policy design. As has been pointed out by Holloway (2012), involvement of these actors does not mean that local customs and values were regarded. Instead, they reflect a reliance on internationally renowned sources of knowledge. Legislation and policy tend to ignore the authoritative role of traditional chiefs, customs and values on the ground. As a consequence, policies are poorly enforced, as shown by the example of the Densu Ramsar site. Strengthening traditional structures and cultural values in environmental and climate change legislation is therefore seen as a major step towards adaptive governance at National level by the director of the MESTI. Belief systems and world views shaping implementation on the ground, however, are not only influenced by traditional values, as a Wildlife Division officer describes:

[Assemblies] want us to go and build some physical structures that require huge sums of money, they don't want wetlands to perform its natural functions. If you go in to support them they think of huge funding to establish drainage systems, expensive drainage systems which the country cannot perform or the district cannot afford. So in the end they back out from supporting you (Wildlife Division, 2014).

The physical structures referred to by the interviewee, e.g. constructed drainage systems, are also known as 'hard infrastructure' solutions. They are considered to have immediate effects but bear the danger of creating a technical lock-in and are costly, whereas 'soft solutions', such as protection of wetlands as ecosystems that naturally collect and filter excess water, are considered to be less costly and they provide a more flexible, sustainable, long-term solution to flood risk (Wesselink, 2016). The underused potential of green space as a sustainable solution to flood risk in Accra has also been pointed out by Karley (2009), and by Fohlmeister et al. (2015) for African cities more generally. The preference for hard

infrastructure in the Densu delta reported by the interviewee is not only an authoritative tool to claim legitimacy as a politician, it is also the manifestation of a world view to prefer engineering over protection of the environment, as well as an indicator of the influential role of the municipal hydraulic paradigm that has shaped water management in (post-) colonial cities of the Global South in the 20th century (Bakker, 2013).

Collaboration in extended families builds on culturally embedded belief systems and world views of trust and reciprocity:

it is part of the system that you must admit other family members especially when they are in difficulties (...) Everybody in Accra has a relation that they can perch with for two or three days for the water to recede. So normally what they do is they put the children and the vulnerable there and then they themselves come and hang around to guard their property. (...) You enable me, I enable you later – those are (...) the coping mechanisms that we have [also in covering emergency costs, for instance for funerals] (NADMO, 2014).

Within this system, money received is paid back depending on the distance of the relation, meaning the closest family is paid back last and thus bears the greatest risk of not being paid back fully. At the same time, the system is slowly eroding in the urban context where relatives are spread across the country. Leakage of meaning and invention of tradition in land sale practices are reconfiguring the links between stool members and their representatives (chiefs), converting them more and more into unclear relations, accompanied by an erosion of trust. Implications for adaptive capacity are not only a loss of social capital but also of financial resources, especially when residents need to pay twice for a plot, or are forced to move to a different plot because of conflicts over land ownership.

These examples merely illustrate how elements of institutional bricolage contribute to an uneven distribution of adaptive capacity such as in the Densu delta. Further examples are the undermining of legal and regulatory frameworks by the leakage of meaning and invention of tradition in chiefly structures and the naturalisation of humanitarian aid structures as NADMO has created voluntary groups. Again, authoritative processes and their unequal outcomes are a particularly evident element of bricolage in all examples of factors of adaptive capacity. Both people in leading roles and structural power relations such as funding mechanisms perform authority.

Next to the authoritative role of people and structures the cases of bricolage in adaptation in the Densu delta reveal the crucial role of bricoleurs in adaptation and in negotiating for an equitable distribution of adaptive capacity. A bricoleur actively puts together more and less formalized institutions that are within his reach in everyday practice (Funder and Marani, 2015; Johnson, 2012). Local measures rely heavily on committed and influential individuals and their relations with people in other functions. Assembly men, for instance, strategically liaise with chiefs, neighbourhood associations, media, government and consultants to the government to act in the locality's interest (here: adapting to flooding). They do so minding the different visible and invisible institutions they are aware of, and consciously utilize elements of bricolage, for instance by improvising the way of communicating community needs to local government, e.g. by shifting from direct communication to indirect

communication via the media. Similarly local NADMO officers adjust the implementation of the 'prevention pays!' strategy to local realities through improvisation in everyday practice, by demanding assurance from the assembly for providing fuel for excavation activities, and combining education activities with the provision of material goods, for example. Both are responses to moral world views according to which the government has the duty to help with material interventions.

1.3.6 Conclusion

We have seen that 'leakage of meaning and invention of tradition', 'authoritative process and unequal outcomes', and 'belief systems and world views' are all elements of bricolage that are key in adaptation, and key local stakeholders act as bricoleurs. Together, elements and bricoleurs influence where adaptation is successful, and where it is not. In Tetegu, authoritative processes have enabled house owners to adapt to flood risk by negotiating with local government, chiefs and the private company GWCL. Both access to adaptive capacity and boundaries of formality/informality have become reconfigured during this process. A similar formation of residents in Glefe did not result in adaptation as the actors did not have the social, symbolic and economic resources to perform authority. The ways in which elements of bricolage shape where adaptation is likely and where it isn't, as well as who is likely to adapt and who isn't have been outlined. Here the role of cultural factors such as world views has been stressed. The culturally embedded practice of relying on an extended web of personal relations to cope with risk shapes perceived needs for preparing for floods as well as access to financial resources and options for relocating in the aftermath of a flood event. The institutional bricolage lens appears particularly insightful in the analysis of adaptation and adaptive capacity in urban water governance. It shows that water flows are co-produced in both social and bio-physical processes and relations. It also shows the manifestation of power relations and inequalities in adaptation as bricolage may enhance the adaptive capacity of individuals or groups, but has negative effects on the adaptive capacity of people elsewhere or in the future. Four lines of thought emerge from the results presented in this article.

Firstly, the bricolage lens has highlighted key elements that foster the decisive role of chieftaincy structures in adaptation to urban flooding in the local context of Accra, which can be generalized for urban areas in Ghana. In the present case, individuals use the authoritative role the chieftaincy structures gives to chiefs to claim legitimacy in creating revenue from land. Outcomes of the respective practices in land management are ineffectiveness of governmental land use regulations and planning, continuous housing development on flood prone sites and a particular exposure of recent migrants who ignore both flood risk and the chieftaincy structures in place. The shift of formal authority over land and water use control from traditional leaders to the state, and of land ownership from stools to families and individuals in Ghana is representative of the elements of institutional bricolage, as described by Cleaver. Governmental rules in land use planning are undermined by chiefdom structures in a bricolage process where customary arrangements for instance for the selling of land plots

are reinvented and change in meaning. The powerful role of chiefs in peri-urban land disputes and speculation in Accra has been studied in depth (Barry and Danso, 2014; Gough and Yankson, 2000; Ubink, 2008). In a similar fashion, 'chefs' in Maputo significantly shape urban land titling as a 'twilight institution' at the intersection of local ('informal') and state institutions (Earle, 2014). 'Mafias' exercise public authority by governing land and water in informal settlements in Bangalore (India) (Ranganathan, 2014). What this study adds to the literature is that it highlights the role of the chief as a dynamic institution that can contribute to or hinder adaptation to urban flooding, depending on his own rationalities and institutional context.

Secondly, the bricolage lens offers new insights in adaptive capacity. As indicated above, culture is a factor that has only recently begun to be explored in adaptation literature. Traditional ways of implementing policies, as well as motivational factors, coordination and governance practices are all context-specific factors shaping adaptive capacity in cities of the Global South; however, concepts that capture these are currently lacking (Heinrichs et al., 2013). The factors of adaptive capacity that have been identified in this research are legislation and policy design, enforcement of regulations and political will, collaboration and coordination. Belief systems and world views, leakage of meaning, and invention of tradition have been exposed as key elements shaping these factors of adaptive capacity. These findings highlight the role of culture in adaptation and provide insight on how culturally embedded practices shape adaptive capacity. While Codjoe and Issah (2015) find that culture in a traditional Accra community creates a resistance to innovation and adaptation and a moral rationale of risk avoidance, the results from the Densu delta show that embedded institutions are innovative in adapting to changing conditions, and indicate that adaptive strategies contribute to an acceptance of risk. The findings resonate in stating a willingness of community members to invest voluntary work in collective adaptation strategies. Institutional bricolage therefore appears as a promising concept in further understanding urban adaptive capacity from a Global South perspective. Further research might look into cultural differences in risk perception as a component of adaptive capacity between historical settlements such as those studied by Codjoe and Issah (2015), and settlements where migrants of diverse cultural backgrounds mix, as in the Densu delta. Further research ought to be devoted to finding solutions to overcome cultural barriers to building adaptive capacity and using it to act, both in policy and in local practice.

Thirdly, looking at adaptation to urban flooding and adaptive capacity through institutional bricolage offers new perspectives on the concept itself and its application in the setting of a growing city in a flood-prone area. Developed for the analysis of natural resource management and deployed mostly in a rural context, institutional bricolage also shapes institutions that manage risk and infrastructure, and that operate in conditions of constant change, typical for growing cities. Informal formalisation describes how "those who master current and characteristic modes of expression, who know when to observe tradition and institutionalize rights in informal settings and when to substantiate them through the formal institutions of the state, thrive" (Benjaminsen and Lund, 2002). The bricolage analysis exposed cultural norms, informal formalisation, dynamic chieftaincy structures and

innovative bricoleurs as key factors that shape the distribution of adaptive capacity and thus uneven urban development. Actors that are not involved in formal arrangements for flood risk management were identified as key agents in adaptation particularly from the analysis of authoritative process and unequal outcomes. Compared to rural settings, the complexity of actors and institutions in cities offers more opportunities for bricolage, with a multitude of elements of bricolage to draw on. The results moreover reveal parallels to an assemblage analysis of urban flooding which "makes visible unusual suspects involved in the production of flood risk, (...) including state agents, developers, and corporate actors [who] are complicit in the risky encroachment of storm channels" (Ranganathan, 2015). The results of the bricolage analysis of the Densu delta case suggest that here land adds as another layer of 'distributed agency' in the assemblage of flood risk (Ranganathan, 2015). Bringing bricolage and assemblage perspectives into engagement therefore appears promising for further research on patterns of urban flooding and adaptation.

Fourthly, an analysis employing a bricolage lens enables incorporating different forms of knowledge towards transformative adaptation. Adaptation to flooding on the ground is shaped by the interaction of designed and embedded institutions, actively pieced together by key stakeholders, both consciously and unconsciously. From a policy perspective, this main finding of this research implies that bricoleurs hold crucial knowledge on the effectiveness of institutions. Engaging with this knowledge and the flexibility of embedded institutions in policy design and planning might improve the effectiveness of designed institutions on the ground. Current frames for studying and managing global cities are dominated by a Western understanding of what is urban development, and tend to be at odds with lived reality shaped by persistence, creativity and resilience in African cities (Macamo, 2013). Water research tends to study materiality rather than the social relations that are likewise part of the co-production of (urban) water (Ahlers et al., 2014; Budds and Hinojosa, 2012). In exposing alternative forms of knowledge and knowledge holders, the bricolage analysis creates a link between theoretical and practical understanding of urban water flows. At the same time the research has shown that institutional bricolage in adaptation entails unequal outcomes, reducing marginalized urban dwellers' capacity to adapt. Unconscious practices in bricolage moreover render the strategic integration of practical knowledge difficult. Major challenges therefore remain in enhancing the capacities to adapt among those poorly represented by active bricoleurs, and in eliciting knowledge from unconscious practices in institutional bricolage to enhance adaptive capacities. Participatory mapping approaches merging qualitative and quantitative assessments of adaptive capacity in geographical information systems may provide important insights for overcoming inequalities in access to adaptive capacity.

The bricolage lens proved particularly useful to understand how bricoleurs patch together institutions that are at the same time designed, bureaucratic, formal, informal, traditional, corporate, embedded, etc. as is typical of arrangements for risk reduction and adaptation to climate change in African cities (Adelekan et al., 2015). In addition to the crucial role of local government officials as bricoleurs, the authoritative role of traditional chiefs was identified to shape adaptive capacities. The findings of the bricolage analysis support the key role of

chiefs due to their culturally embedded authority, but also point to the dynamic of the institution, further influenced by the wider context of global land markets and migration. The authoritative processes and unequal outcomes identified in the triangle of government, traditional and market authority illustrate what Benjaminsen and Lund (2002) have described as informal formalisation in Africa. As the case study illustrates, not only individual bricoleurs but also groups use the ability to know when to draw on what kind of institutions to adapt. The results of bricolage in adaptation are inherently uneven as bricolage may enhance the adaptive capacity of individuals or groups, but at the same time negatively affects adaptive capacity elsewhere, at other scales, or in the future. Institutional bricolage therefore doesn't enhance adaptive capacity of a community as such. Officials' reports on practices undermining the implementation of designed institutions hint to the significance of institutional bricolage and bricoleurs acting across various scales. This paper has focused on bricolage in adaptation at local level. Further research is needed on how people decide which institution to turn to in adaptation, on the role of institutional bricolage in adaptation at higher levels of policy design and implementation across scales, how the uneven outcomes of institutional bricolage in adaptation are shown in the spatial distribution of flood risk, and ultimately how inequalities can be overcome and flood risk reduced for all.

Acknowledgements

This research has been (partly) funded by the German Federal Ministry of Education and Research (BMBF) under the (project funding) reference number 01 LN 1316 A and Heinrich-Böll-Stiftung under the funding reference number P105800. Ethical approval for the research was obtained from the University of Ghana under the reference number ECH 063 13/14. The author declares that she has no conflict of interest.

I would like to thank Antje Bruns, Frances Cleaver, Mark Pelling, and three anonymous reviewers for their thoughtful comments on earlier drafts of this paper. I thank Osman Alhassan, Jesse Sey Ayivor and Martin Oteng-Ababio for their invaluable comments that helped to interpret my data. My extended thanks go to Chris Gordon and his team, Samuel Agyei Mensah and Ernest Olerterey for their support of my field research in Accra, as well as to all interview partners for sharing their knowledge and experiences with me.

I.3.7 References

- Aboagye, D.C. 2012. Living with familiar hazards: Flood experiences and human vulnerability in Accra, Ghana. *Articulo – Journal of Urban Research Briefings*: n.p.
- Adelekan, I.O.; Johnson, C.; Manda, M.; Matyas, D.; Mberu, B.U.; Parnell, S.; Pelling, M.; Satterthwaite, D. and Vivekananda, J. 2015. Disaster risk and its reduction: an agenda for urban Africa. *IDPR* 37(1): 33-43.
- Adger, W.N. 2003. Social capital, collective action, and adaptation to climate change. *Economic Geography* 79(4): 387-404.
- Adger, W.N. and Vincent, K. 2005. Uncertainty in adaptive capacity. *Comptes Rendus Geoscience* 337(4): 399-410.
- Agrawal, A. 2005. *Environmentality: Technologies of government and the making of subjects*. Durham: Duke University Press.

- Ahlers, R.; Cleaver, F.; Rusca, M. and Schwartz, K. 2014. Informal Space in the urban waterscape: Disaggregation and co-production of water services. *Water Alternatives*, 14pp.
- Amoako, C. and Boamah, F.E. 2014. The three-dimensional causes of flooding in Accra, Ghana. *International Journal of Urban Sustainable Development* 7(1): 1-21.
- Amoani, K.; Appeaning Addo, K. and Laryea, W. 2012. Short-term shoreline evolution trend assessment: A case study in Gleebe, Ghana. *Jàmbá: Journal of Disaster Risk Studies* 4(1): 1-7 [af].
- Andoh, D. 2015. More donations pour in for floods/fire victims. *myjoyonline.com*. 12 June 2015. www.myjoyonline.com
- Appeaning Addo, K. 2013. Shoreline morphological changes and the human factor. Case study of Accra Ghana. *Journal of Coastal Conservation* 17(1): 85-91.
- Abheuer, T.; Thiele-Eich, I. and Braun, B. 2012. Coping with the impacts of severe flood events in Dhaka's slums: The role of social capital. *Erdkunde: Archiv für wissenschaftliche Geographie* 67(1): 21-35.
- (Atlas of Urban Expansion) 2016. *The city as a unit of analysis and the universe of cities: Accra*. www.atlasofurbanexpansion.org.
- Bakker, K. 2013. Constructing 'public' water: The World Bank, urban water supply, and the biopolitics of development. *Environment and Planning D: Society and Space* 31(2): 280-300.
- Bankoff, G.; Cannon, T.; Krüger, F. and Schipper, E.L. 2015. Introduction: Exploring the links between cultures and disasters. In Krüger, F.; Bankoff, G.; Cannon, T.; Orłowski, B. and Schipper, L. (Eds), *Cultures and disasters: Understanding cultural framings in disaster risk reduction*, pp. 1-16. Abingdon, Oxon, New York, NY: Routledge.
- Barry, M. and Danso, E.K. 2014. Tenure security, land registration and customary tenure in a peri-urban Accra community. *Land Use Policy* 39(1): 358-365 [af].
- Benjaminsen, T. and Lund, C. 2002. Formalisation and informalisation of land and water rights in Africa: An introduction. *The European Journal of Development Research* 14(2): 1-10.
- Benouar, D.; Diagne, K.; Kiunsi, R.; Songsore, J.; Pelling, M.; Pharoah, R.; Wisner, B.; Ndiaye, A. and Yitambe, A. 2012. Towards a safer urban future: conclusions and recommendations. In Pelling, M. and Wisner, B. (Eds), *Disaster risk reduction: Cases from urban Africa*, pp. 195-210: Routledge.
- Berry, S. 2008. Ancestral property: Land, politics and 'the deeds of the ancestors' in Ghana and Côte d'Ivoire. In Ubink, J.M. and Amanor, K.S. (Eds), *Contesting Land and Custom in Ghana: State, Chief and the Citizen (AUP – Law, Governance, and Development R)*, pp. 27-54. Leiden: Leiden University Press.
- Bhattacharya, N. and Lamond, J. 2011. A review of urban flood risk situation in African growing economies. *Urban flood risk management approaches to enhance resilience of communities*. Graz, Austria: UFRIM (Graz, Austria), 21.-23. September 2011 [af].
- Bicknell, J.; Dodman, D. and Satterthwaite, D. 2009. *Adapting cities to climate change: Understanding and addressing the development challenges*. London, Sterling VA: Earthscan.
- Birkmann, J. 2011. First- and second-order adaptation to natural hazards and extreme events in the context of climate change. *Natural Hazards* 58(2): 811-840.
- Bourdieu, P. 1989. Social space and symbolic power. *Sociological Theory* 7(1): 14-25.
- Bourdieu, P. and Wacquant, L.J.D. 1992. *An invitation to reflexive sociology*. Chicago: The University of Chicago Press.
- Brooks, N.; Neil Adger, W. and Mick Kelly, P. 2005. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change* 15(2): 151-163.
- Bruns, A. and Frick, F. 2013. Coastal cities at multiple risks – The case of Accra. *Mainzer Geographische Studien* 55: 59-77.
- Budds, J. and Hinojosa, L. 2012. Restructuring and rescaling water governance in mining contexts: The co-production of waterscapes in Peru. *Water Alternatives* 5(1): 119-137.
- Bull-Kamanga, L.; Diagne, K.; Lavell, A.; Leon, E.; Lerise, F.; MacGregor, H.; Maskrey, A.; Meshack, M.; Pelling, M.; Reid, H.; Satterthwaite, D.; Songsore, J.; Westgate, K. and Yitambe, A. 2003. From everyday hazards to disasters: the accumulation of risk in urban areas. *Environment and Urbanization* 15(1): 193-204.
- Cleaver, F. 2012. *Development through bricolage: Rethinking institutions for natural resource management*. Abingdon, Oxon, New York, NY: Routledge.
- Cleaver, F.D. and De Koning, J. 2015. Furthering critical institutionalism. *International Journal of the Commons* 9(1): 1-18.
- Codjoe, S. and Issah, A. 2016. Cultural dimension and adaptation to floods in a coastal settlement and a savannah community in Ghana. *GeoJournal* 81(4): 615-624.

- Collins, T.W. 2008. The political ecology of hazard vulnerability: marginalization, facilitation and the production of differential risk to urban wildfires in Arizona's White Mountains. *Journal of Political Ecology* 15: 21-43.
- Collins, T.W. 2010. Marginalization, facilitation, and the production of unequal risk: The 2006 Paso del Norte floods. *Antipode* 42(2): 258-288.
- Cutter, S.L.; Mitchell, J.T. and Scott, M.S. 2000. Revealing the vulnerability of people and places: A case study of Georgetown County, South Carolina. *Annals of the Association of American Geographers*, 90(4): 713-737.
- Denutsui, D.; Akiti, T.T.; Osa, S.; Blankson-Arthur, S.; Tutu, A.; Buah-Kwofi, A. and Palm, N. 2012. Investigating sea water influence and water quality assessment for different purposes in densu delta wetland, Accra, Ghana. *Elixir Agriculture* 42: 6069-6073.
- Diaz-Bone, R. 2012. Elaborating the conceptual differences between conventions and institutions. *Historical Social Research / Historische Sozialforschung* 37(4): 64-75.
- Douglas, M. 1986. *How institutions think*, 1st edition. Syracuse, N.Y.: Syracuse University Press.
- Earle, L. 2014. Stepping out of the Twilight? Assessing the governance implications of land titling and regularization programmes. *International Journal of Urban and Regional Research* 38(2): 628-645.
- Etzold, B.; Jülich, S.; Keck, M.; Sakdapolrak, P.; Schmitt, T. and Zimmer, A. 2012. Doing institutions. A dialectic reading of institutions and social practices and its relevance for development geography. *Erkundung* 66(3): 185-195.
- Fohlmeister, S.; Pauleit, S.; Coly, A.; Touré, H. and Yeshitela, K. 2015. The way forward: Climate resilient cities for Africa's future. In Pauleit, S.; Coly, A.; Fohlmeister, S.; Gasparini, P.; Jørgensen, G.; Kabisch, S.; Kombe, W.J.; Lindley, S.; Simonis, I. and Yeshitela, K. (Eds), *Urban vulnerability and climate change in Africa: A multidisciplinary approach*, pp. 369-399. Cham: Springer International Publishing.
- Foucault, M. 1991. *Discipline and punish: The birth of the prison*. London: Penguin Books.
- Frick, F. 2016. Travelling Through the Densu Delta: Location, Place and Space in the Waterscape. In Niewöhner, J.; Bruns, A.; Hostert, P.; Krueger, T.; Nielsen, J.Ø.; Haberl, H.; Lauk, C.; Lutz, J. and Müller, D. (Eds), *Land use competition*, pp. 333-346. Cham: Springer International Publishing.
- Frick-Trzebitzky, F.; Baghel, R. and Bruns, A. forthcoming. Institutional bricolage and the production of vulnerability to floods in an urbanising delta in Accra. *International Journal of Disaster Risk Reduction*.
- Funder, M. and Marani, M. 2015. Local bureaucrats as bricoleurs. The everyday implementation practices of county environment officers in rural Kenya. *International Journal of the Commons* 9(1): 87-106.
- Gailing, L. 2012. Sektorale Institutionensysteme und die Governance kulturlandschaftlicher Handlungsräume. *Raumforschung und Raumordnung* 70(2): 147-160 [German].
- (Google Maps/Google Earth) 2016. *Densu Delta Protected Area: Map data © 2016 Google*.
www.google.de/maps/place/Densu+Delta+Protected+Area/@5.5301685,-0.3602193,12z/data=!4m2!3m1!1s0x0xfdfbd60260c92dd:0xc267fecfe4f53f55
- Gough, K. and Yankson, P. 2000. Land markets in African cities: The case of peri-urban Accra, Ghana. *Urban Studies* 37(13): 2485-2500.
- (Government of Ghana) 1996. *National Disaster Management Organisation Act: Act 517*.
- Grant, R. 2009. *Globalizing City: The urban and economic transformation of Accra, Ghana*: Syracuse University Press.
- Güneralp, B.; Güneralp, İ. and Liu, Y. 2015. Changing global patterns of urban exposure to flood and drought hazards. *Global Environmental Change* 31: 217-225.
- Heinrichs, D.; Krellenberg, K. and Fragkias, M. 2013. Urban responses to climate change: Theories and governance practice in cities of the Global South. *International Journal of Urban and Regional Research* 37(6): 1865-1878.
- Hetz, K. 2016. Contesting adaptation synergies: political realities in reconciling climate change adaptation with urban development in Johannesburg, South Africa: Regional environmental change. *Regional Environmental Change* 16(4): 1-12.
- Hobsbawm, E.J. 1983. Introduction: Inventing traditions. In Hobsbawm, E.J. and Ranger, T.O. (Eds), *The invention of tradition*, pp. 1-14. Cambridge: Cambridge University Press.
- Holloway, A. 2012. Disaster risk in Africa: Dynamic discourse or dysfunctional dialogue? In Bloemertz, L.; Doevenspeck, M.; Macamo, E. and Müller-Mahn, D. (Eds), *Risk and Africa: Multi-disciplinary empirical approaches*, pp. 2-23. Münster: LIT Verlag.
- Johnson, C. 2012. Bricoleur and bricolage: From metaphor to universal concept. *Paragraph* 35(3): 355-372.

- Juhola, S. and Westerhoff, L. 2011. Challenges of adaptation to climate change across multiple scales: A case study of network governance in two European countries. *Environmental Science & Policy* 14(3): 239-247.
- Karley, N.K. 2009. Flooding and physical planning in urban areas in West Africa: Situational analysis of Accra, Ghana. *Theoretical and Empirical Researches in Urban Management* 4(13): 25-41.
- Koch, F. 2011. Stadtplanung, Governance und Informalität: Vorschlag einer Typologie²⁴. In Frey, O. and Koch, F. (Eds), *Die Zukunft der Europäischen Stadt*, pp. 191-207. Wiesbaden: VS Verlag für Sozialwissenschaften [In German].
- Krüger, F.; Bankoff, G.; Cannon, T.; Orłowski, B. and Schipper, L. (Eds). 2015. *Cultures and disasters: Understanding cultural framings in disaster risk reduction*. Abingdon, Oxon, New York, NY: Routledge.
- Kuma, J. and Ashley, D. 2008. Runoff estimates into the Weija reservoir and its implications for water supply to the Accra area, Ghana. *Journal of Urban and Environmental Engineering* 2(2): 33-40.
- Macamo, E. 2013. Living effervescence: The social in African urban settings. In Obrist, B.; Arlt, V. and Macamo, E. (Eds), *Living the city in Africa: Processes of invention and intervention*, pp. 291-297. Zürich, Berlin: LIT Verlag.
- Marin, A. and Bjørklund, I. 2015. A tragedy of errors? Institutional dynamics and land tenure in Finnmark, Norway. *International Journal of the Commons* 9(1): 19-40.
- Mayntz, R. and Scharpf, F.W. 1995. Der Ansatz des akteurszentrierten Institutionalismus. In Mayntz, R. and Scharpf, F.W. (Eds), *Gesellschaftliche Selbstregulierung und politische Steuerung*, pp. 39-72. Frankfurt am Main / New York: Campus Verlag.
- McFadden, L.; Penning-Rowsell, E. and Tapsell, S. 2009. Strategic coastal flood-risk management in practice: Actors' perspectives on the integration of flood risk management in London and the Thames Estuary. *Ocean & Coastal Management* 52(12): 636-645.
- McNay, L. 2000. *Gender and agency: Reconfiguring the subject in feminist and social theory*. Cambridge, UK, Malden, Mass.: Polity Press; Blackwell Publishers.
- MESTI (Ministry of Environment, Science, Technology and Innovation) 2013. *Ghana National Climate Change Policy*. Accra, Ghana: Ministry of Environment, Science, Technology and Innovation.
- MLGRD (Ministry of Local Government and Rural Development) 2012. *Ghana National Urban Policy Action Plan*. Accra, Ghana.
- Morinville, C. and Harris, L.M. 2014. Participation, politics, and panaceas: Exploring the possibilities and limits of participatory urban water governance in Accra, Ghana. *Ecology and Society* 19(3), 12 p.
- NADMO (National Disaster Management Organisation) 2010. *National Disaster Management Plan*. Accra, Ghana [fr].
- NADMO (National Disaster Management Organisation) 2011. *Ghana National Action Plan of Disaster Risk Reduction and Climate Change Adaptation*. Accra, Ghana.
- NADMO (National Disaster Management Organisation) 2014. Personal communication. By interview. 27 June 2014. Accra, Ghana.
- Næss, L.O.; Bang, G.; Eriksen, S. and Vevatne, J. 2005. Institutional adaptation to climate change: Flood responses at the municipal level in Norway. *Global Environmental Change* 15(2): 125-138.
- Nunan, F.; Hara, M. and Onyango, P. 2015. Institutions and co-management in east African inland and Malawi fisheries: A critical perspective. *World Development* 70: 203-214.
- O'Brien, K. 2013. Global environmental change III: Closing the gap between knowledge and action. *Progress in Human Geography* 37(4): 587-596.
- Osei, J.; Nyame, F.; Armah, A.K.; Osa, S.; Dampare, S.B.; Fianko, J.R.; Adomako, D. and Bentil, N. 2010. Application of multivariate analysis for identification of pollution sources in the Densu Delta wetland in the vicinity of a landfill site in Ghana. *Journal of Water Resource and Protection* 2(12): 1020-1029.
- Osei, J.; Osa, S.; Adamako, D.; Laar, C.; Anim, A.K.; Ganyaglo, S.Y.; Nyarku, M. and Nyarko, E.S. 2011. The impact of Oblogo landfill site in Accra-Ghana on the surrounding environment. *Research Journal of Environmental and Earth Sciences* 3(6): 633-636.
- Oteng-Ababio, M.; Owusu, K. and Appeaning Addo, K. 2011. The vulnerable state of the Ghana coast: The case of Faana-Bortianor. *Jambá: Journal of Disaster Risk Studies* 3(2): 429-442.
- Pahl-Wostl, C.; Becker, G.; Knieper, C. and Sendzimir, J. 2013. How multilevel societal learning processes facilitate transformative change: A comparative case study analysis on flood management. *Ecology and Society* 18(4), 28 p.
- Parnell, S. and Walawege, R. 2011. Sub-Saharan African urbanisation and global environmental change. *Global Environmental Change* 21(S): 12-20.

- Pelling, M. 2011. *Adaptation to climate change: From resilience to transformation*. London, New York: Routledge.
- Pelling, M. and High, C. 2005. Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change* 15(4): 308-319.
- Pelling, M.; High, C.; Dearing, J. and Smith, D. 2008. Shadow spaces for social learning: A relational understanding of adaptive capacity to climate change within organisations. *Environment and Planning A* 40(4): 867-884.
- Ranganathan, M. 2014. 'Mafias' in the waterscape: Urban informality and everyday public authority in Bangalore. *Water Alternatives* 7(1): 89-105.
- Ranganathan, M. 2015. Storm drains as assemblages: The political ecology of flood risk in post-colonial Bangalore. *Antipode* 47(5): 1300-1320.
- Saldaña, J. 2013. *The coding manual for qualitative researchers*. 2nd edition. Los Angeles: SAGE.
- Schwartz, K.; Tutusaus Luque, M.; Rusca, M. and Ahlers, R. 2015. (In)formality: The meshwork of water service provisioning. *Wiley Interdisciplinary Reviews: Water* 2(1): 31-36.
- Stow, D.a.; Weeks, J.R.; Shih, H.-C.; Coulter, L.L.; Johnson, H.; Tsai, Y.-H.; Kerr, A.; Benza, M. and Mensah, F. 2016. Inter-regional pattern of urbanization in southern Ghana in the first decade of the new millennium. *Applied Geography* 71: 32-43.
- TCP (Town and Country Planning Department) 1991. *Structure Plan 2010: Accra Planning and Development Programme*. Accra, Ghana: Ministry of Local Government.
- Tetegu Elder. 2014. Personal communication. By interview. 28 June 2014. Tetegu, Ghana.
- Ubink, J.M. 2008. In the land of the chiefs: Customary law, land conflicts, and the role of the state in peri-urban Ghana. Doctoral thesis, Universiteit Leiden, Leiden.
- Ubink, J.M. and Quan, J.F. 2008. How to combine tradition and modernity? Regulating customary land management in Ghana. *Land Use Policy* 25(2): 198-213.
- (VERBI Software GmbH) 2012. *MAXQDA: The Art of Data Analysis*. Berlin: VERBI Software GmbH.
- von Benda-Beckmann, F. 2001. Legal pluralism and social justice in economic and political development. *IDS Bulletin* 32(1): 46-56.
- von Benda-Beckmann, F. 2002. Who's afraid of legal pluralism? *The Journal of Legal Pluralism and Unofficial Law* 34(47): 37-82.
- Warner, J. and Engel, K. 2014. Disaster culture matters. *Ambiente & Sociedade* 17(4): 1-8.
- Wesselink, A. 2016. Trends in flood risk management in deltas around the world: Are we going 'soft'? *International Journal of Water Governance* 3(4): 25-46.
- (Wildlife Division) 2014. Personal communication. By interview. 4 July 2014. Accra, Ghana.
- Wisner, B.; Blaikie, P.; Cannon, T. and Davis, I. 2004. *At risk: Natural hazards people's vulnerability and disasters*. 2nd edition. Oxon, New York, NY: Routledge.

II. Appendix II: Additional publications

II.1 Working paper A: Risk and Adaptation in (African) Cities

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This paper has been published in the WaterPower Working Paper Series and can be cited as: Frick, F. (2016). *Risk and Adaptation in (African) Cities* (Water Power Working Paper No. 2). Trier University. Trier.

Submitted: April 2015; published: 2016

Abstract

Both water scarcity and flood risk are increasingly turning into safety concerns for many urban dwellers and, consequently, become increasingly politicised. This development involves a reconfiguration of the academic landscape around urban risk, vulnerability and adaptation to climate change research. This paper is a literature assessment of concepts on disaster risk, vulnerability and adaptation and their applicability to the context of studying water in an African city. An overview on water-related risk in African cities is presented and concepts and respective disciplinary backgrounds reviewed. Recent debates that have emerged from the application of risk, vulnerability and adaptation concepts in research and policy practice are presented. Finally the applicability of these concepts as well as the relevance and implications of recent debates for studying water in African cities is discussed. 'Riskscape' is proposed as a conceptual frame for close and integrated analysis of water related risk in an African city.

II.1.1 Introduction

Both the fifth IPCC assessment report and the World Risk Report published in 2014 stress the particular exposure of African (urban) population to climate change and environmental hazards, including water scarcity and flooding. Freshwater systems are reported to be under increasing pressure from land use change, anthropogenic withdrawal and climate change, with wide-ranging consequences for people's well-being. As stated in the IPCC report, "[in] Africa, extreme weather and climate events including droughts and floods have significant impacts on economic sectors, natural resources, ecosystems, livelihoods, and human health." (Field et al. 2014, p. 42). Marginalised groups are particularly vulnerable to such impacts, for instance the urban poor are particularly exposed to floods (ibid. p. 47). Conventional, mostly quantitative risk assessments that underlie these two important assessments give important insights into socio-economic and environmental interactions that shape the uneven

distribution of urban water-related risk. In order to fully understand the conditions of risk and identify strategies for its reduction however it is moreover key to identify underlying processes, relations and perceptions. Various methods and concepts exist to analyse patterns and processes of risk in different disciplines, but an overarching conceptual frame bringing these together is currently lacking. The purpose of this paper is to introduce the multiple dimensions of water related risk particularly for the context of African cities, and to make the case for a conceptual frame that embraces them all.

Urban areas contain large proportions of population at risk. At the same time, adaptation to climate change can entail synergies with urban development e.g. by provision of infrastructure such as storm water drainage (Field et al. 2014). The World Risk report 2014 was published under the title “The city as a risk area” and assesses the accumulation of risk in urban areas, acknowledging that much of the urban growth that is occurring takes place in hazard-prone coastal areas and along deltas. It moreover stresses the “exposure effects of urbanization” observed within cities and neighbourhoods. As indicators for exposure, the assessment refers to parameters on the people exposed to earthquakes, storms, floods, droughts and sea level rise (number of people in cities exposed divided by the population size in a country). The assessment uses parameters on public infrastructure, housing conditions, nutrition, poverty and dependencies, and economic capacity and income distributions as indicators of susceptibility. It looks at parameters on government and authorities, disaster preparedness and early warning, medical services, social networks, and material coverage to assess coping capacity. And it applies parameters on education and research, gender equity, environmental status/ecosystem protection, adaptation strategies, and investment to indicate adaptive capacities. The combined indicators give an approximate estimate of the urban risk in each of the 171 countries assessed. Out of these, 25 Subsaharan African countries are listed among the top third of countries at risk, and none appears in the bottom third of the list. According to the index, small West African countries face the highest risks within the African continent, with Guinea-Bissau on rank 15 and Gambia on rank 19, closely followed by Niger, Benin, Chad and Cameroon (Bündnis Entwicklung Hilft 2014).

Urban water-related risks are linked to access to safe water and flooding, and result from myriad stakeholder networks and processes across multiple scales in the provision and disposal of water in cities. Tight linkages exist not only between regional development and urban water use, but also between industrial production for global markets and local availability of potable water (Budds, Hinojosa 2012; Chapagain, Tickner 2012; Kaika 2005). Urban water scarcity in cities all over the globe has recently gained attention of media and has been a political battleground in many places. It is increasingly presented, discussed and analysed as a ‘security issue’ (see for instance (Patrick 2012; Rigby 2015; Spooner 2015; Stetter et al. 2011)). In parallel to the ‘insecurities’ due to scarcity in urban water supply systems, urban ‘risk’ linked to water overabundance in urban water discharge systems is increasing at a global scale²⁴. The latter is an outcome of the disproportionate urban growth

²⁴ The terms ‘security’ and ‘risk’ are put in inverted commas to underline their constructed nature which plays a considerable role in the politicization of water and flood research, as discussed for instance by Weichselgartner 2002; Stetter et al. 2011; Brauch et al. 2011.

in low-lying, coastal areas that naturally inundate on a regular basis, and increasingly so under the influence of climate change (McGranahan et al. 2007), modification of river flows such as in dams and river straightening (Kruse 2010), and urban development without adequate drainage infrastructure, particularly in the Global South (Few 2003). In addition to that, urban uses such as land use change, drainage and sanitation interact with the natural protection provided by ecosystems, including flood retention and groundwater production in coastal areas (Meltzer 1998; Xue et al. 2004). This interaction is influenced by impacts from climate change, such as changes in rainfall patterns and sea level rise.

Both water scarcity and flood risk are thus turning into safety concerns for many urban dwellers and, consequently, become increasingly politicised. This development involves a reconfiguration of the academic landscape around urban risk, vulnerability and adaptation to climate change research, as we will see in the following subsections. Before turning to a review of concepts and respective disciplinary backgrounds however, an overview on water-related risk in African cities is presented. The overview of concepts and how they have been developed in different disciplines is followed by a presentation of recent debates that have emerged from the application of risk, vulnerability and adaptation concepts in research and policy practice. Finally the applicability of these concepts as well as the relevance and implications of recent debates for studying water in African cities is discussed. ‘Riskscape’ is proposed as a conceptual frame for close and integrated analysis of water related risk in an African city.

II.1.2 Water related risk in African cities

Hoekstra et al. in their assessment of water availability in over 400 river basins across the world conclude “with severe water scarcity occurring at least one month per year in close to one half of the river basins included in this study, our results underline the critical nature of water shortages around the world.” (Hoekstra et al. 2012, p. 7). A similarly alarming message is sent in a World Bank report on climate change and disaster risk in cities stating that water shortages and water borne diseases are major impacts from climate change and environmental hazards on urban residents (The World Bank 2011). At the same time flooding is increasingly putting urban residents at risk as floods occur more frequently, partly as a result of climate change, and urbanisation takes place at disproportionate rate in coastal areas that naturally inundate (Few 2003; McGranahan et al. 2007). Four types of urban flooding can be distinguished, namely drainage overflow, large river floods, coastal floods, and flooding from small streams in built-up areas (Douglas et al. 2008).

In their assessment of water scarcity in Africa, Vörösmarty et al suggest infrastructure to be a major solution to water scarcity in Africa as the latter is an issue of distribution rather than availability (Vörösmarty et al. 2005). Basic infrastructure is also a central component in the creation of flood risk in urban Africa as a study conducted by the NGO Action Aid found. According to the authors, “flooding is one of the major factors that prevents Africa’s growing population of city dwellers from escaping poverty“ (Action Aid 2006, p. 7). Based on the same study Bhattacharya and Lamond (2011) identified two major causes of flooding in

African cities, firstly coastal inundation, storm surge and sea level rise, and secondly intense rainfalls. Both types of events are expected to intensify in the context of climate change (ibid.) which is expected to be felt stronger and earlier in West Africa than elsewhere (Niang et al. 2014, p. 8). Urbanisation, land use change and drainage infrastructure design and management influence the type of floods affecting cities, which range from frequent localised floods especially in slums to seasonal inundations and flash floods (Bhattacharya, Lamond 2011).

The West-African coastal strip between Accra and Lagos is severely affected by the myriad changes in the urban water system. In Accra, urban water supply is about to collapse - due to a leaky supply system and exploding prices on the informal market large parts of the population are already facing the so-called 'water crisis'. Coastal flooding is becoming more and more frequent as a consequence of an overstretched drainage system, on-going soil sealing and solid waste blocking sewers, as well as coastal erosion and sea level rise, the latter triggered by climate change (Appeaning Addo, Adeyemi 2013b). The impacts of floods are particularly devastating in informal settlements where in addition to the lack of infrastructure a high population density promotes the spreading of infectious diseases (Adank et al. 2011, 2011; Rain et al. 2011).

The fact that water related risks are created by politicised urban planning and infrastructure development and affect the poor in particular is not specific to Africa. What is special about water-related risk in African cities is that in the context of scattered data e.g. on climate change impacts and demographics and little knowledge on adaptive capacities there is a particular danger of international development organisations victimising the urban poor instead of targeting their real needs (Adelekan et al. 2015; Douglas et al. 2008). Accra is a city where multiple case studies have been conducted, highlighting the differential vulnerability (Aboagye 2012), interaction of risk from multiple environmental hazards (Appeaning Addo 2013; Appeaning Addo, Adeyemi 2013a; Oteng-Ababio 2013; Stoler et al. 2012), and coping strategies (Abdallah Imam, Tamimu 2015; Addo 2015) in specific neighbourhoods. Obtaining a general understanding of the creation and mitigation of water-related risk in Accra from these studies is however hindered by the lack of an overarching conceptual frame.

II.1.3 Key concepts and their evolution in different disciplines

In this section an overview on concepts that are important for analysing risk and adaptation in African cities is presented as a basis for the riskscape framework. It is followed by a comparison of these concepts as they have evolved and are used in different research communities.

As indicated in the introduction, concepts around disaster risk and climate change have not only evolved within disciplinary context, but moreover have been reframed from various sciences and research fields (Cardona 2004). A mismatch in terminology persists for instance in the definitions of *mitigation* and *adaptation* in disaster risk versus climate change research: within the former *mitigation* is used to refer to the circumvention of disasters by means of

protection (e.g. evacuation) (Lavell, 2011). *Adaptation* in this context means the prevention of disastrous impacts of hazards, e.g. by migration (Wisner, 2004). By contrast in the field of climate change research, *mitigation* is used to describe all measures that contribute to the reduction of the greenhouse effect (i.e. above all the reduction of greenhouse gas emissions). *Adaptation* includes all measures to reduce the impacts from climate change on society and ecosystems – including those that would be considered *mitigation* in disaster risk management (Birkmann, Teichman 2010).

The fifth IPCC report has made efforts to reconcile and integrate the various definitions and concepts on the table. According to this synthesis which is now widely accepted,

risk is the “potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard” (Agard et al. 2014, p. 1772);

vulnerability is the “propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt” (Agard et al. 2014, p. 1775), and

adaptation is the “process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. Incremental adaptation [refers to adaptation] actions where the central aim is to maintain the essence and integrity of a system or process at a given scale. Transformational adaptation [is the adaptation] that changes the fundamental attributes of a system in response to climate and its effects” (Agard et al. 2014, p. 1758).

These concepts are highly relevant for studying water in an African city because they draw out the intrinsic link between changes in the physical environment, including water, on the one hand and societal background conditions on the other hand that contribute to the increasing threats to safety and development in many African cities. When applying them however, an understanding of disciplinary backgrounds and disputes is key to avoid interdisciplinary misunderstandings, as the following overview shows.

Natural sciences

In the natural sciences (environmental sciences), risk was first understood to be the probability of a natural hazardous event such as an earthquake or hurricane to occur. The probability of a hazard and hazard risk was thus defined to be the same thing. This changed towards the 1990s when the likelihood of damage from a hazard was included in the definition of risk, and what had formerly been defined a risk became known as a hazard or threat. In this line of research the causes of a natural hazard are understood to be exclusively environmental. Damages or impacts are defined in terms of quantifiable material loss and demographic characteristics, i.e. exposure as the amount of people and material in a hazard-

prone area. According to this definition Risk equals to Hazard x Exposure. This conceptualisation of risk is influenced and applied in the insurance industry (Cardona 2004).

Applied sciences

In the applied sciences such as environmental planning, urban planning, geography, and others the concept of vulnerability gained attention to complement the above definition. Vulnerability can broadly be defined as a potential for loss (Cutter 1996). It incorporates the potential relative impact into the risk equation under the premise that an affluent person is less likely to experience severe damage from a hazard striking than his poor neighbour, even though his material loss in absolute terms might be greater (Cardona 2004). The equation is thus broadened to Risk = Hazard x Exposure x Vulnerability. A concept increasingly used in DRR and planning research and practice is that of resilience which aims at integrating environmental and social management. Resilience, derived from the concept used in ecology where it describes the ability of ecosystems to bounce back, has been redefined within sustainability science (see subsection below) as “the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop” (Moberg, Simonsen), also (Turner II 2010). In the context of risk and environmental hazard, it refers to the ability of structures and people to withstand disturbances such as floods (Adger et al. 2005). It has become the overall goal of the UN framework for disaster risk reduction (UNISDR 2015).

The concept of ‘*riskscapes*’ that has been developed by geographers describes the environmental injustices causing and caused by the spatial interaction of biophysical and social vulnerability (Boruff et al. 2005; Cutter et al. 2000). It facilitates the spatial representation of biophysical and socioeconomic risk and vulnerability factors and thereby importantly expands the technical view of disaster risk representations that has long been dominating natural and applied sciences. However, because this definition relies on quantifiable indicators and static data the concept is not apt to capture all the dimensions involved in risk creation, as identified in the literature from social and sustainability sciences (Müller-Mahn & Everts, 2013).

Social sciences

In the social sciences concepts around risk and adaptation have evolved in disaster studies which in the mid 20th century primarily studied the way people respond to emergencies, with no particular focus on environmental hazards. Disaster studies were complemented by critical responses to the natural and applied sciences approaches to risk research since the 1970s (Cardona 2004). They turned to constructivist conceptions of socio-environmental risk and vulnerability, stressing that vulnerability is not a predetermined state but defined in social systems and power constellations (Wisner, 2004). Cutter further distinguishes between vulnerability as a pre-existing condition, as tempered response, and as hazard of place (Cutter 1996). A decisive and often underestimated component of the adaptive capacity of social systems is the perception of threat and risk which is constructed in social networks and power constellations (Beck, 2007; Bourdieu, 1983; Castree, 2001; Müller-Mahn, 2007). An additional concept brought in from the social sciences is that of *coping* with disasters which

is achieved by short-term action in anticipation of or response to hazards, without taking into account long-term effects, processes or feed-back loops (Birkmann, 2011; Pelling, 2011: 37-39; Wisner, 2004).

Critical social scientists emphasise that the separate evolution of concepts on risk and vulnerability in urban, development and risk/hazard research has led to a fragmented understanding. Specifically the links between poverty and vulnerability, urban development and risk, and small and large scale hazards are underestimated (Bull-Kamanga 2003). Hazard research has long focused on assessing risk (understood as the probability of an extreme event to occur) and exposure, rather than vulnerability. Urban specialists have been most concerned with building resilience, and development studies have concentrated on poverty reduction (Bull-Kamanga 2003). Yet disasters in urban areas demonstrate that exposure and susceptibility to urban risks is formed by patterns of urban development, and conditions of high exposure and susceptibility tend to correlate with conditions of socioeconomic inequality and poverty. In addition, poverty reduces the ability to prepare for, cope with and adapt to floods and other hazards, and thus negatively affects resilience (Wisner, Luce 1993).

Holistic Approaches and Sustainability Sciences

In the context of global environmental change, sustainability science has emerged as a separate field, “building toward an understanding of the human–environment condition with the dual objectives of meeting the needs of society while sustaining the life support systems of the planet” (Turner et al. 2003, p. 8074).

Vulnerability and resilience Vulnerability is a concept that has been addressed within different disciplines, although often implicitly. It has been made more explicit in recent years, and has moreover been reframed in the context of climate change adaptation and sustainability science as these have emerged as separate fields of research (Birkmann et al. 2013). From these holistic approaches, vulnerability can be summarised as the product of exposure and coping and adaptation capacity of a city, a group or a household (Satterthwaite et al., 2009: 20; Turner, 2010). Considering the duration and unpredictability of change in coastal cities, it is evident that vulnerability cannot be reduced by individual short-term measures to build coping and adaptation capacities or to reduce exposure. Instead, an iterative course of action is required. This is implied in the concept of *resilience* of social-ecological systems (SES): The concept derived from systems theory and ecology and developed in sustainability science anticipates an (urban) development that constantly adapts to the carrying capacity of the SES (Turner et al., 2010). The carrying capacity is defined by the stability of the respective system (Pelling, 2011: 42). Here *stability* is not referring to the maintenance or reproduction of a constant status, but rather means the natural change of the basic state (Ernstson et al., 2010; Pelling, 2011).

Adaptation According to (eco)systems theory, the complex relations of ecological processes (e.g. natural flood retention) and social processes (e.g. managed urbanisation) create a ‘social-ecological system’ where the mutual influences of social and ecological processes are best understood and managed in an ‘adaptive comanagement process’ in order to deal with the complexity of cross-scale dynamics and integrated system feedbacks in social-ecological

linkages (Folke 2006; Olsson et al. 2004, p. 87). The adaptation literature has evolved particularly in climate change research where it entails adaptation to a variety of climatic disturbances and changes (Birkmann 2011). Pelling (2011) adds two further dimensions to the concept of adaptation from a holistic approach: while Adaptation towards resilience aims at the maintenance of functions within a changing environment, adaptation towards transition aims at a comprehensive change of formal planning and governance structures to reduce injustices. Even more comprehensive is adaptation towards transformation that results in a fundamental rearrangement of development mechanisms and structures (ibid.: 50-51).

Adaptive capacity Adaptive capacity refers to the ability of a system to adjust practices and modify processes in response to experienced or expected change in socio-economic and ecological conditions in order to maintain key system functions (Brooks et al. 2005; Folke 2006; Pahl-wostl 2009; Pahl-wostl et al. 2010). This ability is the outcome of the combined (material and immaterial) resources or capital available for implementation of adaptive action (Adger, Vincent 2005; Pelling 2011). Adaptive action “drives scope for action, which in turn can foster or hinder future capacity to act” (Pelling 2011, p. 21), and can have unintended consequences for the distribution of adaptive capacity at different scales (ibid.). Understanding patterns and processes in the distribution of adaptive capacity is key in the analysis of riskscape. This presents a particular challenge in management of multi-level governance regimes such as water sheds (Pahl-wostl et al. 2010). The holder of adaptive capacity (i.e. the system) can be any socio-spatial entity from an individual to a global governance regime (Adger, Vincent 2005). Adaptive capacity is influenced by numerous underlying social factors such as social relationships, social capital (Pelling, High 2005), processes of social learning (Pahl-wostl 2009; Pahl-wostl et al. 2010), the system’s complexity and diversity (Pahl-wostl 2009), its structural design (Pahl-wostl et al. 2010) and resilience (Folke 2006), institutions, availability of information (Pelling 2011), governance, civil and political rights, and literacy (Brooks et al. 2005), amongst others.

Table 1 Influential scholars, typical research questions and key concepts on risk, vulnerability and adaptation used in different research fields. Own compilation based on data from (Wisner, Luce 1993; Cardona 2004; Bull-Kamanga 2003)

Natural sciences	
Hazard research	Influential scholars: Frank Press Research questions: What are the natural/ environmental triggers that create hazards? Key concepts: Rational behaviour; risk as a complex concept, combining objectivist and constructivist views, vulnerability as an outcome of exposure, fragility and lack of resilience
Applied sciences	
Climate Change / Adaptation research	Influential scholars: Mark Pelling, Neil Adger Research questions: How do people adapt to climate change? Key concepts: vulnerability, coping, adaptation, adaptive capacity
Urban research	Influential scholars: Christine Wamsler, Cassidy Johnson, Patricia Romero-Lankao Research questions: How can disaster risk reduction be mainstreamed into urban planning? Key concepts: Focus on everyday-hazards and resilience
Disaster studies	Influential scholars: Susan Cutter Research questions: What are human responses to hazards? focus on reducing vulnerability Key concepts: vulnerability, risk
Social Sciences	
Development studies	Influential scholars: Robert Chambers, Piers Blaikie, Harold Brookfield Key concepts: Climate change, adaptation, mitigation, governance, livelihoods
Risk research	Influential scholars: Ben Wisner, Terry Cannon, Piers Blaikie, Ian Davis Research questions: Who is marginal in society? When? In what kind of situations? Key concepts: Vulnerability (defined as the product of susceptibility and coping), marginalization, realist vs deconstructive approaches, Pressure and Release model (PAR), livelihoods, coping

Vulnerability research	Influential scholars: Jörn Birkmann Research questions: What are the drivers of vulnerability? Key concepts: resilience, marginality, susceptibility, adaptability, fragility, and risk
Holistic approaches	
Global change research / sustainability science	Influential scholars: B.L. Turner, Claudia Pahl Wostl Research questions: Who and what are vulnerable to the multiple environmental and human changes underway, and where? How are these changes and their consequences attenuated or amplified by different human and environmental conditions? What can be done to reduce vulnerability to change? How may more resilient and adaptive communities and societies be built? Key concepts: Vulnerability (defined as the product of exposure, sensitivity, resilience), coupled human-environment systems, resilience, governance, risk as a complex concept, combining objectivist and constructivist views, vulnerability as an outcome of exposure, fragility and lack of resilience

II.1.4 Applying the concepts – trends and debates

While disciplinary divides within vulnerability research are beginning to be bridged, a further gap remains in practices of environmental management and development planning. Vulnerability is “recognised by scientists as a key factor of risk; but not yet acknowledged by urban planners and decisionmakers” (Müller 2012, p. 193). Next to ignorance, there are further underlying reasons that hamper vulnerability reduction in practice are for instance that decision-makers may also have a stake in reproducing conditions of vulnerability in order to maintain power constellations (Pelling, Dill 2010). Traditional, indicator-based, vulnerability assessments tend towards an over-simplification of the multi-dimensional complexity of vulnerability (Barroca et al. 2006). Within different research communities (namely disaster risk research and sustainability science), it is increasingly being acknowledged that taking into account the myriad aspects of vulnerability, addressing the multiple dimensions of it and conceiving vulnerability as a process rather than a state appears most appropriate (Birkmann 2007; Turner et al. 2003).

Patterns of risk and hazards are produced in social and bio-physical (material) processes, including interactions between the two (Cutter et al. 2000). These urban processes are “infused with relations of power” that create inequalities within these patterns of risk and hazard (Cook, Swyngedouw 2012, p. 1967). Yet risk and vulnerability research in the natural and applied sciences have traditionally focused on understanding the patterns, and have largely overseen the role of practices in their creation (Cutter and Solecki 1996). So have hydrologists, who traditionally assess flood risks by measuring discharge and flow. In combination with meteorological data, these variables were long perceived as sufficient to design structural measures in order to prevent flooding.

A pattern of urban flood risk that is commonly described in traditional flood risk assessments has a spatial dimension in terms of the areas of low elevation and nearby rivers or seashores are most at risk, as well as a temporal dimension describing the frequency at which extreme floods occur (cf Fleming and Frost 2002). Structural measures are designed to prevent a flood extreme that has a probability of occurring once in 100 years (Rickard 2002).

Engineered solutions however often didn’t anticipate the vast climatic and land use changes that have contributed to an accelerated pace at which extreme floods now affect urban

dwellers (Fleming and Frost 2002)²⁵. Rather than those responsible for flood anticipation and prevention, the ‘disaster people’, i.e. international humanitarian aid organisations such as the Red Cross, national authorities in charge of disaster relief, and often the army are in charge when extreme events that hadn’t been adequately prepared for, occur (Wamsler 2006). Large sums of money are generally made available in this stage. Several weeks later, emergency relief organisations withdraw their support, and local and regional governments are left to manage long-term impacts, rebuild and strengthen structures to prevent future flooding. The mismatch in resource allocation is thus linked to the disintegrated work of urban planners, development and disaster professionals, operating at different spatial and temporal scales (Wamsler 2006) reinforcing the uneven distribution of risks. Adaptation to climate change adds as another separate field of practice and research as the institutional division into UNFCCC and UNISDR in the UN system illustrates.

As socio-economic and urban development shape adaptive capacity, vulnerability and resilience, and vice versa, there is thus a strong link between urban studies, disaster risk studies, climate change studies, development studies, and the respective communities of professional practice. Mainstreaming of adaptation and disaster risk reduction into development planning is pushed for by international organisations but difficult to put in practice (Wamsler 2006). To be more specific, a major challenge in translating urban adaptation and resilience into practice is the ‘spatial and temporal inconsistency’ in both planned and unplanned development. What appears most beneficial in one place at a given time such as housing development along a river can trigger risks elsewhere, such as water shortage or pollution downstream (Greiving 2006). A second challenge is the lack of contextualisation of adaptation measures in practice, as Johnson (2012) points out: adaptation measures in the built environment are informed by either the location approach, i.e. land use planning where hazard-prone areas are designated as un-suited for construction, or by the design approach, i.e. building codes to ensure that risks are reduced and not enhanced by constructions in hazard-prone areas. Although the former approach has limited effects in rapidly growing cities where informal settlements are spread across hazard-prone areas, it is widely adopted, also in cities with large informal growth. In informal settlements, the design approach allows for incremental improvements and is considered most fruitful when it supports ongoing coping strategies (Johnson 2012). Similarly Briceño (2015) emphasises the lack of contextualisation of current disaster risk reduction strategies.

The need to integrate the above mentioned strands of research and practice has been increasingly stressed in research and governance frames, and yet concrete framings of how to integrate disaster risk reduction (DRR), urban settlement planning and development are lacking (Wamsler 2009). There is moreover a notable mismatch in scales of knowledge and concepts applied (ibid.). The complex interaction of factors that contribute to (coastal) urban vulnerability demands for action at multiple levels to prevent disasters (Dodman, Mitlin 2011; Pelling 2010). Yet incompatible working priorities, concepts and tools as well as competition for funds among practitioners in disaster risk management, development and

²⁵ Whether the frequency of extreme floods has increased over the past century is disputed, but without doubt the number of people affected by floods has increased...

urban planning that result from a historic and bureaucratic divide between these disciplines further hinder their integration (Johnson 2012; Wamsler 2006). The disintegration of these areas of practice even contributes to enhancing the vulnerability and exposure of the urban poor to hazards (Wamsler 2006, 2009). In addition, traditional concepts are challenged by unprecedented processes of global change, importantly climate change, and the informal form of urban growth in cities of the global South.

Regardless of an increasing alert of risk, vulnerability and adaptation scholars to the need to integrate these fields of research as well as sustainable development, future UN agendas on these topical issues are discussed at three different conferences in 2015. At the Third World Conference on Disaster Risk Reduction in Sendai (March 2015) voluntary agreements were sought to overcome current challenges – including the disintegration of disaster risk reduction in all policy fields, lack of awareness on disaster risk, and limited attention to social vulnerabilities (Briceño 2015). In anticipation of the upcoming conferences on Financing for Development (July 2015 in Addis Abeba), the Sustainable Development Summit (September 2015 in New York) and the Framework Convention on Climate Change (UNFCCC; December 2015 in Paris) the negotiations were highly politicised and its unambitious outcomes caused frustration among participants (Ben Wisner 2015; IISD 2015). The separation of discussions in these separate conferences has been criticised by Kelman et al (2015) as a lost opportunity to join efforts in pursuing a common goal, which is currently inhibited by tribalism and vested interests. The authors' conceptualisation of adaptation to climate change sitting within disaster risk reduction which itself forms part of sustainable development would, they argue, overcome these hindrances. Along the same lines it can be argued that the UN Habitat III conference taking place in 2016 with the objective of launching a new urban agenda is duplicating efforts towards objectives that are closely linked to those of the 2015 conferences, and creating another 'tribe' competing for international funds.

II.1.5 Towards an integrative analytical framework

Current challenges in analysing water-related risk and adaptation in African cities

Research on African cities illustrates the need for a shift towards a more integrated framing of urban risk and adaptation that is grounded on contextual understanding rather than funding mechanisms.

Environmental catastrophes such as East African droughts have long shaped the (Western) view of disaster risk in Africa within the concepts of risk, exposure and vulnerability as described above under natural and applied sciences' approaches. These views have led to a number of misconceptions about risk in Africa, namely that disaster risk in Africa a) is caused by natural hazards, b) mostly affects rural areas, and c) requires international intervention (Holloway 2012) quoting Wisner and Pelling). However, more recent research on risk in urban Africa shows the complexity of risks urban dwellers are facing, from both natural and socio-economic hazards, and on a wide continuum from every day small onset

disasters to rare extreme events (Benouar et al. 2012; Dodman et al. 2015; Holloway 2012). In the summary of a collection of contributions on disaster risk in urban Africa, Benouar et al (2012) conclude with a long list of urban environmental hazards which influence one another: “The case studies demonstrate that daily life in urban Africa is rife with dangers: inadequate sanitation, shack fire, violence and crime, traffic accidents and industrial pollution. Episodically there may also be building collapses, large explosions, epidemics, floods or storms. However, national policy-makers, researchers and city managers still tend to look at risk from the point of view of their specialities and give special attention to more conspicuous risk” (Benouar et al. 2012, pp. 200–201).

The same body of literature emphasises the key role of local governments in addressing urban risk which are at the same time often understaffed, underequipped and underpaid in African cities. Conventional views on disaster risk in Africa moreover underemphasise the differential vulnerability of urban dwellers in Africa of which roughly 80% live in informal or slum settlements (Dodman et al. 2015). These differential vulnerabilities are intertwined with the global context of African cities. For instance Nigerian and overseas investment in housing development in Accra, Ghana, is pushing land and housing prices to levels that are out of reach for local residents who are as a result forced to live in hazardous conditions (cf BBC article February 2015; Appeaning Addo 2015). These circumstances lead to conditions where affected residents are able to cope, but not to adapt to water-related risks or build up resilience (Action Aid 2006).

The rural bias in development and disaster research (on Africa) and the haphazard development of cities in recent decades has stood in the way of the development of an African urban theory. Western urban development models hardly apply, but alternative models that might contribute to a better understanding of differential vulnerabilities and adaptive capacities are rare. An exception is the research conducted at the African Centre for Cities chaired by Edgar Pieterse (University of Cape Town 2015).

In summary, the challenges in studying risk and adaptation are that while concepts have been developed independently in different research areas, they cannot be separated from issues of socio-economic (urban) development in practice. An overarching conceptual frame is lacking that is applicable both in theory and in practice, and which could (and should) inform an institutional redesign across all scales. Research/ experience from African cities demonstrates the urgent need for a framing that allows to conduct context-specific assessments of risk, vulnerability and adaptive capacity, a premise for the development of appropriate strategies. Next to paying attention to differential vulnerabilities according to socioeconomic differences / inequalities, it becomes evident from research on African cities that risks cannot be looked at in isolation. Hence in the study of water in an African city it is imperative to understand the distribution of environmental hazards such as earthquakes and storms, technological risks such as fires, as well as socioeconomic and health risks to understand when and where a flood becomes a hazard, and shortage of clean water becomes an issue of water insecurity.

The following discussion of a floodriskscape is an attempt to conceptualise risk and adaptation in a holistic manner that is suited to studying water in an African city.

Analysing power in riskscapes

The notion of ‘landscape’ allows conceptualising the material as well as the social, cultural and cognitive processes that create visible as well as invisible patterns of form and function in a spatial unit (Cosgrove 1990; Terkenli 2001), De Groot 2006, Tschakert et al. 2013). Derived from the concept of landscape, ‘Riskscape’ or ‘Hazardscape’ are concepts that encompass both the processes that produce risks / hazards, and their spatial distribution. Mustafa (2005, p. 22) defines hazardscapes as "simultaneously, an analytical way of seeing, which asserts power, and a social space where the gaze of power is contested and struggled against to produce the lived reality of hazardous places" (Mustafa 2005, p. 22). The term ‘hazardscape’ is sometimes used interchangeably with ‘riskscape’ (cf Cutter et al. 2000). However, as Khan and Crozier point out, they are distinct from one another as "hazardscape depicts the current situation of hazards at a place, [whereas] riskscape illustrates the potential damage" (Khan, Crozier 2009; Morello-Frosch, Shenassa 2006). This distinction becomes clear when contrasting the definitions of ‘hazard’ and ‘risk’, as discussed above. Hence while hazardscape focuses on the processes that lead to (uneven) patterns of exposure to disasters (i.e. hazard probability x exposure), riskscape is more concerned with the combined generation of vulnerability and hazard exposure in the “interplay of community and individual [socioeconomic] stressors or buffers” (Morello-Frosch, Shenassa 2006, p. 1151). Dynamics of gender, politics, religion, socioeconomics, etc. tend to create riskscapes in which disadvantaged groups are both most exposed and most vulnerable to environmental hazards (Mair et al. 2011).

Time, space, and power are all key dimensions in the analysis of riskscapes (Khan, Crozier 2009; Mair et al. 2011; Morello-Frosch, Shenassa 2006). Cutter et al. (2000) stress the role of socioeconomic and biophysical vulnerability in the assessment of riskscapes, which they identify by spatially intersecting indicators of vulnerability and exposure. The outcome of this method is a map that shows an important dimension of riskscape (the spatial dimension), but is less apt to identify temporal processes and the influence of power (Pelling, pers. comm.). Following Müller-Mahn and Everts’ definition of riskscapes as “practised and constituted in practice” (2013: 26) which are “interwoven and need to be analysed in relation rather than in isolation” (ibid.: 27-28), an appropriate analytical frame moreover needs to take into account the role of agency, and spatial dynamics. The authors’ approach of defining and analysing riskscapes by agent-based notions of risk and practices is much more flexible in terms of time and scale, but does not address issues of power. The literature review above has hinted to the role of power relations in risk creation through international conventions, bodies and funding, through national and local governments, and through academic framings. We therefore argue that the riskscape concept needs even further enhancement to fully embrace power relations. Social capital, understood as relations of trust, reciprocity and exchange (Adger 2003) and critical institutionalism, looking into the role of politics in institution-building (Hall et al. 2013), are lenses we propose to add to get an improved understanding on how patterns of risk and adaptation to water-related risk are created.

II.1.6 References

- Abdallah Imam, Haruna; Tamimu, Hardy (2015): 'Life beyond the Walls of my Hometown': Social Safety Networks as a Coping Strategy for Northern Migrants in Accra. In *Asian Journal of Social sciences and Management Studies* 2 (1), pp. 25–43.
- Aboagye, Da Costa (2012): Living with Familiar Hazards: Flood Experiences and Human Vulnerability in Accra, Ghana. In *Articulo - Journal of Urban Research* Briefings (2012). Available online at <http://articulo.revues.org/2110> ; DOI :
- Action Aid (2006): Climate change, urban flooding and the rights of the urban poor in Africa. Key findings from six African cities. Action Aid. London. Available online at http://www.actionaid.org/sites/files/actionaid/climate_change_urban_flooding_and_the_rights_of_the_urban_poor_in_africa.pdf, checked on 2/24/2015.
- Adank, M.; Darteh, B.; Moriarty, P.; Osei-tutu, H.; van Rooijen, D.; Assan, D. (2011): Towards integrated urban water management in the Greater Accra Metropolitan Area. Current status and strategic directions for the future. Accra, Ghana: SWITCH/RCN Ghana. Available online at <http://switchurbanwater.lboro.ac.uk/outputs>.
- Addo, I. A. (2015): Assessing residential satisfaction among low income households in multi-habited dwellings in selected low income communities in Accra. In *Urban Studies*. DOI: 10.1177/0042098015571055.
- Adelekan, I. O.; Johnson, C.; Manda, M.; Matyas, D.; Mberu, B. U.; Parnell, S. et al. (2015): Disaster risk and its reduction: an agenda for urban Africa. In *IDPR* 37 (1), pp. 33–43, checked on 3/4/2015.
- Adger, W. N. (2003): Social Capital, Collective Action, and Adaptation to Climate Change. In *Economic Geography* 79 (4), pp. 387–404, checked on 3/23/2015.
- Adger, W. Neil; Hughes, Terry P.; Folke, Carl; Carpenter, Stephen R.; Rockström, Johan (2005): Social-ecological resilience to coastal disasters. In *Science (New York, N.Y.)* 309 (5737), pp. 1036–1039. DOI: 10.1126/science.1112122.
- Adger, W. Neil; Vincent, Katharine (2005): Uncertainty in adaptive capacity. In *Comptes Rendus Geoscience* 337 (4), pp. 399–410. DOI: 10.1016/j.crte.2004.11.004.
- University of Cape Town (2015): African Centre for Cities. About. Cape Town. Available online at <http://www.africancentreforcities.net/about/>, checked on 3/18/2015.
- Agard, J.; E.L.F. Schipper; J. Birkmann; M. Campos; C. Dubeux et al. (2014): Annex II - Glossary. In Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea et al. (Eds.): IPCC 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, New York: Cambridge University Press, pp. 1757–1776, checked on 2/28/2015.
- Appeaning Addo, K.; Adeyemi, M. (2013a): Assessing the impact of sea-level rise on a vulnerable coastal community in Accra, Ghana. In *Jàmá: Journal of Disaster Risk Studies* 5 (1), pp. 1–8.
- Appeaning Addo, Kwasi (2013): Assessing coastal vulnerability index to climate change: the case of Accra-Ghana. Proceedings 12th International Coastal Symposium (Plymouth, England). In *Journal of Coastal Research* Special Issue (65), pp. 1892–1897.
- Appeaning Addo, Kwasi; Adeyemi, Michael (2013b): Assessing the impact of sea-level rise on a vulnerable coastal community in Accra, Ghana. In *Jàmá: Journal of Disaster Risk Studies* 5 (1). DOI: 10.4102/jamba.v5i1.60.
- Barroca, B.; Bernardara, P.; Mouchel, J. M.; Hubert, G. (2006): Indicators for identification of urban flooding vulnerability. In *Natural Hazards and Earth System Science* 6 (4), pp. 553–561. DOI: 10.5194/nhess-6-553-2006.
- Ben Wisner (2015): Lies, damned lies, and statistics. GNDR. Available online at <http://www.gndr.org/news/events/wcdr2015/item/1370-lies-damned-lies-and-statistics.html>, updated on 3/18/2015.
- Benouar, Djillali; Diagne, Khady; Kiunsi, Robert; Songsore, Jacob; Pelling, Mark; Pharoah, Robyn et al. (2012): Towards a Safer Urban Future: Conclusions and Recommendations. In Mark Pelling, Ben Wisner (Eds.): Disaster risk reduction: Cases from urban Africa: Routledge, checked on 12/15/2014.
- Bhattacharya, N.; Lamond, J. (2011): A review of urban flood risk situation in African growing economies. In : Urban flood risk management approaches to enhance resilience of communities. Urban flood risk management approaches to enhance resilience of communities,. Graz, Austria, 21.-23. September 2011. Graz, Austria: UFRIM, checked on 12/11/2014.
- Birkmann, J. (2007): Risk and vulnerability indicators at different scales: Applicability, usefulness and policy implications. In *Environmental Hazards* 7 (1), pp. 20–31. DOI: 10.1016/j.envhaz.2007.04.002.

- Birkmann, Joern; Cutter, Susan L.; Rothman, Dale S.; Welle, Torsten; Garschagen, Matthias; van Ruijven, Bas et al. (2013): Scenarios for vulnerability: opportunities and constraints in the context of climate change and disaster risk. In *Climatic Change*. DOI: 10.1007/s10584-013-0913-2.
- Birkmann, Jörn (2011): First- and second-order adaptation to natural hazards and extreme events in the context of climate change. In *Natural Hazards* 58 (2), pp. 811–840. DOI: 10.1007/s11069-011-9806-8.
- Birkmann, Jörn; Teichman, Korinna von (2010): Integrating disaster risk reduction and climate change adaptation: key challenges—scales, knowledge, and norms. In *Sustainability Science* 5 (2), pp. 171–184. DOI: 10.1007/s11625-010-0108-y.
- Boruff, Bryan J.; Emrich, Christopher; Cutter, Susan L. (2005): Erosion Hazard Vulnerability of US Coastal Counties. In *Journal of Coastal Research* 215, pp. 932–942. DOI: 10.2112/04-0172.1.
- Brauch, Hans Günter; Oswald Spring, Úrsula; Mesjasz, Czeslaw; Grin, John; Kameri-Mbote, Patricia; Chourou, Béchir et al. (Eds.) (2011): *Coping with Global Environmental Change, Disasters and Security*. Berlin, Heidelberg: Springer Berlin Heidelberg (Hexagon Series on Human and Environmental Security and Peace).
- Briceño, Sálvano (2015): Looking Back and Beyond Sendai: 25 Years of International Policy Experience on Disaster Risk Reduction. In *Int J Disaster Risk Sci*. DOI: 10.1007/s13753-015-0040-y.
- Brooks, Nick; Neil Adger, W.; Mick Kelly, P. (2005): The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. In *Global Environmental Change* 15 (2), pp. 151–163. DOI: 10.1016/j.gloenvcha.2004.12.006.
- Budds, Jessica; Hinojosa, Leonith (2012): Restructuring and Rescaling Water Governance in Mining Contexts: The Co-Production of Waterscapes in Peru. In *Water Alternatives* 5 (1), pp. 119–137, checked on 12/17/2014.
- Bull-Kamanga, L. (2003): From everyday hazards to disasters: the accumulation of risk in urban areas. In *Environment and Urbanization* 15 (1), pp. 193–204. DOI: 10.1177/095624780301500109.
- Bündnis Entwicklung Hilft (2014): *WorldRiskReport 2014*. With assistance of United Nations University. Bündnis Entwicklung Hilft (4). Available online at www.WorldRiskReport.org, checked on 3/18/2015.
- Cardona, Omar D. (2004): The Need for Rethinking the Concepts of Vulnerability and Risk from a Holistic Perspective: A Necessary Review and Criticism for Effective Risk Management. In Greg Bankoff, Georg Frerks, Dorothea Hilhorst (Eds.): *Mapping Vulnerability. Disasters, development & People*. London: Earthscan, pp. 37–51.
- Chapagain, A. K.; Tickner, D. (2012): Water Footprint: Help or Hindrance? In *Water Alternatives* 5 (3), pp. 563–581, checked on 3/18/2015.
- Cook, I. R.; Swyngedouw, E. (2012): Cities, Social Cohesion and the Environment: Towards a Future Research Agenda. In *Urban Studies* 49 (9), pp. 1959–1979. DOI: 10.1177/0042098012444887.
- Cosgrove, Denis (1990): Landscape studies in geography and cognate fields of the humanities and social sciences. In *Landscape Research* 15 (3), pp. 1–6. DOI: 10.1080/01426399008706316.
- Cutter, Susan L. (1996): Vulnerability to environmental hazards. In *Progress in Human Geography* 20 (4), p. 529, checked on 12/15/2014.
- Cutter, Susan L.; Mitchell, Jerry T.; Scott, Michael S. (2000): Revealing the vulnerability of people and places. A case study of Georgetown county, South Carolina. In *Annals of the Association of American Geographers*. - Malden. - 90 (4).
- Dodman, David; Mitlin, Diana (2011): Challenges for community-based adaptation: discovering the potential for transformation. In *Journal of International Development* 25 (5), pp. 640–659. DOI: 10.1002/jid.1772.
- Dodman, David; Soltesova, Katarina; Satterthwaite, David; Tacoli, Cecilia (2015): *Understanding the Assessment and Reduction of Vulnerability to Climate Change in African Cities: A Focus on Low-Income and Informal Settlements*. With assistance of Chris Jack. Agence Française de Développement (série grise). Available online at <http://librairie.afd.fr/en/understanding-the-assessment-and-reduction-of-vulnerability-to-climate-change-in-african-cities-a-focus-on-low-income-and-informal-settlements/>, checked on 2/25/2015.
- Douglas, Ian; Alam, Kurshid; Maghenda, MaryAnne; McDonnell, Yasmin; McLean, Louise; Campbell, Jack (2008): Unjust waters: climate change, flooding and the urban poor in Africa. In *Environment and Urbanization* 20 (1), pp. 187–205. DOI: 10.1177/0956247808089156.
- Few, Roger (2003): Flooding, vulnerability and coping strategies: local responses to a global threat. In *Progress in Development Studies* 3 (1), pp. 43–58. DOI: 10.1191/1464993403ps049ra.
- Field, C.B.; V.R. Barros; K.J. Mach; M.D. Mastrandrea; M. van Aalst et al. (2014): Technical Summary. In Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea et al. (Eds.): *IPCC 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working*

- Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, New York: Cambridge University Press, pp. 35–94, checked on 3/18/2015.
- Folke, Carl (2006): Resilience: The emergence of a perspective for social–ecological systems analyses. In *Global Environmental Change* 16 (3), pp. 253–267. DOI: 10.1016/j.gloenvcha.2006.04.002.
- Greiving, Stefan (2006): Multi-risk assessment of Europe’s regions. In Jorn Birkmann (Ed.): *Measuring vulnerability to natural hazards. Towards disaster resilient societies*. New York: United Nations University, pp. 210–226.
- Hall, Kurt; Cleaver, Frances; Franks, Tom; Maganga, Faustin (2013): Critical institutionalism: a synthesis and exploration of key themes. In *Environment, Politics and Development Working Paper Series* (63).
- Hoekstra, Arjen Y.; Mekonnen, Mesfin M.; Chapagain, Ashok K.; Mathews, Ruth E.; Richter, Brian D.; Añel, Juan A. (2012): Global Monthly Water Scarcity: Blue Water Footprints versus Blue Water Availability. In *PloS one* 7 (2), pp. e32688. DOI: 10.1371/journal.pone.0032688.
- Holloway, Alisa (2012): Disaster Risk in Africa: dynamic discourse or dysfunctional dialogue? In Lena Bloemertz, Martin Doevenspeck, Elísio Macamo, Detlef Müller-Mahn (Eds.): *Risk and Africa. Multi-Disciplinary Empirical Approaches*. Münster: LIT Verlag (Beiträge zur Africa-Forschung), pp. 2–23.
- IISD (2015): SUMMARY OF THE THIRD WORLD CONFERENCE ON DISASTER RISK REDUCTION: 14-18 MARCH 2015. In *Earth Negotiations Bulletin* 26 (15). Available online at <http://www.iisd.ca/isdr/wcdr3/>, checked on 3/23/2015.
- Johnson, Cassidy (2012): Urban and regional planning and disaster. In Ben Wisner, Jean C. Gaillard, Ilan Kelman (Eds.): *Handbook of hazards and disaster risk reduction*: Routledge.
- Kaika, Maria (2005): *City of flows: Modernity, nature, and the city*. Oxon, New York: Routledge.
- Khan, S.; Crozier, M. J. (Eds.) (2009): ‘Hazardscape’: A Holistic Approach to Assess Tipping Points in Humanitarian Crises. Annual Summer Academy on Social Vulnerability: “Tipping Points in Humanitarian Crises”. Munich, Germany, 26.07.-01.08.2009, checked on 11/24/2014.
- Kruse, Sylvia (2010): *Vorsorgendes Hochwassermanagement im Wandel. Ein sozial-ökologisches Raumkonzept für den Umgang mit Hochwasser*. Wiesbaden: VS Verlag für Sozialwissenschaften, checked on 3/18/2015.
- Mair, Christine a.; Cutchin, Malcolm P.; Kristen Peek, M. (2011): Allostatic load in an environmental riskscape: The role of stressors and gender. In *Health & place* 17 (4), pp. 978–987. DOI: 10.1016/j.healthplace.2011.03.009.
- McGranahan, G.; Balk, D.; Anderson, B. (2007): The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. In *Environment and Urbanization* 19 (1), pp. 17–37. DOI: 10.1177/0956247807076960.
- Meltzer, Evelyne (1998): International Review of Integrated Coastal Zone Management. In *Ocean Conservation Report Series*, checked on 3/18/2015.
- Moberg, F.; Simonsen, S. H.: What is resilience? An introduction to social-ecological research. Edited by Stockholm Resilience Centre. Stockholm Resilience Centre. Available online at www.stockholmresilience.su.se, checked on 3/4/2015.
- Morello-Frosch, Rachel; Shenassa, Edmond D. (2006): The Environmental “Riskscape” and Social Inequality: Implications for Explaining Maternal and Child Health Disparities. In *Environmental health perspectives* 114 (8), pp. 1150–1153. DOI: 10.1289/ehp.8930.
- Müller, Annemarie (2012): Areas at risk - concept and methods for urban flood risk assessment. A case study of Santiago de Chile. Stuttgart: Steiner (Megacities and global change, 3).
- Müller-Mahn, Detlef (2013): *The spatial dimension of risk. How geography shapes the emergence of riskscape*. London: Routledge (Earthscan risk in society series).
- Mustafa, Daanish (2005): The Production of an Urban Hazardscape in Pakistan: Modernity, Vulnerability, and the Range of Choice. In *Annals of the Association of American Geographers* 95 (3), pp. 566–586. DOI: 10.1111/j.1467-8306.2005.00475.x.
- Niang, I.; O.C. Ruppel; M.A. Abdrabo; A. Essel; C. Lennard et al. (2014): Africa. In Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach et al. (Eds.): *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, New York: Cambridge University Press, pp. 1199–1265, checked on 12/15/2014.
- Olsson, Per; Folke, Carl; Berkes, Fikret (2004): Adaptive comanagement for building resilience in social-ecological systems. In *Environmental management* 34 (1), pp. 75–90. DOI: 10.1007/s00267-003-0101-7.
- Oteng-Ababio, Martin (2013): Unscripted (in)justice: exposure to ecological hazards in metropolitan Accra. In *Environment and Planning A* 45 (5), pp. 1199–1218. DOI: 10.1068/a45256.

- Pahl-wostl, Claudia (2009): A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. In *Global Environmental Change* 19 (3), pp. 354–365. DOI: 10.1016/j.gloenvcha.2009.06.001.
- Pahl-wostl, Claudia; Holtz, Georg; Kastens, Britta; Knieper, Christian (2010): Analyzing complex water governance regimes: the Management and Transition Framework. In *Environmental Science & Policy* 13 (7), pp. 571–581. DOI: 10.1016/j.envsci.2010.08.006.
- Patrick, Steward M. (2012): The coming global water crisis. What happens when demand for the essential resource starts exceeding supply in many parts of the world? In *The Atlantic* 2012, 05.2012 (05). Available online at <http://www.theatlantic.com/international/>, checked on 3/18/2015.
- Pelling, M.; Dill, K. (2010): Disaster politics: tipping points for change in the adaptation of sociopolitical regimes. In *Progress in Human Geography* 34 (1), pp. 21–37. DOI: 10.1177/0309132509105004.
- Pelling, Mark (2010): Adaptation to climate change. From resilience to transformation. London, New York: Routledge. Available online at <http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10433320>.
- Pelling, Mark (2011): Adaptation to climate change. From resilience to transformation. London, New York: Routledge.
- Pelling, Mark; High, Chris (2005): Understanding adaptation: What can social capital offer assessments of adaptive capacity? In *Global Environmental Change* 15 (4), pp. 308–319. DOI: 10.1016/j.gloenvcha.2005.02.001.
- Rain, David; Engstrom, Ryan; Ludlow, Christianna; Antos, Sarah (2011): Accra, Ghana: A city vulnerable to flooding and drought-induced migration. Case study prepared for Cities and Climate Change: Global Report on Human Settlements 2011. UN Habitat. Available online at <http://www.unhabitat.org/grhs/2011>, checked on 3/18/2015.
- Rigby, Claire (2015): Sao Paulo - anatomy of a failing megacity: residents struggle as water taps run dry. In *The Guardian* 2015, 2/25/2015. Available online at <http://www.theguardian.com/cities/2015/feb/25>, checked on 3/18/2015.
- Spooner, Samantha (2015): Cities without water: The frightening future of Africa's urban areas. The imminent rise of water mafias and water wars. In *Mail & Guardian Africa* 2015, 3/4/2015. Available online at <http://mgafrica.com/article/2015-03-04-cities-without-water-what-the-future-holds-for-africas-urban-areas>, checked on 3/18/2015.
- Stetter, S.; Herschinger, E.; Teichler, T.; Albert, M. (2011): Conflicts about water: Securitizations in a global context. In *Cooperation and Conflict* 46 (4), pp. 441–459. DOI: 10.1177/0010836711422462.
- Stoler, Justin; Fink, Günther; Weeks, John R.; Otoo, Richard Appiah; Ampofo, Joseph A.; Hill, Allan G. (2012): When urban taps run dry: sachet water consumption and health effects in low income neighborhoods of Accra, Ghana. In *Health & place* 18 (2), pp. 250–262. DOI: 10.1016/j.healthplace.2011.09.020.
- Terkenli, Theano S. (2001): Towards a theory of the landscape: the Aegean landscape as a cultural image. In *Landscape and Urban Planning* 57 (3-4), pp. 197–208. DOI: 10.1016/S0169-2046(01)00204-3.
- The World Bank (Ed.) (2011): Climate Change, Disaster Risk, and the Urban Poor. Cities Building resilience for a Changing World. The World Bank, checked on 12/15/2014.
- Turner, B. L.; Kasperson, R. E.; Matson, P. A.; McCarthy, J. J.; Corell, R. W.; Christensen, L. et al. (2003): A framework for vulnerability analysis in sustainability science. In *Proceedings of the National Academy of Sciences* 100 (14), pp. 8074–8079. DOI: 10.1073/pnas.1231335100.
- Turner II, B. L. (2010): Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science? In *Global Environmental Change* 20 (4), pp. 570–576. DOI: 10.1016/j.gloenvcha.2010.07.003.
- UNISDR (2015): Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.
- Vörösmarty, Charles J.; Douglas, Ellen M.; Green, Pamela; Revenga, Carmen (2005): Geospatial Indicators of Emerging Water Stress: An Application to Africa. In *Ambio* 34 (3), pp. 230–236, checked on 12/15/2014.
- Wamsler, Christine (2006): Mainstreaming Risk Reduction in Urban Planning and Housing: A Challenge for International Aid Organisations. In *Disasters* 30 (2), pp. 151–177. DOI: 10.1111/j.0361-3666.2006.00313.x.
- Wamsler, Christine (2009): Urban Risk Reduction and Adaptation. How to Promote Resilient Communities and Adapt to Increasing Disasters and Changing Climatic Conditions?: VDM Publishing.
- Weichselgartner, Juergen (2002): Nach der Elbeflut 2002: Und danach? Nachtrag zur transdisziplinären Hochwasserforschung. In *GIAA-Ecological Perspectives for Science and Society* 11 (4), pp. 310–311, checked on 3/18/2015.
- Wisner, Ben; Luce, Henry R. (1993): Disaster vulnerability: Scale, power and daily life. In *GeoJournal* 30 (2), pp. 127–140, checked on 3/18/2015.

Xue, Xiongzhi; Hong, Huasheng; Charles, Anthony T. (2004): Cumulative environmental impacts and integrated coastal management: the case of Xiamen, China. In *Journal of environmental management* 71 (3), pp. 271–283. DOI: 10.1016/j.jenvman.2004.03.006.Vulnerability

II.2 Working paper B: GIS – what can and what can't it say about social relations in adaptation to urban flood risk?

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This paper has been published within the WaterPower working paper series and can be cited as: Frick-Trzebitzky, F. (2017). *GIS - what can and what can't it say about social relations in adaptation to urban flood risk?* (WaterPower Working Paper Series No. 15). Trier, London. Download available at: <http://www.waterpower.science>.

Submitted: May 2017; published December 2017

Acknowledgements:

The report has been prepared as an output of the WaterPower (Trier University) and Urban ARK (King's College London) projects. I thank all the team members for their recommendations and comments on previous versions.

Abstract

Urban flooding cannot be avoided entirely and in all areas, particularly in coastal cities. Therefore adaptation to the growing risk is necessary. Geographical Information Systems (GIS) based knowledge on risk informs location-based approach to adaptation to climate risk. It allows managing city-wide coordination of adaptation measures, reducing adverse impacts of local strategies on neighbouring areas to the minimum. Quantitative assessments dominate GIS applications in flood risk management, for instance to demonstrate the distribution of people and assets in a flood prone area. Qualitative, participatory approaches to GIS are on the rise but have not been applied in the context of flooding yet. The overarching research question of this working paper is: what can GIS, and what can it not say about relationships / social relations in adaptation to urban flood risk? The use of GIS in risk mapping has exposed environmental injustices. Applications of GIS further allow modelling future flood risk in function of demographic and land use changes, and combining it with decision support systems (DSS). While such GIS applications provide invaluable information for urban planners steering adaptation they however fall short on revealing the social relations that shape individual and household adaptation decisions. The relevance of networked social relations in adaptation to flood risk has been demonstrated in case studies, and extensively in the literature on organizational learning and adaptation to change. The purpose of this literature review is to identify the type of social relations that shape adaptive capacities towards urban flood risk which cannot be identified in a conventional GIS application.

II.2.1 Adaptation to urban flood risk

Because of the interaction of multiple pressures in urban areas, urban flood risk cannot be entirely prevented from happening. Instead adaptation to urban flood risk conditions is needed. This section gives an overview on trends in urban flood risk, conventional flood risk management measures, and stresses the urgency of adaptation measures to urban flood risks. Differences between measures for flood risk mitigation and adaptation to flood risk are made explicit.

Floods rank among the disasters with most detrimental impacts worldwide. Losses of people and assets due to flooding are particularly high in cities, and are likely to continue to rise in the context of ongoing urbanisation and climate change (Few 2003; Levy, Hall 2005). As urbanisation continues at disproportionate rates in coastal areas, large river floods, coastal inundation and storm water surges are putting an increasingly large number of urban dwellers at risk, and among them the poor are particularly vulnerable (Huq et al. 2007; McGranahan et al. 2007). Four types of urban flooding are distinguished in the literature, namely localised flooding due to inadequate drainage, small stream overflow often linked to rainfalls and clogged drains, large river floods and coastal flooding (Douglas et al. 2008, p.191). The former two are occurring with increasing frequency in areas that undergo rapid urban development and are simultaneously exposed to changing rainfall patterns and sea level change as a result of climate change. This is the case in many African cities and led Action Aid to analyse vulnerabilities and adaptive capacities in 5 African cities (Action Aid 2006). The results highlight the disproportionate exposure and limited adaptive capacity among the urban poor and the lack of commitment and capacity in national, regional and local governments to reduce urban flooding in the cities analysed (Douglas et al. 2008; Bhattacharya, Lamond 2011). This is a typical condition of risk not only in urban Africa but in rapidly urbanising regions across the world (Bündnis Entwicklung Hilft 2014).

While current trends exacerbate urban flood risk in many cities, it has been part of urban life for centuries in cities such as London, New York, Hamburg, Amsterdam - all close to the sea and partly built on reclaimed land. Structural engineering measures of flood risk control such as dikes, levees, canals, flood gates, pumping, etc. have been developed to protect these cities. With more and more structural flood control measures necessary to protect cities however, flood risks have been diverted and resulted in unjustifiable costs. The 2002 Elbe flooding in Germany for example was partly the result of river flow modifications serving the protection of settlements and agricultural lands. It has triggered a reorientation of flood risk management from structural mitigation to non-structural preventive measures such as spatial planning (Kruse 2010). Similar shifts from mitigation to adaptation have shaped recent flood risk management approaches in the Netherlands, Switzerland and the UK (Handmer 2001; Kruse 2010; van Herk et al. 2013; Weichselgartner 2003). Nevertheless, reoccurring flood events and their devastating impacts in recent years show that the availability of knowledge, data and experience in dealing with flooding do not translate directly into action that minimises flood risk.

Both the African and the European experiences illustrate the need for adaptive management of urban flood risk because its mitigation is unsustainable and bears the danger of a technical

lock-in (Few 2003; van Herk et al. 2011). Adaptation to flood risk involves both structural and non-structural measures. Next to large scale engineering works as mentioned above, structural measures include drainage systems, as well as ecosystems that provide natural protection such as wetlands (Bhattacharya, Lamond 2011; Elliott, Trowsdale 2007). Non-structural measures instead of fighting the floods pursue a ‘living with the river’ approach focussing on exposure and vulnerability reduction (Few 2003; Handmer 2001; Weichselgartner 2003). Early warning systems, spatial land use planning, building codes and emergency response planning are key components (Handmer 2001; Few 2003). Structural and non-structural measures can be complementary, but can also be incompatible where structural measures enhance risk in the future or on adjacent sites by diverting water, or by creating incentives to settle on exposed sites.

In adaptation to urban flooding, key challenges arise from the multiple dimensions of complexity in vulnerability reduction which Barroca and colleagues have summarised as the complexity of the hazard itself, the complexity of elements at risk, and the complexity of relations between elements at risk (Barroca et al. 2006). Corresponding to these complexities, the Action Aid study shows that first of all, urban floods in Africa occur as the result of multiple interacting social and environmental processes that are poorly monitored. Secondly, they affect slum dwellers with particular severity. Within these, migrant settlers from different regions who have little understanding of local environmental conditions, indigenous groups, women, children, and other groups are considered to be particularly vulnerable in multiple ways (Abdallah Imam, Tamimu 2015; Adelekan et al. 2015). Finally, local flood risk is increasing because disaster risk reduction approaches are top-down lacking local enforcement, and local collective action strategies practically non-existent. The authors of the Action Aid study as well as further studies conclude that improved infrastructure and land use planning at different levels of scale (local, river basin, coastal systems) and poor people's participation in planning is needed to improve adaptation to flood risk in African cities (Action Aid 2006; Bhattacharya, Lamond 2011; Douglas et al. 2008). However, enforcing urban planning for disaster risk reduction in rapidly developing cities remains a challenge particularly where governments have limited resources and basic data is lacking and as a result of institutional and cultural divides between urban planning and DRR workers (Wamsler 2006).

This brief review of recent approaches and challenges in urban flood risk management points to the increasing complexity involved in decision-making in relation to urban development and risk reduction. Complexities range from understanding the causes of floods to understanding vulnerabilities and taking decisions on management options that involve trade-offs. Geographic information science including Geographic Information Systems (GIS), remote sensing (RS), environmental modelling and decision support systems (DSS) are increasingly used to handle these complexities. The following section is a review on how these different tools have been used in flood risk management, and what their contribution is to managing flood risk in conditions of high complexity and uncertainty. It is followed by a discussion of factors that are not yet adequately addressed in these approaches, based on social science's insights on disaster risk and adaptation. Finally the concept of bricolage is

introduced as a frame for gaining a better understanding of networked relations of power in adaptation to flood risk.

II.2.2 GIS in adaptation to urban flood risk

Computerised spatial analysis emerged in the 1960s and was developed as a Geographic Information System (GIS) by landscape architects in the 1980s. The interest in spatial analysis goes beyond cartography or mapping – it allows linking complex databases to spatial coordinates to derive, for instance, the availability of public infrastructure in relation to the density of population in a given place. As such it has become an important tool in public infrastructure and land use planning, as well as for private companies. The visualisation of spatial information is a key component in communicating the results of such analyses, particularly in public decision-making. As GISystem applications have become increasingly complex, GIScience emerged as a separate field, looking into the models, algorithms and ontologies behind the systems (Schuurman 2004).

Table 1 GIS and DSS applications in flood risk management. Key literature identified by keyword search on ‘flood*’ and ‘GIS’ or ‘DSS’, respectively, on Web of Science® and Google Scholar

Research objective	Data sets	Data progressing technology	Case studies	Reference
Description of inundation dynamics	Aerial photography, time series of runoff records	GIS	Ogeechee River/ USA	Benke et al. 2000
Causal tree and hazard mapping to detect minor flooding from sewer blockage	Sewer flood event records, expert knowledge	GIS	Bordeaux/ France	Cherqui et al. 2015
Identifying people's exposure to flooding	Geospatial map, socio-economic census data	GIS based modelling	Manchester/ UK	Kaźmierczak, Cavan 2011
Adaptation of a novel method of multicriteria flood risk assessment, that was recently developed for the more rural Mulde river basin, to a city	Raster data, land use data, census data	DSS, GIS	Leipzig/ Germany	Kubal et al. 2009
Modelling run-off under climate change: identifying possible changes in the magnitude, extent and depth of floods	Time-series for precipitation and discharge, climate change scenarios	Hydrological model, GIS	Ganges, Brahmaputra and Meghna rivers/ Bangladesh	Mirza et al. 2013
Define the proper location of shelters and distribution centers for flood victims	Raster data	GIS, optimization model	Villahermosa/ Mexico	Rodríguez-Espíndola, Gaytán 2015
Identifying hydrological impacts of urbanization for integrated flood risk management	Satellite imagery, GPS data	Land use classification, Rainfall runoff modelling, flood hazard mapping using RS and GIS, Flood zone mapping using 1D model	Thirusoolam watershed, Chennai/ India	Suriya, Mudgal 2012
GIS based composite vulnerability index for the coastal zone of the state of Pará	Raster data, maps and socio-economic statistics	GIS, modelling	Pará/ Brazil	Szlafsztein and Sterr 2007
Model the potential of flood inundation	DEM, digital hydrography datatran	GIS based raster/grid and vector/network analysis and modelling	Roanoke river floodplain, NC/US,	Townsend, Walsh 1998

Vulnerability analysis	hydrological information and flood records; geographical information on topography and land use; river morphology; meteorological information relating to flood seasons; information about existing infrastructure demographic and socio-economic conditions; and information on the damage and loss caused by previous flood disasters; participatory mapping	GIS	Thua Thien Hue province, Vietnam	Tran et al. 2009
Scenario-based risk assessment	Building attributes from council databases and fieldwork mapping, DEM	Commercial relational database management system, a GIS-based decision support system.	Cairns/Australia	Zerger, Wealands 2004
Developing a framework for analysis of flood risk in urban areas	quantitative and qualitative environmental and socio-economic indicators	Risk mapping	Santiago de Chile/ Chile	Müller 2012

GIS is applied at all stages of the emergency response cycle (Cutter 2003). In flood risk management GIS is applied in risk assessment to inform preventive spatial planning, early warning systems and emergency response systems (cf. table 1). A typical GIS application in flood risk management is the spatial overlay of asset values, population size and flood prone areas, the later for instance by calculation of 20, 50, 100 year events. Environmental modelling is often applied in GIS flood risk assessments because of the extent of data needed to obtain spatial information in uncertain conditions of change with regard to climate and demography (Levy, Hall 2005). Overlaying a digital terrain model with hydrological models and land use classifications from aerial images for instance serves to identify floodplains and estimate potential inundation areas, e.g. (Benke et al. 2000; Mirza et al. 2013; Townsend, Walsh 1998). Such risk assessments can be combined with spatial socio-economic data to identify population at risk or suitable locations for emergency shelters, e.g. (Rodríguez-Espíndola, Gaytán 2015; Szlafsztein and Sterr 2007). The data generated in GIS based flood risk assessment is a central input to Decision Support Systems (DSS) which facilitate flood risk management decisions. A DSS is a “customized, interactive computing environment that integrates models/analytical tools, databases, graphical user interfaces, and other systems” designed to facilitate decision-making by weighting and adding priorities of alternative options (Levy 2005, p. 441). DSS have been applied in flood emergency evacuation, mitigation and control, and preventive planning (Levy 2005).

Table 2 QGIS, PGIS and PPGIS applications in risk management. Literature identified by keyword search on ‘risk’, ‘vulnerability’, ‘adaptation’ and ‘Qualitative GIS’ or ‘Participatory GIS’, respectively, on Web of Science® and Google Scholar

Research objective	Data sets	Data progressing technology	Case studies	Reference
Developing a method for assessing vulnerability in spatial terms using both biophysical and social indicators.	Historical data, socio-economic indicators, social vulnerability index	GIS,	Georgetown County, North Carolina/ USA	Cutter et al. 2000
Engaging youth in PGIS	Participatory planning, participatory data collection	GIS	Youth Planning Project (USA?)	Dennis 2006
Developing a QGIS approach	Narratives	Narrative analysis, 3D GIS-based time-geographic methods, and computer-aided qualitative data analysis	Ohio/ USA	Kwan, Ding 2008
Applying PPGIS in collaborative forest governance	Data from participatory mapping in workshops, survey	Stakeholder analysis, GIS	Kofiase/ Ghana	Kyem 2002
Applying QGIS in conflict studies	Narrative interviews, remote sensing data	GIS	Uganda	Madden, Ross 2009
Applying PGIS to gain understanding of the nature and variation of risks	Data from participatory risk mapping, questionnaire data	GIS	Ethiopia, Kenya	Smith et al. 2000
Integrating GIS in qualitative data analysis software (ATLAS.ti)	Field notes from observation, in-depth interviews with key actors, urban documents and plans, photographs, press releases, documents of formal communication between the actors	Qualitative document analysis, georeferencing, GIS	Barcelona	Verd, Porcel 2012

In both GIS and DSS applications in flood risk management shortcomings in the assessment of vulnerability are currently a limiting factor because indicators of vulnerability are not as universally applicable and quantifiable as, for instance, those of bio-physical exposure (surface water runoff, rainfall, geomorphological conditions, etc.). Table 1 summarising state of the art research on GIS and DSS in flood risk management illustrates the tendency to use statistical data and quantitative socio-economic indicators to assess vulnerability. However, the use and meaning of vulnerability indicators is context specific and needs to be adjusted accordingly to be used in modelling and DSS, particularly in the urban context. New approaches are needed to enable context-specific flood risk assessments (Barroca et al. 2006). The authors have developed a flexible set of social, economic and ecologic/environmental indicators of urban vulnerability, which is yet to be linked to GIS. Limited data availability on variables that influence socioeconomic vulnerability, such as housing prices, household income and purchasing prices constrain urban DSS (Kubal et al. 2009). With regard to GIS in DRR, (Cutter 2003) identifies 4 limitations that parallel those identified in DSS based flood risk assessment, namely the need for development in integration of ecological processes and social models, improved visualisation of social vulnerability, capturing mobile groups (tourists, migrants) in social vulnerability analysis, and the need for coherent technological and data infrastructure.

While the literature reviewed above is mainly concerned with technical limitations of vulnerability assessments in GIS and DSS, another strand of literature points to limitations in understanding vulnerability from a critical GIScience perspective. These studies aim towards a better understanding of differential vulnerabilities and critical engagement with relations of

power embedded in decision-making structures as well as the practice of GIS itself (Schuurman 2004; Elwood 2011; Pickles 1995a, 1995b). Critical applications of GIS adopt participatory and qualitative data collection methods and visualise them in a GIS (Elwood 2011). Qualitative, participatory and public participatory GIS (QGIS, PGIS and PPGIS, respectively) has rarely been applied in flood risk research (cf table 1), but is increasingly being explored in DRR and environmental governance research more generally (cf table 2). This body of research points out the role of data ownership among marginalised groups as a tool in vulnerability reduction and empowerment (Kyem 2002; Dennis 2006, amongst others).

II.2.3 In what ways can/ do these approaches improve flood risk assessment and adaptive management?

Qualitative and participatory methods in GIS and DSS reveal differential social vulnerability, making marginalised experiences and perceptions visible. In her review of QGIS studies, Elwood (2011) lists the method's contribution to an understanding of the 'spatial and temporal unfolding' of an event (or hazard) through the interpretation of qualitative data based on spatial information. This is particularly valuable where information is difficult to obtain and heavily biased such as in conditions of conflict or crisis (Madden, Ross 2009). Tran and colleagues explore the potential of integrating local knowledge in GIS based flood risk mapping and find that besides eliciting local knowledge on risk and vulnerability, participatory mapping raised awareness on risk among the population and created a space for dialogue among stakeholders and thus actively triggered adaptive learning (Tran et al. 2009). Similar observations of empowerment have been made in the context of youth engagement in urban planning (Dennis 2006) and natural resource management (Kyem 2002).

However, these studies also highlight the constraint local power relations can place on PPGIS (also Smith et al. 2000). Power relations come into play not only in decisions on who participates, but also on how information is visualised and translated into analytical categories (Smith et al. 2000; Elwood 2011; Wood et al. 2010). Craig and colleagues conclude their collection of PPGIS studies by pointing out that PPGIS potentially facilitates the democratisation of spatial decision-making (planning), but current case studies do not provide more than anecdotes on this (Craig et al. 2002). PPGIS is both a tool of empowerment and disempowerment, depending on where, how, by whom it is applied. Case studies reveal that the political context is more of an obstacle to PPGIS than technological issues. In the context of flood risk reduction and adaptation this means that QGIS, PGIS and PPGIS are potentially tools to make vulnerability of marginalised groups visible and integrate it in risk assessments and planning decisions, but only so if it is applied cautiously of power relations and political context. Hence whether GIS supported assessments create authoritative, top-down or empowering, bottom-up knowledge on flooding and risk depends not only on the tool and who uses it, but importantly on the context and process of its application.

In summary GIS facilitate understanding of complex social, economic and ecologic interactions that contribute to flood risk. DSS moreover facilitate decision-making under conditions of complexity and uncertainty, a crucial factor in adaptive flood risk management / non-structural measures which always involve trade-offs. Critical GIS approaches crucially add to the assessment of vulnerability and adaptation options by eliciting local knowledge, raising awareness, making differential vulnerability visible, and ultimately democratising the dialogue on policy options and decisions by empowering marginalised groups. However, GIS and DSS continue to come short on understanding and identifying underlying drivers of social vulnerability and adaptive capacity to flood risk such as power relations and political context. The objective of the next section is to identify relational aspects of social vulnerability and adaptive capacity that cannot be identified in GIS.

II.2.4 Assessing adaptive capacity in urban flood risk research

Research on social capital and social learning in adaptive processes has shown that (networked) social relations are a key factor in successful adaptation to change. Accordingly, a third strand of literature on flood risk, vulnerability and adaptive capacity is engaged in the analysis of social relations, networks, and learning. These studies pay little attention to spatial data and are less concerned with hazard and vulnerability assessment. They rather analyse data from empirical field research, literature and document reviews to derive theoretical concept and gain an understanding on social processes that create risk and adaptive capacity (cf. table 3). Capacities are analysed at different scales, going down to household level. The underlying argument of these studies as opposed to spatial analyses has been summarised by Adger: “I argue that many aspects of adaptive capacity reside in the networks and social capital of the groups that are likely to be affected. This capacity to adapt suggests that some groups within society may be less at risk than modelling studies have portrayed because of their latent ability to cope in times of stress. It will always be difficult to test this proposition because future changes in climate are likely to be outside the range of institutional memory or lived experience” (Adger 2003, p.401). The diversity of aspects of adaptive capacity is illustrated by the findings of the studies listed in table 3. Comparing research objects and aspirations with the findings moreover indicates the complexity of indicators of adaptive capacity when further development of analytical frames is aspired (e.g. Barroca et al. 2006) or findings revealed factors beyond the scope of the research (e.g. Pelling 1999).

Social capital can be defined as social networks and norms that create relations of trust, reciprocity and exchange (Pelling, High 2005; Adger 2003). It has been applied to case studies of coping with and adaptation to flood risk (Abheuer et al. 2012; Adger 2003). In a case study from Vietnam informal institutions, bonding (informal relations such as kinship) and networking (regulated by external norms and institutions) social capital replaced state planning in adaptation to flood risk (Adger 2003). (Abheuer et al. 2012) identified trust relations and informal resource exchange as strategies among slum dwellers in Dhaka to overcome flood related situations of crisis which had, however, no impact on their long-term adaptive capacities. The comparison of the two analyses highlights the role of informal

institutions that provide networking capital particularly where the state is absent. In the Dhaka case the households analysed seem to have limited adaptive capacity because their social capital predominantly consists of bonding relations. Both assessments are situational in so far as an individual's capacity to build relations is constantly changing (Pelling, High 2005).

The case studies by Pelling and Næss by contrast shed light on the interaction of formal and informal institutions where the state is (partly) present in flood risk management. In Guyana a politicised context facilitated community organisations' engagement in vulnerability reduction among better-off residents but hindered the formation and political participation of horizontal networks in urban and periurban poor neighbourhoods (Pelling 1999). In Norway local capacities for proactive flood risk management were dormant as a result of high incentives to rely on national emergency response systems, different governance cultures at national and local level, and personalised rather than institutionalised learning (Næss et al. 2005). Both studies reveal the decisive role of individuals' interests within governments and organisations in creating adaptive capacities. Informal, personal relations shape those of formal institutions engaged in flood risk management, particularly in the context of adaptive learning (Pahl-Wostl et al. 2013). Van Herk et al. 2011 show how informal relations can be used proactively in learning and action alliances on the integration of flood risk reduction in urban planning. However, the Guyana case indicates that for such an approach to contribute to enhanced adaptive capacities also among the most vulnerable, power relations must be understood and taken into account in its design.

II.2.5 Where to from here?

Relations of power are involved in decisions while 'doing' GIS: in choosing data, algorithms, categories and labels in visualisation. Particularly in application of GISystems (as opposed to GIScience) these decisions tend to be taken unconsciously (Elwood 2011). Intertextual analysis of GIS related and planning practices have been suggested as a tool to discover these relations (Pickles 1995b). This literature review has moreover shown that although GIS is an important instrument in identifying adaptation needs and informing adaptation decisions, some components of adaptive capacity are out of reach of GIS based assessments. More specifically, the interaction of informal and formal institutions and relations have shown to be a key factor in the creation of adaptive capacity. Further questions that emerge from this literature review are: How are the different types of floods currently visualised and known through GIS?, and How does the dominant 'conventional' use of GIS in urban planning and the respective knowledge of floods produced contribute to the increase of urban floods in specific locations?

As described in the case studies, the interaction of informal and formal institutions can both hinder and foster adaptive flood risk management. Human geographer Frances Cleaver defines the process of patching together formal regulations and informal traditions and norms in natural resource governance as 'bricolage'. This process is shaped by people who act as 'bricoleurs' – agents who consciously as well as unconsciously shape the way natural

resources are managed (Cleaver 2012, p. 112). Analysing the formation of institutions from a bricolage perspective means focussing on linkages and intersections between resources, networks of actors, institutions and domains of action. Power, learning and knowledge are lenses through which linkages and intersections can be explored. In doing so, the approach “allows us to map patterns of adaptation and their outcomes for different people over time” (Cleaver 2012, p. 212). The approach thus promises to provide a better understanding of both the differential vulnerability (as analysed in QGIS studies) and adaptive capacity (a main focus of social flood risk research) when applied to flood risk research.

Table 3 Social analyses of adaptation to flood risk. Literature identified by keyword search on ‘flood*’ and ‘social capital’, ‘adaptive capacity’ or ‘vulnerability assessment’, respectively on Web of Science and Google Scholar

Reference	Research objective (aspiration)	Findings	Data collection and analysis methods	Case studies
(Aßheuer et al. 2012)	Understanding the role of social capital in coping with floods in slum dwelling, i.e. how various aspects of social capital lead to social support during severe floods	Social capital is formed in networks at multiple levels (micro, meso, macro). Microlevel bonding ties are strongest yet not sufficient in times of crisis when other members of the network are affected themselves. Linking ties, norms and trust are key elements that are drawn on in coping with flooding	Comparative case study analysis, household surveys, qualitative interviews	Dhaka/ Bangladesh
(Barroca et al. 2006)	Developing a tool for local vulnerability assessment - organize into a software tool the choice of vulnerability indicators and the integration of the point of view of various stakeholders	Tool developed with 7 indicator groups: testers appreciate flexibility of the tool, further improvement based on stakeholders' knowledge needed in terms of variety of indicators, links to further decision support tools and data input	Indicators derived from literature, reports, case studies; tool test runs	France
(Næss et al. 2005)	Identifying the role of institutions in adaptation to climate change taking floods as an example	Institutional structures of decision-making reflect and consolidate existing power relations through learning processes and flood protection measures, and thus hinder local adaptation	Semi-structured interviews, comparative case study analysis	Glomma-Lågen river basin/ Norway
(Næss et al. 2006)	How to improve vulnerability assessments for their use in local level adaptation to climate change	Conflicts of interests in the generation of data between scientific validity and local relevance, institutional challenges around the use of vulnerability assessments relate to the terminology used (communication), the perceived relevance of the topic, institutional capacities and the ability of institutions to learn and change. A multi-level approach to vulnerability assessment integrating top-down and bottom-up indicators is suggested	Literature-based comparative case study analysis of top-down and bottom up indicator development	Norway
(Pahl-Wostl et al. 2013)	Identifying factors of transformative change in flood risk management - understanding (1) the link between largely informal learning cycles and formal policy processes; and (2) the vertical coordination of governance levels to capture the role of different kinds of activities at various levels with bottom-up and top-down processes.	Different modes of informal learning influenced policy change on flood risk management in the three cases, namely shadow systems in Hungary, advocacy coalitions at local and regional levels in the Netherlands, and local and regional advocacy groups in Germany	Comparative case study analysis, document analysis, expert interviews	Tisza/ Hungary, Rhine/ Germany, Netherlands

(Pelling 1999)	Understanding the process and maintenance of environmental hazard taking coastal flooding as an example	Next to vulnerabilities the analysis revealed beneficiaries of flood hazard, namely contractors in the private sector in reconstruction, political and economic elites. It demonstrates how political environment by focusing on immediate causes of flooding instead of underlying causes and drivers of vulnerability consolidates power relations	Case study analysis, historical review, household survey	Georgetown/ Guyana
(Restemeyer et al. 2015)	Understanding of flood resilience to evaluate the flood resilience of cities, and to recognize potential strategies to build flood resilience - convert the concept of resilience into an operational framework that can be used by both scientists as well as policy- and decision-makers, to evaluate the flood resilience of cities.	Two case studies from Hamburg show that social capital as well as historic trajectory and economic interests shape decision-making between holistic and structural approaches to flood risk management. The separateness of water management and urban planning are a barrier to holistic planning for flood resilience	Literature review, document analysis, comparative case study analysis, expert interviews	Wilhelmsburg ; HafenCity, Hamburg/ Germany
(van Herk et al. 2011)	Evaluating a framework for collaborative learning and planning in flood risk management	Learning and Action Alliances (LAAs) were found to support collaborative planning among professionals and politicians. The framework evaluating collaborative learning along activities (system analysis, collaborative design and governance), threads (facts, images and ambitions) and streams (problems; solutions; participants/politics) were found to be a useful framework	Literature review, comparative case study review, expert interviews	De Stadswerven, Dordrecht; Westflank Haarlemmer meer/ Netherlands
(van Herk et al. 2013)	understanding how learning takes place and can be stimulated within a programme, based on a case study of the development of a framework for network learning in a river management programme -	Community building among professionals and politicians was stimulated by structures that promoted their interaction in documentation of lessons learned, guidelines, training and networking events. the setup allowed for integration of top-down and bottom up learning	Document analysis, semi-structured interviews	Room for the River Programme/ Netherlands

Many of the factors of adaptive capacity are not spatial, and are linked to power relations that are difficult to capture in GIS based research. Social capital analysis reveals vulnerabilities that cannot be modelled (Adger 2003), but ultimately an integration of such analysis with spatial assessments is needed to improve informed decision-making in adaptive flood risk management. Analysing the creation of flood risk and adaptation from a bricolage perspective may contribute to closing the gap between GIS based risk and vulnerability assessment and non-spatial assessments of adaptive capacity. A step-wise approach may be applied, by first looking at bricolage, before conducting a QGIS assessment of risk and adaptive capacity. This would also add to emerging approaches of ‘fit for purpose’ approaches in adaptive governance, as outlined below.

Adaptation science needs to close a wide range of knowledge gaps in terms of decision processes, knowledge requirements, knowledge production, understanding vulnerabilities, data generation, barriers to adaptation, transdisciplinary learning and communication (Moss et al. 2013; Swart et al. 2014). Given the remaining challenges related to the lack of

knowledge in adaptive governance practice, a body of literature on ‘fit for purpose’ or ‘good-enough’ approaches in governance of adaptation to climate and environmental change is emerging. These approaches aim at making adaptation in planning and policy more tangible by focusing on adjustments that are in line with existing institutional arrangements and objectives rather than calling for fundamental change. Rijke and colleagues (2012) and Christoplos and colleagues (2014) make a case for good enough approaches in governance. They propose a ‘fit for purpose’ or ‘good enough’ governance approach that uses existing networks and social learning to adjust dominant institutions in order to enhance their effectiveness. They moreover argue that while the fit for purpose governance can be interpreted as a ‘step back’ with regard to adaptive governance principles such as flexibility and self-organisation, it would enable decision-makers to handle uncertainties (Christoplos et al. 2014; (2012).

Further studies focus on the pragmatic generation of data and knowledge. In a study for the European Commission for example, (Miola et al. 2015) developed a ‘fit-for-purpose’ index for climate resilient development in an attempt to streamline risk and vulnerability assessments with economic and ecological development objectives. A set of indicators on climate hazards, mitigation, vulnerability and adaptive capacity was identified from academic and grey literature. The authors found it challenging to integrate the variety of indicators particularly when data is missing, and propose a web-based platform for exchange among experts for further development of the index. Enemark (2013) argues that in spatial adaptation planning and land administration a fit for purpose approach does not require more precise data but better understanding and incorporation of trust, reliability, credibility and representation in the generation and use of data. Similarly Haasnot and colleagues (2014) developed a model for decision-making in adaptation planning on the Rhine, focusing on flood protection and water supply for the Netherlands. The model integrates biophysical indicators as well as closed questions to be answered by decision-makers to identify alternative adaptation pathways. A certain level of uncertainty in the model was accepted.

The ‘good enough’ and ‘fit for purpose’ approaches in adaptation governance and data generation hence imply integration of practical knowledge where scientific knowledge is absent, imprecise or deemed illegitimate. This review of literature on risk and vulnerability assessments has restated that scientific methods currently used are often inadequate to produce an overall picture of risks and vulnerabilities. However, the review also hints to the danger that both the lack of involvement of decision-makers in risk and vulnerability assessments, and the involvement of the most visible stakeholders implies, namely the reproduction of social relations that create risk and vulnerability. Instead of retreating from science, a wider mix of methods from critical social and spatial sciences is most promising to overcome existing gaps in assessments of adaptive capacity.

II.2.6 References

- Abdallah Imam, Haruna; Tamimu, Hardy (2015): 'Life beyond the Walls of my Hometown': Social Safety Networks as a Coping Strategy for Northern Migrants in Accra. In *Asian Journal of Social sciences and Management Studies* 2 (1), pp. 25–43.
- Action Aid (2006): Climate change, urban flooding and the rights of the urban poor in Africa. Key findings from six African cities. Action Aid. London. Available online at http://www.actionaid.org/sites/files/actionaid/climate_change_urban_flooding_and_the_rights_of_the_urban_poor_in_africa.pdf, checked on 2/24/2015.
- Adelekan, I. O.; Johnson, C.; Manda, M.; Matyas, D.; Mberu, B. U.; Parnell, S. et al. (2015): Disaster risk and its reduction: an agenda for urban Africa. In *IDPR* 37 (1), pp. 33–43, checked on 3/4/2015.
- Adger, W. N. (2003): Social Capital, Collective Action, and Adaptation to Climate Change. In *Economic Geography* 79 (4), pp. 387–404, checked on 3/23/2015.
- Abheuer, Tibor; Thiele-Eich, Insa; Braun, Boris (2012): Coping with the impacts of severe flood events in Dhaka's slums. The role of social capital. In *Erdkunde: Archiv für wissenschaftliche Geographie* 67 (1), pp. 21–35.
- Barroca, B.; Bernardara, P.; Mouchel, J. M.; Hubert, G. (2006): Indicators for identification of urban flooding vulnerability. In *Natural Hazards and Earth System Science* 6 (4), pp. 553–561. DOI: 10.5194/nhess-6-553-2006.
- Benke, Arthur C.; Chaubey, Indrajeet; G. Milton Ward; Dunn, E. Lloyd (2000): Flood Pulse Dynamics of an Unregulated River Floodplain in the Southeastern U.S. Coastal Plain. In *Ecology* 81 (10), pp. 2730–2741. DOI: 10.2307/177337.
- Bhattacharya, N.; Lamond, J. (2011): A review of urban flood risk situation in African growing economies. In : Urban flood risk management approaches to enhance resilience of communities. Urban flood risk management approaches to enhance resilience of communities., Graz, Austria, 21.-23. September 2011. Graz, Austria: UFRIM, checked on 12/11/2014.
- Bündnis Entwicklung Hilft (2014): WorldRiskReport 2014. With assistance of United Nations University. Bündnis Entwicklung Hilft (4). Available online at www.WorldRiskReport.org, checked on 3/18/2015.
- Cherqui, Frédéric; Belmeziti, Ali; Granger, Damien; Sourdril, Antoine; Le Gauffre, Pascal (2015): Assessing urban potential flooding risk and identifying effective risk-reduction measures. In *The Science of the total environment* 514, pp. 418–425. DOI: 10.1016/j.scitotenv.2015.02.027.
- Christoplos, Ian; Aben, Charles; Bashaasha, Bernard; Dhungana, Hari; Friis-Hansen, Esbern; Funder, Mikkel et al. (2014): Towards "good enough" climate and disaster governance. Emerging lessons from Zambia, Nepal, Viet Nam and Uganda. Copenhagen: DIIS (DIIS Report, 2014:21).
- Cleaver, Frances (2012): Development through bricolage. Rethinking institutions for natural resource management. Abingdon, Oxon, New York, NY: Routledge.
- Craig, William J.; Harris, Trevor M.; Weiner, Daniel (2002): Conclusion. In William J. Craig, Trevor M. Harris, Daniel Weiner (Eds.): Community participation and geographic information systems. London, New York: Taylor & Francis, pp. 367–372.
- Cutter, Susan L. (2003): GI Science, Disasters, and Emergency Management. In *Transactions in GIS* 7 (4), pp. 439–445.
- Cutter, Susan L.; Mitchell, Jerry T.; Scott, Michael S. (2000): Revealing the vulnerability of people and places. A case study of Georgetown county, South Carolina. In *Annals of the Association of American Geographers* 90 (4), pp. 713–737.
- Dennis, Samuel F. (2006): Prospects for qualitative GIS at the intersection of youth development and participatory urban planning. In *Environment and Planning A* 38 (11), pp. 2039–2054. DOI: 10.1068/a3861.
- Douglas, Ian; Alam, Kurshid; Maghenda, MaryAnne; McDonnell, Yasmin; McLean, Louise; Campbell, Jack (2008): Unjust waters: climate change, flooding and the urban poor in Africa. In *Environment and Urbanization* 20 (1), pp. 187–205.
- Elliott, A. H.; Trowsdale, S. A. (2007): A review of models for low impact urban stormwater drainage. In *Environmental Modelling & Software* 22 (3), pp. 394–405. DOI: 10.1016/j.envsoft.2005.12.005.
- Elwood, S. (2011): Geographic Information Science: Visualization, visual methods, and the geoweb. In *Progress in Human Geography* 35 (3), pp. 401–408. DOI: 10.1177/0309132510374250.
- Enemark, Stig (2013): Fit-for-Purpose: Building Spatial Frameworks for Sustainable and Transparent Land Governance. In The World Bank (Ed.): Land and Poverty Conference. Annual World Bank Conference on Land and Poverty. Washington, D.C., 8.-11.4.2013. The World Bank.

- Few, Roger (2003): Flooding, vulnerability and coping strategies: local responses to a global threat. In *Progress in Development Studies* 3 (1), pp. 43–58.
- Haasnoot, M.; van Deursen, W. P. A.; Guillaume, J. H. A.; Kwakkel, J. H.; van Beek, E.; Middelkoop, H. (2014): Fit for purpose? Building and evaluating a fast, integrated model for exploring water policy pathways. In *Environmental Modelling & Software* 60 (0), pp. 99–120. DOI: 10.1016/j.envsoft.2014.05.020.
- Handmer, J. (2001): Improving flood warnings in Europe: a research and policy agenda. In *Global Environmental Change Part B: Environmental Hazards* 3 (1), pp. 19–28.
- Huq, S.; Kovats, S.; Reid, H.; Satterthwaite, D. (2007): Editorial: Reducing risks to cities from disasters and climate change. In *Environment and Urbanization* 19 (1), pp. 3–15.
- Kaźmierczak, Aleksandra; Cavan, Gina (2011): Surface water flooding risk to urban communities: Analysis of vulnerability, hazard and exposure. In *Landscape and Urban Planning* 103 (2), pp. 185–197.
- Kruse, Sylvia (2010): Vorsorgendes Hochwassermanagement im Wandel. Ein sozial-ökologisches Raumkonzept für den Umgang mit Hochwasser. Wiesbaden: VS Verlag für Sozialwissenschaften, checked on 3/18/2015.
- Kubal, C.; Haase, Dagmar; Meyer, V.; Scheuer, Sebastian (2009): Integrated urban flood risk assessment – adapting a multicriteria approach to a city. In *Natural Hazards and Earth System Science* 9 (6), pp. 1881–1895.
- Kwan, Mei-Po; Ding, Guoxiang (2008): Geo-Narrative: Extending Geographic Information Systems for Narrative Analysis in Qualitative and Mixed-Method Research*. In *The Professional Geographer* 60 (4), pp. 443–465.
- Kyem, Peter A. Kwaku (2002): Promoting local community participation in forest management through PPGIS application in Southern Ghana. In William J. Craig, Trevor M. Harris, Daniel Weiner (Eds.): *Community participation and geographic information systems*. London, New York: Taylor & Francis, pp. 218–231.
- Levy, Jason K. (2005): Multiple criteria decision making and decision support systems for flood risk management. In *Stoch Environ Res Ris Assess* 19 (6), pp. 438–447.
- Levy, Jason K.; Hall, Jim (2005): Advances in flood risk management under uncertainty. In *Stoch Environ Res Ris Assess* 19 (6), pp. 375–377.
- Madden, Marguerite; Ross, Amy (2009): Genocide and GIScience: Integrating Personal Narratives and Geographic Information Science to Study Human Rights. In *The Professional Geographer* 61 (4), pp. 508–526.
- McGranahan, G.; Balk, D.; Anderson, B. (2007): The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. In *Environment and Urbanization* 19 (1), pp. 17–37.
- Miola, Apollonia; Paccaghan, Vania; Papadimitrou, Eleni; Mandrici, Andrea (2015): Climate resilient development index: theoretical framework, selection criteria and fit-for-purpose indicators. Luxemburg: European Commission (JRC Science and Policy Reports).
- Mirza, M. M.Q.; Warrick, R. A.; Ericksen, N. J. (2013): The Implications of Climate Change on Floods of the Ganges, Brahmaputra and Meghna Rivers in Bangladesh. In *Climate Change* 57, pp. 287–318.
- Moss, R. H.; Meehl, G. A.; Lemos, M. C.; Smith, J. B.; Arnold, J. R.; Arnott, J. C. et al. (2013): Climate change. Hell and high water: practice-relevant adaptation science. In *Science* 342 (6159), pp. 696–698.
- Næss, Lars Otto; Bang, Guri; Eriksen, Siri; Vevatne, Jonas (2005): Institutional adaptation to climate change: Flood responses at the municipal level in Norway. In *Global Environmental Change* 15 (2), pp. 125–138.
- Næss, Lars Otto; Norland, Ingrid Thorsen; Lafferty, William M.; Aall, Carlo (2006): Data and processes linking vulnerability assessment to adaptation decision-making on climate change in Norway. In *Global Environmental Change* 16 (2), pp. 221–233.
- Pahl-Wostl, Claudia; Becker, Gert; Knieper, Christian; Sendzimir, Jan (2013): How Multilevel Societal Learning Processes Facilitate Transformative Change: A Comparative Case Study Analysis on Flood Management. In *Ecology and Society* 18 (4).
- Pelling, Mark (1999): The political ecology of flood hazard in urban Guyana. In *Geoforum* 30, pp. 249–261.
- Pelling, Mark; High, Chris (2005): Understanding adaptation: What can social capital offer assessments of adaptive capacity? In *Global Environmental Change* 15 (4), pp. 308–319.
- Pickles, John (1995a): Conclusion. Toward an economy of electronic representation and the virtual sign. In John Pickles (Ed.): *Ground truth. The social implications of geographic information systems*. New York: Guilford Press (Mappings), pp. 223–240.
- Pickles, John (Ed.) (1995b): *Ground truth. The social implications of geographic information systems*. New York: Guilford Press (Mappings).
- Restemeyer, Britta; Woltjer, Johan; van den Brink, Margo (2015): A strategy-based framework for assessing the flood resilience of cities – A Hamburg case study. In *Planning Theory & Practice* 16 (1), pp. 45–62.

- Rijke, Jeroen; Brown, Rebekah; Zevenbergen, Chris; Ashley, Richard; Farrelly, Megan; Morison, Peter; van Herk, Sebastiaan (2012): Fit-for-purpose governance. A framework to make adaptive governance operational. In *Environmental Science & Policy* 22, pp. 73–84.
- Rodríguez-Espíndola, Oscar; Gaytán, Juan (2015): Scenario-based preparedness plan for floods. In *Natural Hazards* 76 (2), pp. 1241–1262.
- Schuurman, Nadine (2004): GIS. A short introduction. Malden, MA.: Blackwell Pub. (Short introductions to geography).
- Smith, Kevin; Barrett, Christopher B.; Box, Paul W. (2000): Participatory Risk Mapping for Targeting Research and Assistance: With an Example from East African Pastoralists. In *World Development* 28 (11), pp. 1945–1959.
- Suriya, S.; Mudgal, B. V. (2012): Impact of urbanization on flooding: The Thirusoolam sub watershed – A case study. In *Journal of Hydrology* 412-413, pp. 210–219.
- Swart, Rob; Biesbroek, Robbert; Lourenço, Tiago Capela (2014): Science of adaptation to climate change and science for adaptation. In *Front. Environ. Sci.* 2, pp. 1–8.
- Szlafsztein and Sterr (2007): A GIS based vulnerability Assessment of Coastal Natural Hazards, State of Pará, Brazil. In *Journal of Coastal Conservation* 11 (1), pp. 53–66.
- Townsend, Philip A.; Walsh, Stephen J. (1998): Modeling floodplain inundation using an integrated GIS with radar and optical remote sensing. In *Geomorphology* 21 (3-4), pp. 295–312.
- Tran, Phong; Shaw, Rajib; Chantry, Guillaume; Norton, John (2009): GIS and local knowledge in disaster management: a case study of flood risk mapping in Viet Nam. In *Disasters* 33 (1), pp. 152–169.
- van Herk, Sebastiaan; Rijke, Jeroen; Zevenbergen, Chris; Ashley, Richard; Besseling, Broos (2013): Adaptive co-management and network learning in the Room for the River programme. In *Journal of Environmental Planning and Management* 58 (3), pp. 554–575.
- van Herk, Sebastiaan; Zevenbergen, Chris; Ashley, Richard; Rijke, Jeroen (2011): Learning and Action Alliances for the integration of flood risk management into urban planning: a new framework from empirical evidence from The Netherlands. In *Environmental Science & Policy* 14 (5), pp. 543–554.
- Verd, Joan Miquel; Porcel, Segio (2012): An Application of Qualitative Geographic Information Systems (GIS) in the Field of Urban Sociology Using ATLAS.ti: Uses and Reflections. In *Forum Qualitative Sozialforschung / Forum Qualitative Research* 13 (2).
- Wamsler, Christine (2006): Mainstreaming Risk Reduction in Urban Planning and Housing: A Challenge for International Aid Organisations. In *Disasters* 30 (2), pp. 151–177.
- Weichselgartner, Juergen (2003): Nach der Elbeflut 2002: Und danach? In *GIAA-Ecological Perspectives for Science and Society* 12 (4), pp. 245–248, checked on 3/18/2015.
- Wood, Denis; Fels, John; Krygier, John (2010): Rethinking the power of maps. New York: Guilford Press. Available online at <http://www.worldcat.org/oclc/471811787>.
- Zerger, Andre; Wealands, Stephen (2004): Beyond Modelling: Linking Models with GIS for Flood Risk Management. In *Natural Hazards* 33, pp. 191–208.

II.3 Book chapter: Travelling through the Densu Delta: Location, Place and Space in the Waterscape

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This book chapter has been published in Niewöhner et al. (2016) and can be cited as: Frick, F. (2016). Travelling Through the Densu Delta: Location, Place and Space in the Waterscape. In J. Niewöhner, A. Bruns, P. Hostert, T. Krueger, J. Ø. Nielsen, H. Haberl, . . . D. Müller (Eds.), *Land Use Competition* (pp. 333–346). Cham: Springer International Publishing. doi:10.1007/978-3-319-33628-2_20

Submitted: 17.12.2015, published: 2016

Abstract

In Greater Accra, Ghana, pressures on formerly undeveloped land increase with rising demand for land as a resource for housing development. Land - water interactions create a waterscape inflicted by risk: ongoing development negatively impacts downstream communities as it reduces the natural capacity of local wetlands to regulate high discharge levels and eventually leads to flooding. The absence of water and sanitation infrastructure exacerbates flood-related risks, and the conversion of land surface changes ecosystem functions, which further contributes to flooding and water pollution. The purpose of this contribution is to explore material and spatial socio-natural land water interactions that are shaping the Densu Delta waterscape. Dynamics in space in the waterscape are explored through the lens of competition over land- and water-use control at different sites along the flow of the lower Densu Delta. In the case study area urban development is both a cause of flood risk and a driver of risk reduction. As well-off areas gradually become served with basic infrastructure, less affluent communities along the road also experience less flooding and improved access to coping strategies. Competition over access to land thus often becomes a struggle over infrastructure. As a result of these ongoing processes, the nature of competition over land and water (use) is constantly changing in space, time and scale. Both land and water are unstable, fluid resources. The results show that competition between actors over the ownership of land is played out at a local level, between traditional authorities and individuals. Competition over the use of land by contrast is played out between local interest groups interested in further development on the one hand, and, on the other hand, governmental authorities at city and national level intending to preserve the land from being developed. International interests including ecosystem conservation, investment in land for development and industrial production mediate the competition over both land and the use of water.

II.3.1 Introduction

Human settlements have developed near rivers and coasts for centuries. As urbanisation continues to concentrate on coastal areas across the globe, river deltas, floodplains and wetlands are being altered. In combination with climate change impacts, this development implies a growing exposure of people to flood risk – because of both: more people living in flood prone areas and reduced capacities of coastal ecosystems to level off the impact of storm surges and high runoff levels (Kundzewicz et al. 2013; McGranahan et al. 2007; Alice Newton et al. 2012; Nicholls et al. 1999; Nicholls et al. 2008). People are shaping and are being shaped by coastal ecosystems and water flows. For instance, poor and vulnerable groups tend to live in the most flood-prone area of an urbanised flood-plain whereas more affluent groups usually live on less exposed sites, or where exposure is reduced by protective infrastructure such as levees. Such infrastructure in turn diverts flood risk to other areas, reproducing socio-economic inequalities and differential vulnerabilities (Boruff et al. 2005). At the same time waterbodies are a source of livelihoods for many coastal and riverine settlers. It is in this sense that floodplains and society have co-evolved over time and constitute a socionatural entity (Di Baldassarre et al. 2013).

Less than 20 km west of Accra, the expanding capital of Ghana, lies the Densu Delta (Figure 1). The Densu wetland and the Sakumo lagoon through which the river discharges into the Atlantic Ocean are protected as a Ramsar site (convention for the protection of wetlands), to maintain these ecosystems as habitat for migratory bird species (Denutsui et al. 2012). Only a few kilometers upstream the Densu river has been dammed in the 1950s to provide water for irrigation of agricultural land and to supply Accra with water (Kuma and Ashley 2008). However, as the population has increased in size over the past decades, industrial, agricultural and urban land uses have intensified and are increasingly degrading the ecological functions and natural resources in the Densu river, the Weija reservoir, the Densu wetlands and the Sakumo lagoon (Fianko et al. 2009; Kusimi 2008a). Pressures on formerly undeveloped land have increased with rising demand for land as a resource for housing

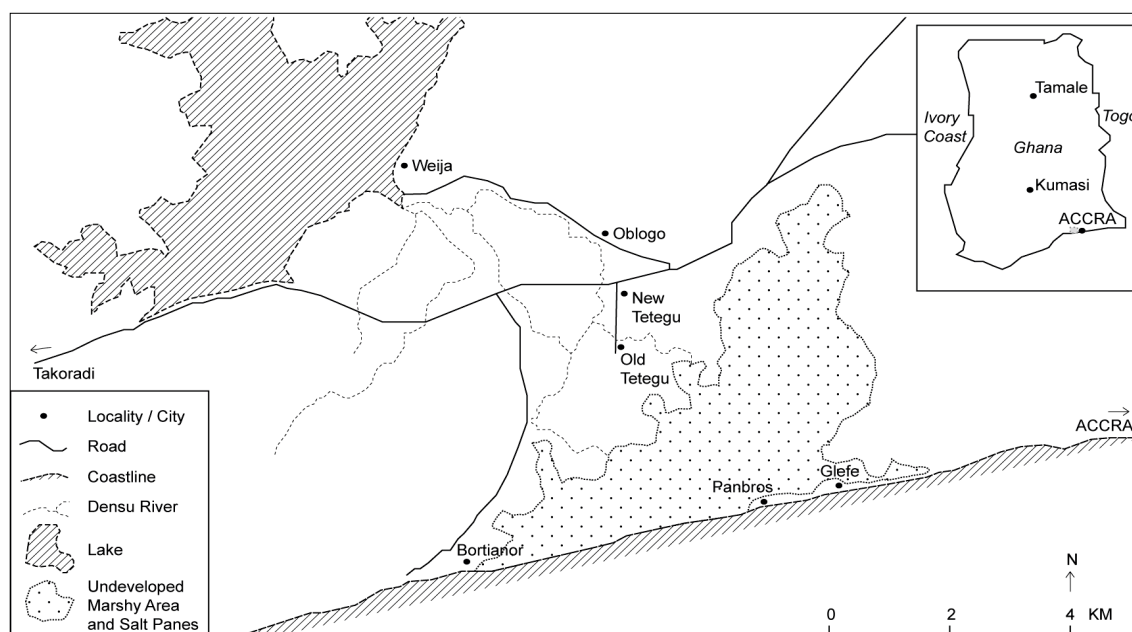


Figure IIC.1 The Densu delta. Source: Own design based on Osei et al. 2010 and Google Maps/Google Earth 2016

development, fuelled by litigation and speculation on land (Barry and Danso 2014; Doan and Oduro 2012). At the same time, the combined processes of sedimentation, pollution and urbanization have led to an increasing number of households being exposed to flooding, shortage of potable water, and disturbance of livelihood strategies (Kuma and Ashley 2008; Kusimi 2008a; Osei et al. 2011).

In light of the multifaceted character of social and ecological interactions linked to water, the concept of waterscape has been introduced by critical geographers. A waterscape can be understood as “a socionatural entity, in which water and power are coproduced and expressed” (Budds and Hinojosa 2012, p. 133). It is constantly shaped and altered as co-production is played out in material forms such as infrastructure and land use, as well as in discourse and social practices around water. (Ahlers et al. 2014). While more conventional studies on situations similar to that described on the Densu Delta focus on competition and conflict over resources, research on waterscapes and the hybrid landscapes seeks to elicit the ‘subtle contestations’ over resources, environments and landscapes that shape people’s livelihoods (Goodman et al. 2008). The latter approach emphasizes the action of disputing rather than the end of gaining, winning, defeating or establishing superiority that is entailed in ‘competition’ (cf. Oxford University Press 2015, see also chpt. 1). A waterscape analysis implies changes in the distribution and use of resources are to be understood not as the outcome of a competition over the resources themselves but over the power to control resource use. (Funder and Marani 2015). Subtle contestations as well as competition over water and land control between actors are played out in land- and water-use change on the ground. Contestations of meanings are a means of conscious and unconscious competition over resource control and shape co-production in a waterscape. Water acts as an agent shaping social relations and discourse, and vice versa, and space and scale are constantly reconfigured (Allan 2004; Budds 2008; Budds and Hinojosa 2012).

The purpose of this contribution is to explore material and spatial socio-natural land water interactions that are shaping the Densu Delta waterscape. More specifically: what are the objects, actors, interactions and scales involved in contestation and competition over land and water use control at different sites along the Densu Delta? A journey along the river serves to identify the different forms of competition over land and water use control in the Densu Delta waterscape in its spatial dimension. Here the river is taken as a point of reference for an imagined transect through the waterscape’s spatial dimension. Selected sites are analysed for objects and modes of competition over land and water control. The covariance of anthropogenic and river flows and reach of interactions are discussed subsequently. Methods are a review of literature and grey literature, transect walks, and narrative interviews with actors in the case study area. Fieldwork in the Densu Delta was conducted between April and July 2014.

II.3.2 A journey along the Densu Delta

The Densu river, which originates in the Eastern Region in Ghana, was dammed at Weija in 1952, creating the Densu reservoir for irrigation of close-by agricultural lands and water

supply to Accra. After the first dam breached as a result of flooding in 1968, the present dam was erected in 1978 (Kuma and Ashley 2008). The quality of water collected in the reservoir is poor, mainly due to discharge of industrial and agricultural pollutants upstream, but also due to nearby domestic discharges. The pollution of the water contained in and discharged from the reservoir potentially enhances flood-related and fishing-related risks²⁶ as the water acts as a vector for diseases. Upstream land-use change further contributes to siltation of the Weija reservoir, thus reducing its storage capacity (Kusimi 2008b). Water discharge into the reservoir currently exceeds extraction and necessitates regular spillage during the rainy season, as a manager of the Ghana Water Company explains:

“The dam was built purposely for two things: one for Ghana Water [Company] to extract 30% of whatever was in the reservoir to treat for the people of Accra, and two for irrigation development authority to also extract 60% for irrigation purposes. There used to be (...) farmland (...) but for some time now the aspect of irrigation has been suspended because the farmlands have been converted into building lands and people have built on it. So in short what it means is that the 60% percent that the irrigation authority was supposed to extract for irrigation purposes is still sitting in the reservoir. However we have reached our maximum of 30% (...). If we have to extract more water from the reservoir then we have to sit with the Water Resources Commission, sit with the Irrigation Development Authority and strike an agreement that (...) we maybe take additional 30% for the purposes of treating water. That is, when we have an expansion [of treatment facilities].”

(GWCL Manager 2014)

For the treatment process to meet WHO standards for drinking water, the company is using chemicals and lime imported from China and Europe. At accelerating inflation rates, this procedure is becoming increasingly unsustainable. Hence an expansion of the treatment plant currently appears unlikely. Small scale subsistence fishery is practiced in the reservoir, a livelihood strategy among the local population that – according to the GWCL official interviewed - potentially exacerbates pollution of the water and is therefore monitored by GWCL.

The Weija dam has five gates, which are closed during the dry season and partly opened during the rainy season when water levels in the reservoir are rising as a result of increased rainfall in the Eastern Region, to regulate water levels and prevent overspill. Roughly once or twice in two years incoming water quantities are so large that the full opening of all five gates of the dam is necessary to avoid uncontrolled overspill of the dam. In this case, water levels downstream rise significantly and result in flooding of streets and houses in close-by neighbourhoods, as occurred in June 2014. To prevent such damaging events from happening, water levels and rainfall data are monitored on a daily basis at Nsawam station roughly 30 km upstream and reported to the Weija dam management station to guide decisions on opening the dam gates. Sites close to the dam along the reservoir and the river shore are being converted into plots and developed for housing. GWCL sends out warning

²⁶ I use the definition by Wisner et al. of risk as “a compound function of the natural hazard and the number of people, characterised by their varying degrees of vulnerability to that specific hazard, who occupy the space and time of exposure to the hazard event” (Wisner et al. (2004).

letters at the beginning of each rainy season and visits chiefs and other spokespersons of communities located downstream on the day preceding a dam release to warn residents of upcoming floods.

The topography of the landscape allows water from Weija to be channelled to Accra by gravity. The first neighbourhood along the way is Oblogo, situated on the slopes of the Densu valley. In the midst of the settlement only a few kilometres downstream of the Weija dam, a large open dumpsite is situated. 1250 tons of solid waste have been brought here daily from Accra for more than 10 years from 2002 onwards without any environmental health protection measures: Pollutants have leached into the groundwater and from there travelled into the Densu river which serves as a raw water source for many households of the area, and have ended up in the Densu wetland (Osei et al. 2011). Fire outbreaks on the dumpsite have frequently led to the spreading of toxic fumes in recent years. According to a community leader, this is a much more immediate risk faced by the inhabitants than that of flooding, as they can adapt to the latter. The dumpsite is now closed and being covered with gravel for beautification purposes by a local investor –a measure that does not, however, halt groundwater leaching.

South of the Accra-Cape Coast highway the river opens into the Densu wetland, stretching over approximately 20 km² from here to the coast and providing habitat for rare migratory bird species and marine turtles, besides providing protection from flooding. The delta has been declared a Ramsar site, protected under the international convention through the national Wildlife Division. It is being encroached on from all sides because of limited support from both municipalities and traditional leaders:

“Wetlands (...) absorb more runoff water and therefore they tend to minimize or reduce flooding, but [municipal authorities] don’t see it that way. They want us to go and build some physical structures that require huge sums of money, they don’t want wetlands to perform its natural functions. (...) The other challenge is the fact that the land belongs to the people, to traditions, to clans, to chiefs (...). We are trying to adopt a management approach that will seek the support of all stakeholders. But because the area is close to the urban sector (...) the economic value of the land keeps increasing and it will be difficult for you to convince a chief who owns the land to leave mangroves in the area as compared to selling of the land to a developer.”

(Manager at the Wildlife Division, Accra, June 2014)

Regardless of the rapid deterioration of the conservation site, it continues to be visited by eco-tourists.

The first settlement through which the Densu flows into the delta is New Tetegu, a settlement established in the course of relocation of Old Tetegu after the latter had been hit by severe floods in the 1960s. The rapid development of middle and high income housing in the area has given the community’s landowners association considerable power in negotiation for infrastructure. Anticipating the property taxes to be gained from the community, the municipality has granted building permits to all houses in the community in 2010, which paved the way for infrastructure development by governmental authorities. Gutters, water

pipes, electricity and a river wall have been installed, and the road up to the bridge leading to Old Tetegu has been paved. The community has moreover negotiated with Ghana Water Company that dam openings be reduced to a minimum, reducing the chance of flooding in the community.

New Tetegu is delimited by the bifurcation of the Densu River. Old Tetegu comprises an old fishermen's village, Dzelukope, as well as large areas of new development. Dzelukope used to be cut off from other communities by the two streams of the Densu. It is now connected to New Tetegu by a bridge that has presumably been erected in the interest of investors looking to acquire land south of Dzelukope. Here wetlands are being reclaimed for plot development by the community's chiefs who act as caretakers for the custodian, the Aplaku stool chief from Jamestown in central Accra. Litigation over landownership between different proclaimed chiefs is strong, and the setup of the chieftaincy system is intransparent. Regardless of Greater Accra planning documents that designate the area as a 'green belt', the caretakers plan to sell plots from the community's current edge up to the seafront. Built into the wetland, all of the houses in Old and New Tetegu are exposed to flooding and inundation, particularly in the rainy season. Residents recall flood events in the past that have destroyed homes or made them uninhabitable for weeks. They have, however, developed a number of strategies to bear the flooding such as raising houses and navigating flooded streets in canoes, and do not perceive flooding as a major risk. What is a major concern particularly to fishermen in Dzelukope is that

“the Densu River is being contaminated [because] some people at the other side [of the river], they put gutters, their excess water, urine and that kind of thing they just (...) pipe into the river. It worries the fishes and even it affects us because (...) we feed on the fish and at times we use the water raw. At times when they [the GWCL] close the pipe borne water we depend on the Densu River. We use it to bath, clean our utensils; when it is difficult people use it to cook.”

(Fisherman in Dzelukope, May 2014)

Following the western river arm from Dzelukope, the swampy land is pervaded by scattered construction sites of large concrete houses and plots marked for development. The vast majority of these houses are uninhabited and most construction sites seem abandoned. Speculation and litigation is high in the two neighbourhoods to which these plots belong, namely Old Tetegu and Bortianor, both controlled by influential stools (Barry and Danso 2014). The stream finally enters the sea at Bojo beach, a resort popular with expats and the upper middle class living in Accra. Here surrounding mangroves and a wide beach conceal the vast anthropogenic interferences with the ecosystem. The beach offers a view of Faana-Bortianor, an isolated traditional fisher village of wooden huts that can be reached by canoe only.

Along the eastern stream, the Densu water passes basins for salt production managed by Panbros Salt Industry. The company was established in the 1950s by a Greek investor. South-East of Panbros Salt Industry, sandwiched between the Sakumo lagoon and the Atlantic Ocean, lies Glefe, an old Ga fishermen village. Panbros Salt Industry is a major employer of

Glefe residents, but at the same time is seen as the origin of frequent flooding, as the salt basins prevent discharge of excess water:

“Panbros Salt Industry, they are the number one problem why this place [gets flooded]. [They blocked the lagoon outfall], so whenever it rains [the water] can’t (...) get through here to the sea and whenever the level of the sea is high then the water become[s] stagnant. It cannot flow into the sea again, so it enter[s] into people’s houses, people’s rooms and you see them coming out calling NADMO, AMA to do something.”

Community leader (assemblyman of Glefe-Mpoase), May 2014

Stagnating rainwater in the lagoon is, however, not the only source of flood risk in Glefe. The village is constantly moving inland as a result of ongoing shoreline erosion. On top of that, Glefe has undergone rapid development over past decades, mainly from low-income migrants from across Accra and neighbouring countries who construct their houses on land obtained from local chiefs. As the land between the lagoon and the sea is limited, reclaiming more land from the lagoon by depositing gravel, stones and waste is a common practice. New settlers purchasing land are often unaware of the exposure before experiencing the first rainfall. Sand is mined at the beachside of Glefe as cheap building material for raising structures, creating a tension between those at risk from shoreline erosion and those on reclaimed land in the lagoon. Since part of Glefe’s land area is below sea level, simple gutters are no option for waste- and stormwater discharge. A few households have constructed individual drains, which end abruptly on the only street, creating ponds of waste water. Other than that, water is left to drain away into the unpaved ground. In light of the poor sanitary conditions in the community, government officials describe the community as the new ‘Sodom and Gomorrah’ – referring to the colloquial name of the allegedly most deprived informal settlement of Accra. Just as in surrounding communities, land litigation and conflict over chieftaincy are common in Glefe. Land speculation has added to the chaotic layout of the settlement that impedes proper infrastructure development. Neither ambulances, fire brigades, nor any other emergency vehicle can access the dense settlement. Solid waste is dumped next to the lagoon in the absence of waste collection services and thus adds to the pollution of the lagoon and consequently the Densu wetland.

Competition and the land-water nexus in the Densu Delta waterscape

In sum the journey through the Densu Delta illustrates that different objects, actors, modes of competition and scales are involved in contestation over land and water use control at different sites.

At the starting point of the journey, around the Weija reservoir, settlers, governmental agencies (here: the irrigation authority) and a private company (Ghana Water Company Limited, GWCL) compete for controlling water as a resource for fishery, agricultural production and extraction of potable water, respectively. Upstream of the dam the main object of contestation is the quality of water, whereas it is mainly the quantity of water flows in contestation between GWCL and downstream settlers. Both objects of contestation are not

stable, but have historically developed in socio-ecological interactions (cf. chpt. 22)²⁷. In the context of ongoing urbanisation both quality and quantity are becoming increasingly contested. Modes of competition over water quality control are formal regulations enforced by GWCL in combination with more ‘informal’ control mechanisms among fishermen. Modes of competition over water quantity control include a formal agreement between governmental agencies and GWCL, as well as less formal arrangements between residents’ association, assembly man, traditional authorities and GWCL following the petitioning of GWCL by traditional authorities.

In Oblogo, land-water interactions are shaped by the competition over land between actors responsible for managing Accra’s waste, and individuals protecting their backyards. The location of the Oblogo landfill in a risk-prone informal settlement as well as the absence of waste management in Glefe suggest a power game in Accra that is played out in the competition over control of land as a resource for development. Only a very small fraction of Accra’s population, living in high-income areas of the city, is served by household waste collection services. Less affluent areas are served by waste collection from communal containers, which are often inadequate in size and irregularly collected, and thus create unsanitary conditions such as is the case in Glefe. Both waste collected from households and that from containers is brought to open dumpsites that are unsanitary and thus present health risks to adjacent settlers. Regardless of such risks, the selection of sites for dumps is guided by the price of the land and accessibility for trucks, rather than considerations of environmental justice (Boadi and Kuitunen 2003; Oteng-Ababio 2013). As a result, the location of dumpsites serving Accra coincides with that of poor and indigenous areas in the urban fringe and has caused social unrest in Oblogo in the past (Oteng-Ababio 2013).

Competition over control of land as a resource for development is particularly evident in the Densu wetlands. Governmental authorities representing different interests and levels of decision-making, traditional authorities and land owners, Panbros Salt industries, residents and new migrants all have a stake in either developing the land for residential use, or keeping it free from development. Beyond competition over the land use, traditional authorities contest land ownership. The unclear situation of land ownership in Tetegu, Bortianor and Glefe is leading to physical fights over plots (Abbey 2013). Guards are being contracted by chiefs to protect land and tear down buildings they consider illegitimate (Ghana News Agency 2013). Development that grossly contradicts planning guidelines and standards is not a particularity of the Densu Delta area, but can be observed across Greater Accra as well as urban Ghana as a whole. Reminders of colonial land management in current urban planning, unaccountable use of expropriated land by the government as well as the co-optation of land market mechanisms by traditional chiefs in the urban fringe contribute to ongoing land

²⁷ Changes in land use from rural to urban have created an imbalance in the management of the reservoir and thus spurred competition over land and water use control. The construction and management of the dam has changed local opportunities and necessities of land use, for instance by enabling irrigated agriculture and housing development in areas that had previously been exposed to regular flooding. In combination with rising demand for (and thus economic value of) land for development, this has led to the emergence of control over land as a resource for development as an object of competition among and between traditional and governmental authorities.

disputes (Mensah 2003). In competition over land as a resource for development, the modes of competition are again a mixture of formal regulations (by laws and land use planning by AMA), management contracts between Panbros Salt and Wildlife Division, mechanisms not formally codified and often based on violence and speculation, and traditional leadership.

The periodical overabundance of water in the wetland that eventually results in flooding creates tensions between the interest of conservationists (namely the Wildlife Division, acting as a national representative of the international Ramsar convention) to restore and protect wetlands and their ecosystem service of flood prevention on the one hand, and the desire to protect developed plots in the wetland from floods on the other hand. The competition over land as a resource for development enhances the scattered development of Accra's peri-urban areas, with "pockets of undeveloped land surrounded by vast stretches of built-up areas" (Doan and Oduro 2012, p. 1320). As a consequence, compacted soils and impermeable surfaces are spreading into the wetland thus continuously reducing its capacity as a buffer for water retention. The levees built in Tetegu trigger what is known as the 'levee effect' by which the risk of flooding is transferred to settlements up- and downstream (Di Baldassarre et al. 2013). Accordingly, Glefe was severely affected by the opening of the Weija dam in June 2014. Besides, levees tend to create an intriguing sense of security that attracts people to risk-prone areas (Di Baldassarre et al. 2013), indicated in Tetegu by low perceptions of risk from flooding among most interviewees, even shortly after the June 2014 flood event.

Competition and contestation in controlling unstable resources

The analysis of actors, objects, modes and scales reveals two characteristics of the Densu Delta waterscape read through the lens of space: Firstly, the contestation over land- and water-use control is chiefly driven by the occupation of land in the river's buffer zone and the lagoon. Rising land prices and demands for land for housing development creates an incentive for further land reclamation, which in turn alters water flows. Thus both land and water are fluid resources, there is no stable pool of these resources over which actors compete. In and around Weija, urbanization of agricultural land has altered the demand for irrigation water, and reduced the outtake of water for this purpose from the reservoir. As the treatment plant's capacity is limited, this has resulted in regular overabundance of water in the reservoir during the wet season, making dam spillage necessary. Variabilities in the quantity of discharge water across the delta are thus the consequence of both natural rainfall and urbanization patterns. In Tetegu, ongoing development of the wetland implies that land which is part of the river's discharge area is being occupied by residential land use – In other words, the boundaries between land and water are redefined, and contestation over land use control involves the contestation over the control of water flows. This is even more explicit in Glefe where land is claimed from a lagoon, i.e. a permanent water body. Contestations over land and water use control are thus not only strongly interlinked. The stocks of these resources themselves are constantly reconfigured and are thus 'fluid'.

Secondly, the different faces of contestation and competition over land and water control at different points in the Densu Delta are linked by moments of land-water interactions and shape the spatial dimension of the waterscape. Waterflows link Weija to Nsawam in the

Eastern region, to Accra and Tetegu and the Sakumo lagoon at Glefe. Waste flows from Accra to Oblogo and continues to flow into groundwater as leakage on site. In Oblogo local wastewater flows separate the affluent and serviced New Tetegu from the old fisher village by discharging into and thus polluting the Densu that forms the natural boundary between the two parts of the locality. Infrastructure in Weija connects the place to Accra via water pipelines, and separates the Weija lake and upstream areas from downstream localities in the form of the dam. The separation is paralleled by governance arrangements that are designed to protect water quality in the reservoir and improve it at the treatment plant for Accra's water supply, whereas downstream of the dam water quality is not monitored or protected by any formal arrangement. Local institutional arrangements compete with national representatives responsible for implementation of the international interest in wetland conservation over the control of land use. Rights to sell and access land and infrastructure have repeatedly been the object of contestation in all localities analyzed, which has spurred haphazard urbanization of the delta. And finally, divergent discourses on risk from flooding and water pollution are used by different actors to legitimize and contest wetland land and water use in the Densu Delta²⁸. Discursive coalitions can be identified between community representatives of Tetegu and the GWCL official in presenting flood risk in the Densu Delta as 'manageable', provided the infrastructure is in place.

Both the fluid nature of land and water, and the moments of their interaction create a waterscape that has a spatial dimension but at the same time shifting boundaries that are difficult to define. The moments of land-water interaction, which have only briefly been addressed here, indicate that the Densu Delta waterscape forms part of urban Accra, particularly in providing infrastructure for water, urban development and waste management. It is at the same time a peri-urban area providing eco-system services to the city (water supply, land) and for local livelihood strategies that are conventionally considered 'rural', such as fishery. The wetland's value as a habitat for migratory birds moreover construct it as part of a global network of conservation sites – however, this global dimension of the waterscape might vanish as the site is threatened to lose its Ramsar site status as a result of ongoing environmental degradation (interview with Wildlife official, May 2014). The analysis therein points at how scales are 'jumped' and 'shifted' in multi-level power dynamics and relations in the contentious geographies of a waterscape (Goodman et al. 2008).

II.3.3 Conclusion

“Not only does the valley rule the stream, [...] but increasingly, human activities rule the valley” (Allan 2004). The cross-scale interactions, legacy effects, covariance of anthropogenic activities and ecological processes and non-linearities identified by Allan in stream ecosystems are equally present in the Densu Delta. To begin with, the waterscape is shaped by the competition between actors over land, the use of land, and the use of water.

²⁸ Compare, for instance, Tetegu's residents' statement that 'flooding is not a problem' with their ongoing activities in constructing a river wall, and with the academic literature presenting the area as highly flood-prone Nyarko (2000).

The competition between actors over the ownership of land is played out at a local level, between traditional authorities and individuals. Competition over the use of land by contrast is played out between local interest groups interested in further development on the one hand, and on the other governmental authorities at city and national level who intend to preserve the land from being developed²⁹. International interests including ecosystem conservation, investment in land for development and industrial production mediate the competition over both land and the use of water. Spatial interactions and legacy effects are manifested for instance in Weija, where the dam as large scale infrastructure is reducing everyday risks from flooding of nearby households while enabling encroachment of the wetlands.

Water and land are linked once more as the development of land for housing is influenced by the abundance of surface waters as a source of livelihoods in fishery, tourism and salt production, for delivering water to the city and as a source of environmental risks. At the same time the quality and distribution of water in the case study area is transformed by the modification of land surfaces and land use change, e.g. through pollution, decrease of infiltration rates and enhanced surface runoff, and infrastructure development.

“Thinking in terms of waterscapes avoids confining analyses to conventional scalar containers, and taking scale choices for granted.” (Budds and Hinojosa 2012) The findings from this case study support the argument that rather than looking at watersheds, a flexible take on scale and space is key in understanding and governing a waterscape. Both water and land in the Densu Delta waterscape are non-constant resources, their availability is fluid: water because it flows, and because of its seasonal variability in quantity and variability in quality in both space and time, and land because new land is being reclaimed at the same time as sites are becoming uninhabitable due to enhanced flood risks. Water, as a result of the land use changes, has become an unusable resource and a source of environmental risk to health, property, and lives. It is undergoing a transformation from a resource for livelihoods to also being an environmental hazard, thereby also transforming the quality of land as a resource for socio-economic development. Land has become a commodity of economic speculation. The quality of land for housing development is further transformed in uncontrollable ways as upstream modifications and development enhance the risk of flooding on plots further downstream. Here, land competition is mediated through space and by the river as the vector that connects places. As the stock of the resource(s) being competed for is unstable, the nature of competition in the Densu Delta waterscape is constantly changing in space, time and scale.

Looking at competition and contestation over land and water use control allowed for a specific understanding of the socio-natural production of the Densu Delta waterscape as it is played out its spatial and material dimension. Nonmaterial dimensions of the waterscape such as discourse and rights have only been touched on in this analysis. A closer analysis of these

²⁹In general, local interest groups act in the interest of certain individuals, on a short term basis, whereas official government actions represent national and long-term interests. The main interests of local actors are access to affordable and safe land for housing purposes and economic gains from land plot sales respectively. National and city level interests are the protection of residents from environmental hazards and the fostering of socioeconomic development.

components would allow for a better understanding of the socio-political reproduction of risk and vulnerability in the waterscape.

Acknowledgements

This research has been (partly) funded by the German Federal Ministry of Education and Research (BMBF) under the (project funding) reference number 01 LN 1316 A and Heinrich-Böll-Stiftung under the funding reference number P105800. The paper is a contribution to THESys Summer School.

I would like to thank Esinam Attipoe, Esther Dansu-Wiredu, Martin Oteng-Ababio and Kofi Owusu for their invaluable comments in interpreting my findings, and all interview partners in the Densu Delta for sharing their knowledge and experiences with me.

II.3.4 References

- Abbey EE (2013) Bortianor youth protest sale of land. Daily Graphic Ghana
- Ahlers R, Cleaver F, Rusca M, Schwartz K (2014) Informal Space in the Urban Waterscape: Disaggregation and Co-Production of Water Services. *Water Alternatives*
- Alice Newton, Tim J.B. Carruthers, John Icely (2012) The coastal syndromes and hotspots on the coast. *Estuarine, Coastal and Shelf Science* 96:39–47
- Allan JD (2004) Landscapes and Riverscapes: The Influence of Land Use on Stream Ecosystems. *Annual Review of Ecology, Evolution, and Systematics* 35(1):257–284. doi: 10.1146/annurev.ecolsys.35.120202.110122
- Barry M, Danso EK (2014) Tenure security, land registration and customary tenure in a peri-urban Accra community. *Land Use Policy* 39:358–365. doi: 10.1016/j.landusepol.2014.01.017
- Boadi K, Kuitunen M (2003) Municipal solid waste management in the Accra metropolitan area, Ghana. *The Environmentalist* 23:211–218
- Boruff BJ, Emrich C, Cutter SL (2005) Erosion Hazard Vulnerability of US Coastal Counties. *Journal of Coastal Research* 215:932–942. doi: 10.2112/04-0172.1
- Budds J (2008) Whose Scarcity? The Hydrosocial Cycle and the Changing Waterscape of La Ligua River Basin, Chile. In: Michael K. Goodman, Maxwell T. Boykoff and Kyle T. Evered (ed) *Contentious Geographies : Environmental Knowledge, Meaning, Scale* (Ashgate Studies in Environmental Policy and Practice), pp 59–79
- Budds J, Hinojosa L (2012) Restructuring and Rescaling Water Governance in Mining Contexts: The Co-Production of Waterscapes in Peru. *Water Alternatives* 5(1):119–137
- Denutsui D, Akiti TT, Osae S, Blankson-Arthur S, Tutu A, Buah-Kwofi A, Palm N (2012) Investigating sea water influence and water quality assessment for different purposes in densu delta wetland, Accra, Ghana. *Elixir Agriculture* 42:6069–6073
- Di Baldassarre G, Kooy M, Kemerink JS, Brandimarte L (2013) Towards understanding the dynamic behaviour of floodplains as human-water systems. *Hydrol. Earth Syst. Sci.* 17(8):3235–3244. doi: 10.5194/hess-17-3235-2013
- Doan P, Oduro CY (2012) Patterns of Population Growth in Peri-Urban Accra, Ghana. *International Journal of Urban and Regional Research* 36(6):1306–1325. doi: 10.1111/j.1468-2427.2011.01075.x
- Fianko JR, Osae S, Achel D (2009) Impact of anthropogenic activities on the Densu River in Ghana. *Water and Environment Journal* 23(3):229–234. doi: 10.1111/j.1747-6593.2008.00137.x
- Funder M, Marani M (2015) Local bureaucrats as bricoleurs. The everyday implementation practices of county environment officers in rural Kenya. *International Journal of the Commons* 9(1):87–106
- Ghana News Agency (2013) Land guard terrorises land owners at Bortianor, December 19
- Goodman MK, Boykoff MT, Evered KT (2008) *Contentious Geographies: Environmental Knowledge, Meaning, Scale*. In: Michael K. Goodman, Maxwell T. Boykoff and Kyle T. Evered (ed) *Contentious Geographies : Environmental Knowledge, Meaning, Scale* (Ashgate Studies in Environmental Policy and Practice), pp 1–23

- GWCL Manager (2014) Interview at Weija dam and treatment plant
- Kuma J, Ashley D (2008) Runoff estimates into the Weija reservoir and its implications for water supply to the Accra area, Ghana. *Journal of Urban and Environmental Engineering* 2(2):33–40. doi: 10.4090/juee.2008.v2n2.033040
- Kundzewicz ZW, Kanae S, Seneviratne SI, Handmer J, Nicholls N, Peduzzi P, Mechler R, Bouwer LM, Arnell N, Mach K, Muir-Wood R, Brakenridge GR, Kron W, Benito G, Honda Y, Takahashi K, Sherstyukov B (2013) Flood risk and climate change: global and regional perspectives. *Hydrological Sciences Journal* 59(1):1–28. doi: 10.1080/02626667.2013.857411
- Kusimi JM (2008a) Analysis of Sedimentation Rates in the Densu River Channel: The Result of Erosion and Anthropogenic Activities in the Densu Basin. *West African Journal of Applied Ecology* 14
- Kusimi JM (2008b) Stream Processes and Dynamics in the Morphology of the Densu River Channel in Ghana. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Sciences XXXVII(Part B8 Beijing):1177–1182*
- McGranahan G, Balk D, Anderson B (2007) The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. *Environment and Urbanization* 19(1):17–37. doi: 10.1177/0956247807076960
- Mensah SO (2003) The Institutional Capacity for Land Utilization for Development: Constraints and Suggested Solutions. In: Ghana Academy of Arts and Sciences (ed) *Land as a Resource for Development*. Ghana University Press, Accra, Ghana
- Nicholls RJ, Hoozemans, Frank M J, Marchand M (1999) Increasing flood risk and wetland losses due to global sea-level rise: regional and global analyses. *Global Environmental Change* 9:569–587
- Nicholls RJ, Wong PP, Burkett V, Woodroffe CD, Hay J (2008) Climate change and coastal vulnerability assessment: scenarios for integrated assessment. *Sustainability Science* 3:89–102
- Nyarko BK (2000) Flood risk zoning of Ghana: Accra experience. *International Archives of Photogrammetry and Remote Sensing* 33(B7/3; PART 7):1039–1050
- Osei J, Nyame F, Armah AK, Osaе S, Dampare SB, Fianko JR, Adomako D, Bentil N (2010) Application of Multivariate Analysis for Identification of Pollution Sources in the Densu Delta Wetland in the Vicinity of a Landfill Site in Ghana. *JWARP* 2(12):1020–1029. doi: 10.4236/jwarp.2010.212122
- Osei J, Osaе S, Adamako D, Laar C, Anim AK, Ganyaglo SY, Nyarku M, Nyarko ES (2011) The Impact of Oblogo Landfill Site in Accra-Ghana on the Surrounding Environment. *Research Journal of Environmental and Earth Sciences* 3(6):633–636
- Oteng-Ababio M (2013) Unscripted (in)justice: exposure to ecological hazards in metropolitan Accra. *Environment and Planning A* 45(5):1199–1218. doi: 10.1068/a45256
- Oxford University Press (ed) (2015) *Oxford Dictionaries*, Oxford, UK
- Scolobig A, Pelling M (2015) The co-production of risk from a natural hazards perspective: Science and policy interaction for landslide risk management in Italy. *Nat Hazards*. doi: 10.1007/s11069-015-1702-1
- Wisner B, Blaikie P, Cannon T, Davis I (2004) *At risk: Natural hazards people’s vulnerability and disasters*, 2. ed. Routledge, Oxon, New York, NY

7. Supplemental material

7.1 List of interviews

List of interviews conducted

ID	Date	Location	Position/ Description of Interviewee	Type (E=expert; S=stakeholder; st=street)	Organisation
00	28.04.2014	Accra	Deputy Director of Hydromet of NADMO; Researcher	E	NADMO
001	28.04.2014	Accra	Director of Hydromet of NADMO	E	NADMO
002	01.05.2014	Gleefe	Assembly member	S	Glefe
003	01.05.2014	Gleefe	Mankrado and Acting Chief	S	Glefe
004	07.05.2014	Gleefe	Head of the Pentecoast School	S	Glefe
005	07.05.2014	Gleefe	Owner of the Pentecoast School and Elder of Pentecoast Church	S	Glefe
006	07.05.2014	Gleefe	Head of the Intl School, Princess	S	Glefe
007	07.05.2014	Gleefe	Chairman of the Gleefe Community Development Association	S	Glefe
008	07.05.2014	Gleefe	Queen Mother	S	Glefe
009	08.05.2014	Chorkor	Head of NADMO Ablekum Submet. Office; information manager at NADMO Ablekuma submet.	E	NADMO
010	08.05.2014	Chorkor	Head of Env Health Unit at Ablekuma Submet.	E	Environmental Health Unit
011	11.05.2014	Gleefe	Chief	S	Glefe
012	14.05.2014	Gleefe	Street seller	st	Glefe
013	14.05.2014	Gleefe	Fisherman living in floodprone area	st	Glefe
014	14.05.2014	Gleefe	Resident (Ewe; tailor)	st	Glefe
015	14.05.2014	Gleefe	Shop-owner, long time resident in Gleefe	st	Glefe
016	14.05.2014	Gleefe	Residnt (Ewe), houseowner	st	Glefe
017	14.05.2014	Gleefe	Migrant from Chorkor, woman headed household, houseowner	st	Glefe
018	19.05.2014	Accra	Former Director of Hydro Services, independent consultant	E	
019	19.05.2014	Accra	Director of NADMO at AMA	E	NADMO
020	20.05.2014	Weija	Operations Manager NADMO at Ga South	E	NADMO
021	21.05.2014	Tetegu	Stool elder Tetegu	S	Tetegu
022	21.05.2014	Tetegu	Stool linguist	S	Tetegu
023	21.05.2014	Weija	Tetegu Chief	S	Tetegu
024	21.05.2014	Oblogo	Assembly member	S	Tetegu
025	21.05.2014	Tetegu	Elder	S	Tetegu
026	24.05.2014	Tetegu	Chief of New Tetegu	S	Tetegu
027	24.05.2014	Tetegu	Residents' association representative	S	Tetegu
028	24.05.2014	Tetegu	Owner of Holy Cross school; member of residents' association	S	Tetegu
029	24.05.2014	Tetegu	Resident	st	Tetegu
030	24.05.2014	Tetegu	Resident	st	Tetegu
031	24.05.2014	Tetegu	Resident	st	Tetegu

032	24.05.2014	Tetegu	Resident	st	Tetegu
033	26.05.2014	Gleefe	Chairman of migrants' and residents' associations in Gleefe	S	Glefe
034	27.05.2014	Accra	Operations manager at Hydro	E	Hydrological Services Department
035	28.05.2014	Accra	Director of Town and Country Planning Accra	E	Town and Country Planning
036	29.05.2014	Accra	Head of drainage section at Hydro Services Dpt	E	Hydrological Services Department
037	30.05.2014	Accra	Director of Red Cross Ghana, AMA (Greater Accra?) Office	E	Red Cross
038	02.06.2014	Gleefe	Member of voluntary group Red Cross Dansoman	S	Red Cross
039	27.06.2014	Accra	Head of Emergency Relief and Operations at NADMO HQ	E	NADMO
040	27.06.2014	Gleefe	Assembly Member	S	Glefe
041	28.06.2014	Gleefe	Chairman of the Gleefe Community Development Association	E	Glefe
042	28.06.2014	Tetegu	Elder	S	Tetegu
043	02.07.2014	Mallam	Red Cross Volunteer (Coordinator)	S	Red Cross
044	03.07.2014	Accra	Ghana Red Cross Society National Senior First Aid Instructor	S	Red Cross
045	03.07.2014	Accra	World Vision International Ghana National DRM and Relief Coordinator	E	World Vision
046	04.07.2014	Accra	Wildlife Division	E	Wildlife Division
047	09.07.2014	Weija	GWCL head of operations at Weija	E	GWCL
048	10.07.2014	Accra	Researcher at WRI CSIR	E	Water Research Institute
049	13.01.2015	Accra	PWD	E	Public Works Department
050	16.01.2015	Accra	Slum Union Ghana	S	Slum Union Ghana
051	19.01.2015	Accra	Independent planner and GIP member	E	Ghana Institute of Planners
052	20.01.2015	Accra	Town and Country Planning Head Office	E	Town and Country Planning
053	20.01.2015	Accra	Lands Commission	E	Lands Commission
054	22.01.2015	Weija	Environmental monitoring and communication officer	E	Panbros Salt Ind. Ltd.
055	22.01.2015	Accra	Deputy director NDPC	E	National Development Planning Commission
056	23.01.2015	Accra	UNDP Adaptation and DRR program leaders	E	UNDP Ghana
057	23.01.2015	Accra	Head of NADMO within AMA	E	NADMO
058	26.01.2015	Accra	Head of Built Environment Division	E	EPA
059	27.01.2015	Accra	Consultant at GNWP/ Witeveen & Bos	E	Witeveen & Bos
060	28.01.2015	Accra	Director	E	MESTI
061	28.01.2015	Accra	Head of Natural Resources Division EPA	E	EPA
062	28.01.2015	Accra	Lecturer at UoG IESS	E	University of Ghana
063	29.01.2015	Accra	Lecturer at UoG Dept of Geography and Resource Development	E	University of Ghana
064	02.02.2015	Accra	Lecturer at UoG Institute of African Studies	E	University of Ghana
065	30.05.2014	Glefe	Nurse	S	Environmental Health Unit

Total interviews conducted

Experts	32
Stakeholders	24
Street interviews	10

7.2 List of participatory field observations

List of participatory field observations

ID	Date	Description
01	20. May 2014	Regular meeting of the disaster risk committee at AMA
02	02. June 2014	Walk across community with head of Glefe neighbourhood association
03	21. June 2014	Regular meeting of the disaster risk committee at AMA
04	30. June 2014	Trip to the Densu delta with representatives of several authorities and agencies invited by NADMO national director following June floods
05	02. July 2014	Walk across community with Red Cross volunteers in Mallam
06	22. January 2015	Tour across the Ramsar site with Panbros Salt industries' officer