Climate Change, Security Risks, and Violent Conflicts

Essays from Integrated Climate Research in Hamburg

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1 Introduction: Research on climate change and security in Hamburg

Michael Brzoska and Jürgen Scheffran

The papers in this collection present a sample of the research conducted from 2013 to 2018 within the context of the second phase of the Cluster of Excellence "Integrated Climate System Analysis and Prediction" (CLISAP). This research focused on issues related to security in a broad sense, from the study of determinants of local conflict to conditions of human security in the Anthropocene. Within CLISAP, research on these topics was organized in the C4 research area and was affiliated with the research group Climate Change and Security (CLISEC) at the University of Hamburg, led by Jürgen Scheffran. Research was also conducted in various departments at the University of Hamburg, the Institute for Peace Research and Security Policy (IFSH) at the University of Hamburg, and the Climate Service Center (GERICS) in Hamburg. Several researchers who had worked in CLISEC continued to be affiliated with the research group following their departure to other institutions.[1]

The Hamburg group has become one of a handful of centers conducting research on security-related aspects of climate change worldwide. Between 2013 and mid-2019, a total of more than 200 books, book chapters, research reports and journal articles were published by researchers affiliated with C4/CLISEC, including in such journals as Nature, Science, Journal of Peace Research and Political Geography. Some of these publications are among the most quoted articles in the field. Researchers from Hamburg were present at major international conferences where work on climate change and security was presented and discussed. In addition, they organized more than two dozen such conferences themselves and contributed to a number of authoritative books and reports on the security consequences of climate change. The chapters in this book (mostly based on previously published research) are intended to provide a single source from which to learn more about the activities of researchers affiliated with C4/CLISEC, although they cannot document the full breadth of CLISAP's achievements.

[1] A list of researchers and their fields of research can be found at http://www.clisec.uni-hamburg.de, last accessed 3 March 2020.

The beginnings of security-related research on climate change in Hamburg

Hamburg's international reputation as a leading location for research on climate change and security was secured within a fairly short period of time, beginning in earnest in 2008, following the establishment of CLISAP. Interest in this field has a longer tradition, however, with discussions on joint research between climate and social scientists having taken place since the 1990s, stimulated by increasing recognition of the potential scale of the consequences of climate change for peace, security and conflict. Among those who emphasized the potential impact on society were Hartmut Grassl, Director of the Max Planck Institute for Meteorology in Hamburg, Hans von Storch, Director of the Institute for Coastal Research, Martin Claussen, then working at the Potsdam Institute for Climate Impact Research (PIK), and Dieter Lutz, Director of the IFSH.

Two of these climate scientists, Hans von Storch and Martin Claussen (the latter of whom was then Director of the Max Planck Institute for Meteorology in Hamburg), saw an opportunity to stimulate research on climate change and security when they led the planning of a proposal for a Cluster of Excellence on climate research for a major research program in Germany in the mid-2000s. The German government had decided to fund a limited number of large Clusters of Excellence that aimed to bring together researchers from universities and research institutes to produce challenging and innovative research. With its strong tradition in meteorology and other climate-related sciences, Hamburg was a natural choice as the proposed Cluster of Excellence's location. It was clear to the leaders of the proposal drafting process, however, that the chances of receiving funding would increase if the scope of the research were expanded beyond traditional climate science to include social scientists. Research on peace, conflict and security emerged as a potential topic.

In addition to the personal interests of some in the core group, the intense public debate on climate change and security in the second half of the 2000s had a major impact (Schäfer, Scheffran, and Penniket 2016). By late 2006, when the application for the CLISAP Cluster of Excellence was being prepared, a lively public discussion on the consequences of climate change for future violent conflict was on its way. Among its roots was widespread public dissatisfaction with the climate mitigation efforts of many governments. In particular, the US government, led by President George W. Bush, saw no need to undertake measures against global warming and indeed was skeptical about the idea of man-made climate changes as such, thus contradicting the clear majority view among climate experts, as expressed in assessment reports by the Intergovernmental Panel on Climate Change (IPCC). Prominent individuals in the US (such as former Vice President Al Gore) and members of other governments (in particular the UK government) increasingly stressed the dangers of future large-scale violence as a likely consequence of the lack of adequate measures against climate change. They were supported, primarily in the US, by many former (and a few active) high-ranking military officers, whose interviews and reports stressing the traditional security implications of climate change were in turn used by activist groups as authoritative support for climate mitigation actions. In 2007 in Germany, the Advisory Council on Global Environmental Change (WBGU) published a groundbreaking report on the security risks of climate change.

These activities received a further push when the Nobel Peace Prize was awarded to Al Gore and the IPCC in 2007. This raised much public attention due to the Peace Prize Committee's identification of a direct, strong connection between climate change and future armed conflict in their justification – a connection which the Nobel laureates also highlighted in their acceptance speeches.[2] Nevertheless, many in the relevant academic communities were skeptical about the empirical justification of such statements. The same was true for other strong assertions along these lines, such as UN Secretary-General Ban Ki-Moon's claim that the war in Darfur, which began in 2003, was the first climate change war.[3] Despite indications in the relevant academic literature that climate change did in fact increase the likelihood of future violent conflict, the number of academic studies investigating the link between climate change and violence was low. Public discourses had clearly run ahead of scientific evidence.

These discrepancies provided even more reason to intensify research on the security implications of climate change. Hamburg seemed like a good place to pursue this aim, not only because of its leading role in climate research but also because it was home to important research centers on peace and conflict in Germany: the Institute of Peace Research and Security Policy (IFSH), in operation since 1971, and the then newly founded Carl Friedrich von Weizsäcker-Centre for Natural Science and Peace Research (ZNF).

The first phase of research: CLISAP-1

The first researcher to be approached as a possible contributor in this direction was Martin Kalinowski, recently appointed director of the ZNF. Kalinowski in turn invited a number of affiliates of the ZNF to join their efforts. In the end, he and Michael Brzoska wrote a section of the proposal for a Cluster of Excellence, in consultation with interested colleagues and the core group, entitled "Interactions between humans and

2 Cf. https://www.nobelprize.org/nobel_prizes/peace/laureates/2007/press.html, last accessed 3 March 2020.

3 Cf. https://www.un.org/sg/en/content/sg/articles/2007-06-16/climate-culprit-darfur, last accessed 3 March 2020.

the climate: Security aspects." The proposal set out an ambitious research program with three components:

- A systemic analysis of the mechanisms and dynamics linking climate change, local conflict and collective violence in identified or potential climatological and climate change–related security "hotspots", as well as the wider effects of such conflict on regional and international security.
- A critical overview of climate change and security discourses, with the primary objective of providing an inventory and critical analysis of linkages and feedbacks suggested in empirical work (including historical), theoretical frameworks and the security policy discourse.
- Analysis of the recursive effects of climate change and the use of energy resources, based on global energy scenarios as proposed in response to climate change effects and their national and international security.

CLISAP was selected as a Cluster of Excellence, and work began in 2008. Perhaps the most important effect of the available funding was the opportunity to establish a Junior Research Group (JRG) on Climate Change and Security (CLISEC). Jürgen Scheffran from the University of Illinois, who had worked on several of the topics listed in the CLISAP proposal, was recruited in 2008 to lead the group. One of his first activities was to organize a large international conference in 2009, which brought together a number of leading researchers on topics related to violence, conflict and peace in the context of climate change and which resulted in the publication of a large volume of contributions by both conference attendees and additional experts (Scheffran, Brzoska, Brauch, Link, and Schilling 2012). The conference served the further function of signaling that researchers from Hamburg were set to join the international debate on climate change and security.

Of the three topics listed in the CLISAP-1 proposal, the first received the most attention during CLISAP's 2008–2013 funding period. The main reason for this was the productivity of the core CLISEC group. Jürgen Scheffran, his first post-doc Peter Michael Link, and PhD student Janpeter Schilling were soon joined by a number of other PhD students and post-docs. As suggested in the CLISAP-1 proposal, they focused on the identification of hotspots of climate security (Scheffran and Battaglini 2011) on the one hand and the analysis of systematic interactions between climate-related and conflict-related factors on the other. They substantially advanced both empirical and conceptual knowledge of hotspots, which led them to pursue a system-oriented approach rather than attempting to find simple indicators for geographical labelling. Beyond what had been suggested in the CLISAP-1 proposal, they developed a four-sector system-of-systems approach, which is discussed further in Jürgen Scheffran's and Jasmin Link's contribution to this volume. First published in Science in 2012 (Scheffran, Brzoska, Kominek, Link, and Schilling 2012), this approach has guided much of the group's work. In addition, Scheffran and his collaborators began to formalize ideas and concepts in agent-based models.

Much of the work concerning the second topic was carried out by Angela Oels (2013), Michael Brzoska (2009) and associates. The main focus of the work was a critical assessment of various conceptions of the "securitization" of climate change, which included analysis of views and discourses on climate change by central security actors.

The third topic received comparatively little attention, although some relevant work was carried out by Clifford Singer, a guest researcher from the University of Illinois at the ZNF over several summers (Singer and von Brevern 2011). This was mainly due to the departure from the ZNF of Martin Kalinowski, who had led this part of CLISAP's work. Jürgen Scheffran, Michael Link, and others contributed to research on energy landscapes and energy transition (Scheffran and Froese 2016; Link and Scheffran 2017; Link, Böhner, and Scheffran 2018; Shaaban 2017, 2018).

Issues and research in CLISAP-2

Before CLISAP-1 came to an end, discussions on extending the work to a second phase of CLISAP-2 began. Under the leadership of Brzoska and Scheffran, a group of interested researchers discussed possible options. It was agreed that they would build on the achievements of CLISAP-1 while including additional important aspects:

- Continuation of the analysis of climate-conflict linkages with a focus on identified or potential climate-change related security hotspots, with a major (but not exclusive) regional focus on northern Africa and the Mediterranean region.
- Research on the security implications of climate-related migration, one objective of which was to assess, primarily through case studies, both the role of environmental factors in causing migration and the consequences of migration, which are or can be viewed as climate induced in receiving regions.
- The implications, for international security, of different strategies for coping with climate change, including energy policy and geo-engineering, along with a critical analysis of their changing justifications and relevance for climate policy.

The research objectives of CLISAP-2 have largely been achieved. Before briefly introducing the individual contributions to this volume, the following list highlights a few overarching themes resulting from research in the C4/CLISEC context, primarily using examples of work not included in this collection.

There has been continued work on the development of an integrative conceptual framework to systematize and explain types of social responses to climate change. Building on the foundation of the systemic circular model for analyzing the complex connections between climate change and human security, including societal stability, violent conflict and cooperation, further research has been conducted to address the complexity of pathways and interactions. Using a variety of methods – including qualitative and quantitative approaches, conceptual and theoretical analysis, agent-based modelling and social network analysis participating researchers have gleaned numerous new insights. Case studies in a variety of regions, including parts of Latin America, Pakistan, southern Africa, and the Mediterranean and North Africa (Link, Brücher, Claussen, Link, and Scheffran 2015; Ide, Link, Scheffran, and Schilling 2016; Scheffran 2016; Solomon et al. 2018; Bukari, Sow, and Scheffran 2018) provided the foundation for this work.

This research has reinforced the view that simple models that assume a direct relationship between climate change and violent conflict are not in line with the empirical reality of the past few decades. The variance of the results of linear statistical studies can be explained by the importance of a range of factors and conditions that shape the social effects of climate-related environmental changes, including vulnerability and adaptive capacity. These increase the propensity for violent conflict and societal instability in some constellations, and for cooperation and social innovation in others. A central condition is the degree of vulnerability to climate change on the one hand and of human security on the other. Where vulnerabilities combine, they also tend to re-enforce each other in cycles of violence (Scheffran, Ide, and Schilling 2014; Ide and Scheffran 2014), although they may be contained by environmental peacebuilding and cooperation (Ide 2018).

Among the numerous empirical studies (often involving extensive field research) within C4/CLISEC on particular links in the overall nexus between climate-rated environmental change and human security, only a few can be mentioned here. To identify subnational hotspots of climate change and violence in Kenya and Uganda, Ide, Schilling, Link, Scheffran, Ngaruiya, and Weinzierl (2014) analyzed the spatial distribution of factors commonly associated with high exposure and vulnerability to climate change and a high risk of violent conflict onset. They developed a composite risk index to identify regions of joint vulnerability to violent conflict and environmental change. While northern Uganda and Western Kenya were found to be particularly vulnerable, the analysis reveals the weaknesses of the existing data, especially with respect to land degradation and reporting conflict events. To explain the local occurrence of livestock raiding between pastoral groups under different climatic conditions in northern Kenya, Schilling, Akuno, Scheffran, and Weinzierl (2014) developed the RAST (Resource Abundance and Scarcity Threshold) hypothesis. Field research suggests that in regular years with sufficient rain, raiding is mostly conducted before and during the rainy seasons because animals are healthier, they can travel greater distances and raiders can find cover for their attacks. When rains partly or completely fail and a certain threshold of resource scarcity is reached, however, raids are conducted under less favorable conditions. Another empirical highlight was the study of rural–urban interactions under ecological stress (Rodriguez Lopez, Rosso, Scheffran, and Delgado 2015; Rodriguez Lopez, Heider, and Scheffran 2017; Heider, Rodriguez Lopez, García Avilés, and Balbo 2018) and the environmental benefits of urban land use in Chinese cities (Song, Chang, Yang, and Scheffran 2016).

Water scarcity was a particularly active research field. Extensive research was conducted on local situations in Namibia (Schnegg 2016; Schnegg, Bollig, and Linke 2016) and regional aspects in Israel/Palestine (Fröhlich 2012; Ide and Fröhlich 2015). To analyze the conditions for conflict and cooperation between upstream and downstream countries under climate change and population growth, a framework of water security was applied in a global comparative analysis of river basins (Link, Scheffran, and Ide 2016). Further contributions focused on the development of a river flow model applied to the Elbe and Nile river basins (Alwardt 2016) and the analysis of water use in river basins worldwide (Link, Scheffran, and Ide 2016).

The use of agent-based modelling (ABM) was a particular methodological specialty in CLISEC (Bendor and Scheffran 2019). Outcomes critically depend on the marginal cost of the relevant action pathways, making improved water use efficiency and cooperation a preferable option compared to violent conflict in the long run. China's Pearl River Delta has served as a case study for the impact of flood risks, allowing for analysis (based on multiple indicators of exposition, sensitivity, and adaptive capacity) of the vulnerability of populated urban areas to various climate impacts, such as variation in temperature and rainfall variability, rising sea levels and extreme weather events (Yang, Scheffran, Qin, and You 2015). ABM was used to assess household responses to GIS-based rainfall and flood scenarios, demonstrating the importance of flood warnings for the reduction of flood losses and investment in protective measures (Yang, Scheffran et al. 2018), and to simulate individual responses to environmental stresses in urban Areas (Yang, Hoffmann et al. 2018). Other studies in China examine the effect of bioenergy on food security in the energy landscapes of Jiangsu Province (Shu, Schneider, and Scheffran 2015; Shu 2016), using a model approach that was extended to energy landscapes in northern Germany (Scheffran, Link, Shaaban, Süsser, and Yang 2017; Link, Böhner, Held, and Scheffran 2018; Link, Scheffran, and Shu 2018). A study of climate vulnerability and farming adaptation in Pakistan's Punjab province combined field research, statistical analysis, and assessment of agent-based decision making and interactions among agents. Novel farm-level data from three distinct agro-ecological zones were gathered to analyze farmers' awareness of climatic changes and their adaptive capacities. Key results showed the need to address barriers to the adoption of advanced adaptation measures and different types of institutional services (Abid, Scheffran, Schneider, and Ashfaq 2015; Abid, Schilling, Scheffran, and Zulfiqar

2016; Abid, Ngaruiya, Scheffran, and Zulfiqar 2017) and land use options (Scheffran, Link, Shaaban, Süsser, and Yang 2017). A workshop on ABM supported by CLISAP was conducted in March 2017, in preparation for a special issue on the subject.

Other innovative methodological approaches were also used in the context of CLISAP/C4, including the approaches set out by Ide (2017). Social network analysis was used to identify local barriers to climate adaptation and to assess the adaptive capacities of stakeholder networks in rural areas of Loitoktok in southern Kenya (Ngaruiya and Scheffran 2013, 2016). The analysis incorporates data gathered in field research on revolving fund network schemes to address climate change and proposes a collaborative network to coordinate community actions to exploit “beneficial climate change opportunities” that strengthen the adaptive capacity to sustain livelihoods.

Environmental migration has been a major research field in C4/CLISEC, both in terms of critical analysis of its securitization and in terms of its role in climate adaptation. In addition to original research, activities included participation in a COST project on climate change and migration and the organization of various academic conferences and workshops in Hamburg. Research has included both empirical and conceptual/theoretical work highlighting the importance of the social, economic and political embeddedness of the consequences of migration. Migration is often viewed in both the academic literature and the policy world as an important link between climate change and human insecurity, including armed violence, but this is disputed (Nash 2015; Rothe 2016). Beyond a few cases, empirical evidence for cases of violence resulting from climate-driven migration is lacking (Brzoska and Fröhlich 2016). One important explanation is that of migration as a climate change adaptation strategy which is often supported through remittances and knowledge in migrant networks (Scheffran, Marmer, and Sow 2012; Gioli, Khan, Bisht, and Scheffran 2014; Sow, Marmer, and Scheffran 2016). A particularly controversial example of the link between climate change, migration, and violence is Syria, on which Christiane Fröhlich has published major contributions, summarized in her chapter in this volume (see also Fröhlich 2017; Selby, Dahi, Fröhlich, and Hulme 2017). Extending theoretical frameworks from critical security studies, researchers affiliated with C4 have analyzed the social and political foundations of the fear of large-scale migration and its political implications (Rothe 2016). Dominant conceptions of social risk and security result in perceptions of migration, including climate-related migration, which are used to justify exceptional measures designed to limit the flow of migrants.

An integrative approach has also marked work on the gender aspects of climate change, security risks, migration, and violent conflict, which thus far have not been considered in either traditional threat-centered or newer opportunity-centered approaches to environmental-related migration. Activities include a number of workshops, the establishment of an international network of experts and field research focusing on the gendered aspects of adaptation in out-migration areas (Fröhlich and Gioli 2015). In northern Pakistan and Nepal, it was found that circular labor migration is deeply gendered, with shifting practices of adaptation being taken up predominantly by women (which complements the narrative of the so-called "feminization of agriculture"). While this has been described as bringing women to the "frontline of adaptation" it has also had negative repercussions in terms of health, drudgery and domestic violence (Gioli et al. 2014).

Grounding research in an integrative framework implies a need for multi- and interdisciplinary approaches. The C4 has benefited from the use of a variety of disciplinary approaches and methods. Participating researchers have also used their results from work on the effects of climate change on human security in related contributions to their academic fields. A historical perspective has focused on Africa and genocide research, bringing together two communities (research on the consequences of climate change and genocide studies) that had previously had little contact. An environmental perspective promises new insights into genocide, for instance in Africa, adding new dimensions to the analysis of how environmental change contributes to large-scale violence (Zimmerer 2015).

A particular focus of the work of ethnographers and social geographers related to C4 has been the perception of climate change in local settings in various regions (Gurgieser et al. 2015). Thomas Friedrich, for instance, examines how scientific knowledge about climate change is integrated into local knowledge about nature and the weather on the Philippine island of Palawan (Friedrich 2018). The results reveal that climate change is "localized" by local political, NGO and expert groups. Both its causes and possible mitigation strategies are located in the region, and local environmentalism is perceived and practiced as an appropriate response to climate change, which is treated as yet another natural hazard.

With respect to climate-related policies and their discursive foundations, two aspects have received particular attention. One is geo-engineering (Brzoska, Link, Maas, and Scheffran 2012; Link, Brzoska, Maas, Neuneck, and Scheffran 2013; Maas and Scheffran 2012), the other migration policy (Baldwin, Methmann, and Rothe 2014; Nash 2018). Overall, researchers from the group have attempted to link empirical research with a critical theoretical perspective, working with concepts such as complexity, tipping points, cascades, and risk multipliers (Scheffran 2016), resilience (Boas and Rothe 2016; Schilling et al. 2017; Balbo et al. 2016), and the Anthropocene and sustainability transitions (Brauch, Oswald Spring, Grin, and Scheffran 2016).

Summaries, reflections, and future directions: Contributions to this volume

Research on climate change and security will continue in Hamburg. Prior to the end of CLSAP-2, a new focus was established with a project funded by the German Research Foundation on governance in the Anthropocene, led by Delf Rothe, who has also contributed to this volume. In addition, work on climate change and security is part of the new Cluster of Excellence in Hamburg on research into climate change and its consequences, CLICCS (Climate, Climatic Change, and Society).

The contributions in this volume provide an important foundation for this ongoing effort but also indicate future directions with respect to both the scope of the topics relevant to the study of the relationship between climate change and security and conceptual reconsiderations of security in a changing world.

A systematic overview of the risks and threats of climate change is provided by Jürgen Scheffran in Chapter 2. He embeds his analysis in a wide-ranging investigation into the interaction of the components of the climate system, particularly focusing on those interactions and feedback loops that render climate change a risk factor in multiple social settings and that make it a threat to security. As outlined above, a number of themes have been central both to the debate on climate change and security and to the Hamburg group in particular. This volume contains contributions on the issues of energy, water, and migration.

In Chapter 3, Martina Neuburger, Rafaela Rau, and Tobias Schmitt write about Agrofuel expansion and black resistance in Brazil. Increasing global energy consumption and the worldwide discourse on renewable energy has encouraged the Brazilian government to promote the expansion of sugar cane and ethanol production in the country. In their case studies, the authors analyze the displacement of alternative rural livelihoods through the expansion of sugar cane plantations in the region of Pompéu (Minas Gerais) by working out underlying power relations between the relevant actors – which are mostly embedded in Brazil's colonial history – as well as shifting property rights on land and water. In addition, they demonstrate the dominance of development and climate change discourses that legitimize the violation of traditional property rights and negate alternative development models.

Janpeter Schilling and Louise Werland present a challenge to the belief that the negative effects and conflict implications of wind energy projects are negligible by analyzing the implications of wind energy for local communities in northern Kenya. Specifically, the paper explores how the recently completed wind park in Marsabit County affects the local population's vulnerability to climate change and how the project continues to influence existing and new conflict dynamics.

In his contribution "Roadmap to Energy Security in Egypt," Mostafa Shaaban outlines a new approach to dynamic temporal and spatial sustainability assessments that involves modeling future pathways of greenhouse gas emissions and technologies for electricity planning. His focus is on alternative energy pathways and a sustainable electricity supply mix as part of an energy strategy until the year 2100. For this purpose, he models the decision-making processes of multiple actors in the energy sector by integrating three methodologies: multi-criteria decision analysis (MCDA), spatial Geographic Information System (GIS) data analysis and agent-based modelling (ABM).

"Water Allocation in Transboundary River Systems in Times of Climate Change," by P. Michael Link, presents a theoretical framework for the assessment of water conflict and cooperation in times of climate change. Challenges arise when a river is shared by more than one country, as their respective governments must agree on how to allocate the river water among them. While cooperative arrangements have dominated in the past, climate change adds uncertainty to water availability in many transboundary river systems, making it hard or impossible for some countries to comply with existing treaties and to achieve societal stability. The chapter presents the Nile River Basin as a case study.

Liang Emlyn Yang's "Managing Water-Related Vulnerability and Resilience of Urban Communities in the Pearl River Delta, China" addresses the climate-related water risks faced by coastal cities, which are also dealing with increasing populations and property intensity. The chapter analyses the vulnerability and resilience of coastal urban communities in South China, integrating a reanalysis dataset and model projections with literature results on long-term climate changes. It also reviews strategies and priorities for resilience building.

The CLISEC group's work on water-related issues has been enriched by the long-term historical perspectives on changing environments provided by CLISAP visiting researcher Andrea L. Balbo and a number of co-authors in Chapter 8. The contribution summarizes work on the challenges and opportunities confronting historical irrigated agricultural systems in Ricote (Murcia, Spain). Historical irrigated agricultural systems in the Mediterranean region have a long record of sustainability and adaptation to changing climatic, environmental, and social conditions but currently face challenges that may threaten their persistence over the next decades.

The same case study also features in another contribution, which takes a wider perspective. The topic of Miguel Rodriguez Lopez, Katharina Heider, Andrea Balbo, and Jürgen Scheffran's contribution in Chapter 9 is urban–rural transformation. They present an innovative framework for understanding urban–rural interaction influenced by environmental changes, which focuses on the management of property rights as a central problem. The approach is illustrated with the help of two brief case studies from the southern part of Mexico City and southern Spain (Ricote).

This volume also contains two critical discussions of prevailing discourses. The first, by Christiane Fröhlich, summarizes her work on migration as a factor in the popular uprising in Syria in 2011. Syria has evolved into a "showcase study" of sorts for the often assumed but also contested linear causality between mobility following prolonged drought, floods, and other climate-related environmental changes and (violent) conflict. Fröhlich questions and critically reviews, step by step, the argument that drought-related internal migration was a significant factor in the Syrian uprising.

Chapter 11, written by Sarah Louise Nash, is a critical examination of established categories used to describe different kinds of human mobility, based on a distinction between forced and more-or-less voluntary forms of human mobility. None of these are objective, neutral representations of the world, and they generally say a lot about the speakers using these categories. The chapter provides an impetus to look beyond established categories from policymaking, to strengthen critique of these categories in academic work, and to move beyond policy-relevant research.

An important concept in the debate on the consequences of climate change is that of resilience. In Chapter 12, "Resilience in translation", Delf Rothe explains the diversity of conceptions of resilience in climate change and security discourse. Resilience has become a popular concept with Western practitioners and decision makers in development, environmental, and security policy, and the (Western) discourse on the security implications of climate change is no exception. Its usage, however, resists conceptual fixation. The chapter seeks to explain the heterogeneity and ambiguity of resilience by looking at processes of its "translation" into other languages, different discourses and concrete practices.

Linking resilience with security invites the interest of many social and political actors to address the risks and threats arising from climate change. One such group, which often views itself as being at the center of security issues, are the armed forces. In Chapter 13, Michael Brzoska investigates security actors' perception of climate change with respect to future consequences for armed forces. Based on a close reading of 53 national security documents from 38 countries published between 2001 and 2014, he develops a classification of potential future military roles and functions. He demonstrates that although climate change has become an important issue for military planning, conceptions of its implications for the future of armed forces differ widely.

Consideration of the way in which climate change is conceived of by armed forces and ministries of defense illustrates the problems associated with grasping the extent of, and qualitative changes to, security in a warming world. Jasmin S. A. Link's chapter takes a theoretical sociological approach to climate change research. She investigates how path dependence affects the connection between climate change and conflict. Sociological conflict theories are used to determine the way in which and the extent to which path dependence influences social reactions to climate change.

A lack of understanding of the extent and qualitative nature of the transformations to security inherent to climate change are also the subject of Chapter 15. Judith Hardt analyses theoretical and empirical conceptual approaches to the connection between the environment and security with respect to their function as guiding concepts in the multiple and complex challenges posed by the Anthropocene. She ultimately proposes the Critical Environmental Security Studies (CESS) approach, empirically demonstrating its application in a case study of the Environment and Security Initiative (ENVSEC), which was launched by various international organizations.

Her systematic analysis is inherently linked to the concept of the Anthropocene. Originally a geological concept, the Anthropocene has received increasing attention as a dramatic shift in the Earth's system in which humanity has become aware of the role of collective human agency as the primary planet-transforming factor. This offers a unique opportunity to address the limitations of established divisions between academic communities and of their representativeness in issues involving science and society. Nevertheless, empirical analysis on various levels reveals the polarization of the natural and Earth sciences on the one hand and the humanities and social sciences on the other. The authors of Chapter 16, Andrea L. Balbo, Delf Rothe, and Jürgen Scheffran, suggest ways forward in the development of a transdisciplinary and sustainable Anthropocene science, embracing inclusiveness, openness, curiosity, and knowledge sharing.

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2 Climate change and weather extremes as risk multipliers

Tipping points, cascading events, and societal instability

Jürgen Scheffran

Abstract

The role of global warming as a risk multiplier is discussed in an integrative framework connecting climate and societal stability, acting through complex and destabilizing impact chains beyond thresholds. These include complex social interactions and self-enforcing collective dynamics such as breakdown of vulnerable infrastructures and networks; tradeoffs in the water-food-energy nexus; economic and financial crashes; social protest and turmoil; mass migration and violent conflict. Adressing the challenges through adaptive and anticipative governance can induce societal transformation processes to protect human security, develop social livelihood, strengthen societal resilience and solve problems along cooperative and sustainable pathways. In this context, key questions considered are conditions when climate stress exceeds the adaptive capacity of natural and social systems; tolerance ranges of stability and instability; impacts of climate stress on critical infrastructures and human-environment-interaction; thresholds of negative and positive tipping points triggering cascading events; and conditions for sustainability transition and societal transformation processes.

KEYWORDS: *Anthropocene, cascades, conflict, hot spot, migration, tipping points.*

Introduction: Tipping points and risk cascades in complex systems

During the 1980s, complexity emerged as a new paradigm in science and politics, increasingly shaping international relations. In 1989, the Cold War ended in a domino effect that led to the fall of the Berlin Wall, the breakup of the Eastern Bloc and a chaotic breakdown of the East-West conflict, which became a tipping point to an era of ever-growing complexity[1] (Scheffran 2008). In the new world (dis)order cascading chains of events have emerged, including complex social interactions and self-reinforcing collective dynamics such as stock market crashes, social turmoil, mass migration, and violent conflicts that increasingly challenged international security and stability (Kominek and Scheffran 2012). A particular form of social instability is conflict, based in incompatible values, priorities, and actions of agents who undercut each other's values and provoke responses, thus leading to the waste of resources and an escalating interaction if the conflict is not resolved.

A crucial issue is whether growing complexity breeds instability, a question that has been extensively discussed for ecosystems (Scheffran 1983). While artificially constructed complex systems are dysfunctional if the components do not fit together, unstable modes tend to disappear in evolving complex systems while those with better fitness or control mechanisms survive. Systems are often robust and adaptive against the most likely disturbances in the core region of stability (Held and Schellnhuber 2004); however, close to critical thresholds between regions of stability and instability small and rapid variation can lead to a systemic break down. This is symbolized by the famous butterfly effect in chaos theory, which may occur when a system is already "on the edge", driven by other processes. A key term is the sensitivity of couplings between variables, which determines how changes spread through the network of interconnections (Scheffran, Link, and Schilling 2012). Beyond a given sensitivity, threshold changes may trigger instabilities, tipping points, and cascading sequences. To maintain stability, it is essential to understand the conditions under which small-scale micro-level events lead to qualitative changes at the macro level that propagate in space and time. New and unforeseen "disturbances" may endanger system stability and force it to adapt to changing conditions.

A key term is "tipping point", which is defined as the "point or threshold at which small quantitative changes in the system trigger a non-linear change process that is driven by system-internal feedback mechanisms and inevitably leads to a qualitatively different state of the system, which is often irreversible." (Milkoreit et al.

1 Complexity expresses the difficulty to describe, understand, or explain something. A critical issue is to find a description of a system that contains the essential features and components (Scheffran 2015a). Systems that initially appear complex can become simple once they are understood or controlled.

2018: 9). Tipping points often involve the three notions "that events and phenomena are contagious, that little causes can have big effects, and that changes can happen in a nonlinear way but dramatically at a moment when the system switches." (Urry 2002:8; Scheffran 2008:14).

The continued expansion of human activities has become a driving force that transforms the earth system into a new geological epoch, the "Anthropocene". Climate change, together with other environmental challenges such as land degradation, resource scarcity, and biodiversity loss, is interconnected with other problem areas such as globalization, poverty, and violent conflict through multiple linkages from local to global levels. Associated risks affect human living conditions and undermine the stability of natural and social systems, particularly in fragile and failing states (Starr 2008). Thus, global climate change has been called a risk multiplier that amplifies other risks through complex impact chains that possibly exceed thresholds to instability.

In this context, key questions are considered: What happens if climate impacts exceed the adaptive capacity of natural and social systems? Are there ranges of tolerance, in which systems remain stable, and beyond which destabilization to qualitatively different system states is likely? Will climate change trigger regional or global risk cascades? When will critical infrastructures that are essential for the economy and society become dysfunctional? Does the risk-multiplying effect of climate change connect various problem areas? How will human-environment interaction be influenced by climate stress?

In the following, the role of climate change as a risk multiplier is discussed in an integrative framework that connects climate and societal stability. The main processes include instabilities in the climate system; hot spots of climate change and human insecurity; vulnerable infrastructure and networks; economic and financial crises; social and political instability; environmental migration; and violent conflict.[2]

Instabilities in the climate system

Weather and climate are considered primary examples of complex systems, and the Lorenz equations (a simplified mathematical model for atmospheric convection dynamics) became one of the roots of chaos theory (Sparrow 1982). The climate system is characterized by complex dynamic processes that are difficult to predict from knowledge of individual factors and equations. Although much is known about the effects of climate change on the components of the earth system, the interaction between the subsystems is still poorly understood. Since changes in one system can

2 This chapter is based on several publications of the author that are adapted for this purpose (Scheffran 2015b, 2016a, b, c, and Scheffran 2017a, b).

have direct or indirect effects on other systems, local events can propagate through complex causal chains and feedbacks on various spatial and temporal scales.

One focus of climate change research is on weather extremes such as hurricanes, droughts, forest fires, floods, and heatwaves, often corresponding to processes of non-linear dynamics such as phase transitions, critical thresholds, and chaos, which are paradigms in complex systems theory (Bunde et al. 2002; Kurths et al. 2009). In terms of their intensity, extreme weather events are rare in a particular location and a given time of year within a probability density function estimated from observations (IPCC 2013: Glossary). They represent phenomena outside of a given range around the average, representing too much or too little of the respective variable (such as temperature, rainfall, wind intensity, etc.). They are associated with extreme consequences that can burden the functionality and stability of the natural and social systems affected and exceed their resilience and viability range. The number and intensity of extreme weather events are likely to increase in the future (IPCC 2012; Rahmstorf and Coumou 2011).

In addition to single local events, the climate system itself can become unstable if critical tipping points are reached, for example by exceeding certain thresholds in global mean temperature that trigger amplifying effects (Lenton et al. 2008). These include the weakening of the North Atlantic thermohaline circulation, the rapid melting of ice shelves in Greenland and west Antarctica, the release of greenhouse gases such as methane from frozen soils in Siberia or Canada, and the change in the Asian monsoon. These phenomena and related chains of events can lead to a global and lasting transformation of the earth system. Massive and abrupt climate change could also overwhelm the adaptive capacities of even the strongest states and societies. Less time-critical, although globally hazardous in the long term, is the rise in sea level putting many coastal regions and islands at risk, which in the end can exceed the local coping capacity and trigger instability. Given the large number of uncertainties, it is a risky experiment to move into unknown areas of the climate system, where amplification of impacts and tipping elements open up the possibility of global destabilization. A sequence of tipping elements could drive the world's climate system into a qualitatively new state of a "hothouse earth", posing one of the gravest dangers facing humanity (Steffen et al. 2018).

In a world of interconnected crises, climate change can act as a potential risk multiplier through interactions between climate stress, environmental change, human responses, and social conflicts. We discuss how climate change affects human security and basic human needs (such as the availability of water, food, energy, health, and wealth) and societal instability events (such as forced displacement, riots, insurgencies, urban violence, and war) as well as the role of responses for transformation, including stability, resilience, sustainable development, and peace.

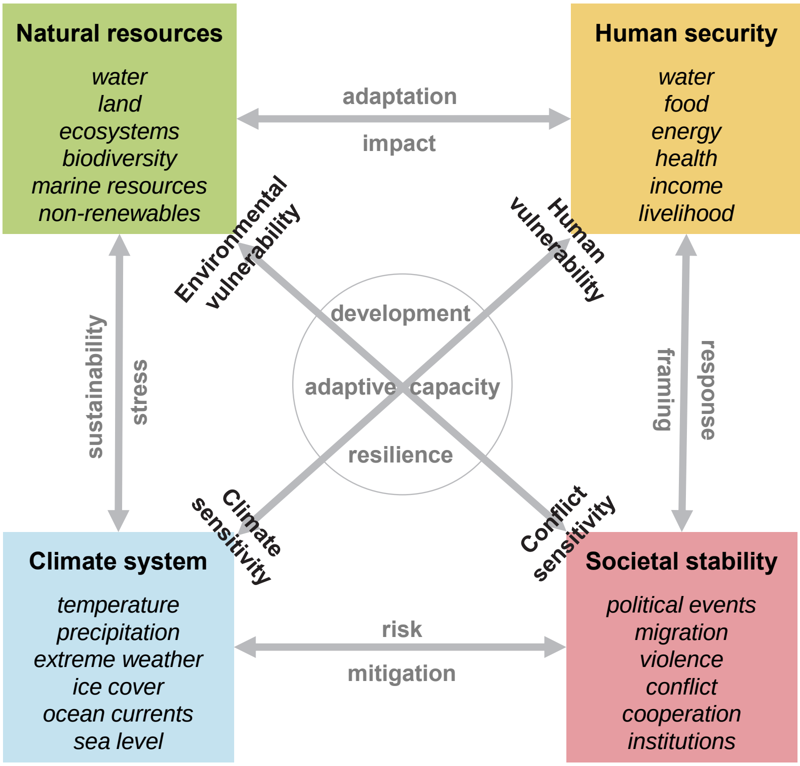

Figure 1: Impact chains and feedbacks in climate–society interaction. Source: adapted from Scheffran et al. 2012a.

Figure 1 presents an integrative framework describing the complex interactions in the earth system (Scheffran et al. 2012a, 2012b). The couplings in this network can be characterized by sensitivities that represent the impact that a change in one variable has on another variable. In particular, climate sensitivity is "the degree to which a system is affected, either adversely or beneficially, by climate variability or climate change" (IPCC 2007: 881). Changes in the climate system affect the functioning of ecological systems and natural resources (e. g. soil, forests, and biodiversity). Depending on the vulnerability, this can have an impact on human security, e. g. by degrading the supply of water, energy, food, or economic goods. The sign of sensitivities can provide valuable information to classify qualitative patterns or "syndromes" (Eisenack et al. 2007a). Human reactions to environmental change can affect the stability of societal structures, driving conflicts and social destabilization in regional climate hot spots. The challenge is to develop practical strategies to address complexity, avoid dangerous instabilities of climate change, and maintain stability despite system changes. To meet the goal that was agreed on in the 1992 UN Framework Convention on Climate Change (UNFCCC) to prevent dangerous anthropogenic interference with the climate system and the temperature limits of the 2015 Paris agreement[3], an anticipatory-adaptive policy framework is needed that avoids risky pathways and allows for a timely and qualitative system transformation that takes the form of a self-organized stabilization. Some types of complex interactions are discussed below, with climate change acting as a "risk multiplier" and possibly triggering social destabilization in complex crises.

Hot spots of climate change and human insecurity

In hot spots strongly affected by climate change, compound effects lead to multiple stressors on human security. Hydro-meteorological disasters (storms, floods, and droughts) are an immediate danger to the life and health of the most affected people (Germanwatch 2018) in both developing countries (e. g. the Indus flood in Pakistan in 2010, a drought in China in 2010–11, or the typhoon in the Philippines in 2013) and industrialized countries (e. g. the European heatwave of 2003; the Elbe floods in Germany in 2002 and 2013; tropical storms in the US in recent years; wildfires in Russia in 2010; the European hot summer of 2018). For the most severe consequences, adequate assistance is hardly possible and social systems become overloaded in the regions of concern. For instance, in 2005 Hurricane Katrina caused enormous damage to the southern coast of the US and led to more than 1800 deaths; it displaced hundreds of thousands of citizens and overwhelmed disaster management. The heatwave of 2003 in Europe left behind tens of thousands of casualties and damage to agriculture worth tens of billions of euros. The Indus flood in 2010, the worst in more than eighty years, flooded a fifth of the land area of Pakistan with consequences for twenty million people; it led to approximately 2000 deaths and destroyed 1.7 million homes and a large part of the infrastructure (Gemenne et al. 2011).

On the other hand, climate change affects the long-term availability of natural resources, which can contribute to shortages and an unbalanced distribution of resources. Examples include the degradation of fresh water, forests and farmlands, shortage of nutrition, the threat to biodiversity, and overfishing. Whether people are able to cope with the consequences and to limit the risks depends on their vulnera-

3 The Paris Agreement of the 21st UNFCCC Conference of Parties (COP21) in 2015 aims to limit "the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels".

bility and adaptive capacity. These are influenced by their access to resources, information and technologies, as well as by the stability and effectiveness of institutions (Adger et al. 2009).

In hot spots, the stress from climate change can be associated with great human suffering and significant economic and social losses that undermine human security. A large share of the risks is neither exclusively nor primarily related to climate change, but often also affected by pre-existing local problems instead. These include the degradation of ecosystems, poverty, political instability, overuse of land, and the absence of early warning systems and disaster protection. Most vulnerable to climate stress are regions whose economies are dependent on climate-sensitive resources and where infrastructures are particularly exposed to climate change, particularly developing countries with a high level of dependence on agriculture; coastal areas and river basins; as well as hot and dry regions. Human security is at stake if natural resources that are of fundamental importance for the existence of people and the satisfaction of their needs are depleted or degraded.

While the primary consequences are often locally confined, it is possible that remote regions are affected through teleconnections as well as by humanitarian aid, civil protection or other direct interventions (including military operations). Some reactions may further aggravate the given situation, e. g. when people in need enforce the overexploitation of resources, move to other areas at risk, or use violence against competitors, in order to ensure their own survival. For instance, rising land prices may induce a search for cheaper land, a problem often found in developing countries, leading to environmental and supply risks and displacement of local users. Another example is the impact of land scarcity on the availability of water and on related crop losses. In case of droughts in major crop producing areas, global food markets can cause a fall in prices elsewhere. In this context, various trade-offs and exchange processes between different resources need to be taken into account. This is expressed in the nexus of water, energy, and food (see the following sections).

Vulnerability of infrastructure, technical systems, and supply networks

Critical economic and social infrastructure and supply networks are potentially vulnerable to climate change. This includes systems for the supply of water, food and energy, goods and services, systems for the provision of communication, health, transportation and security, as well as human settlements and political institutions. When important subsystems fail, the disruption may spread through couplings and lead to the collapse of the entire system. The consequences differ for developing countries, which depend directly on ecosystem services and agriculture, and developed countries that rely on interconnected technical systems but have more sophisticated protection and response mechanisms. The stronger the impacts are and the more subsystems are affected, the harder it is for societies to absorb the consequences. Corresponding relationships have been studied in risk research for the failure of complex technical systems, in which the combination of different events can result in the loss of control (e. g. Bhopal, Challenger, and Chernobyl). Since not all contingencies are predictable in complex systems, often a minor event can initiate a chain of events that initially appears to be a "normal accident" that triggers catastrophes in tightly coupled human-machine systems (Perrow 1984). In a globalized world, these tight couplings occur not only in technical systems but in other fields as well.

Although geophysical events are not related to weather disasters, they can provide insights with regard to their impact on social stability. A spectacular example of a disaster risk cascade was the earthquake in Japan on 11 March 2011, which triggered a chain of events with global effects. The subsequent tsunami flooded parts of the Japanese coast extinguishing thousands of human lives, and triggered the nuclear accident at Fukushima that destroyed several reactors and spread radioactivity globally through the atmosphere and the ocean. Because of the consequences of this large-scale accident, the Japanese power grid, the nuclear industry, stock markets, oil prices, and the global economy were all affected. Automobile manufacturers and electronics companies worldwide cut back production because important components were no longer being delivered from Japan. The shock waves from the nuclear disaster triggered a nuclear phase-out and renewable energy transition in Germany. This disaster impressively demonstrates how a single event can set in motion cascading events that overwhelm human coping and planning capacities (Kominek and Scheffran 2012; Scheffran et al. 2015; Scheffran 2016b).

In addition to earthquakes or technical accidents, weather extremes can also hit critical nodes in economic and social networks. For industrialized countries such as Germany, where both the economy and society depend on a functioning infrastructure, the stability of a sustainable supply system in response to extreme weather events is of great importance. Weather extremes such as the heatwave in 2003, the storm surge following storm Xaver in 2013, or the Elbe flood in 2013 lead to temporary impairments of transport or energy supply systems. From the perspective of climate research, it is important to assess whether extreme weather events can occur that exceed the adaptive capacities of supply networks. It is important to identify critical nodes and links in the global supply network and to understand how local failures of infrastructure components affect the global chain. Key research questions ask what happens in case of the failure of network elements, how shocks propagate in power grids, and whether a collapse of the network is possible.

An example is the failure of power grids, on which the functioning of other supply networks and socio-economic systems depends. Hydro-meteorological disasters can temporarily affect the supply of electricity before power is restored. There have been cases, in which minor events triggered a major blackout. In the biggest blackout in history in July 2012, more than 600 million people in northern and eastern India were affected due to an overload of the power grid. In November 1965, approximately thirty million people in the northeastern United States and in many parts of Canada remained without electricity for about six days. In California, there were regular power outages caused by insufficient generation capacity and market manipulation (Brand and Scheffran 2005). In November 2006, parts of Germany, France, Belgium, Italy, Austria, and Spain were temporarily disconnected from power supply. While there were various underlying causes in these instances, weather events were identified as trigger in other cases. In November 2005, after heavy snowfall in North Rhine-Westphalia and Lower Saxony, one of the largest power outages in German history occurred, and some 250 000 people were without power for several days, resulting in a financial loss of approximately €100 million (Deutschländer and Wichura 2005). A snowstorm in North America at the turn of 2013 and 2014 caused major power cuts for hundreds of thousands of people, leading to partial failure of the communication and transport systems[4].

If a particular resource supply system is hit, this often has effects on other resources, in particular the nexus of water, energy, and food (Beisheim 2013; IEA 2012). Energy is needed for irrigation and for the production of food or water, and to maintain the energy supply, in particular for the extraction, transportation and processing of fossil and nuclear energy. The development of unconventional gas and oil reserves (fracking, oil sands, and oil shales) has led to an increasing need for water and land. In addition, renewable energy sources such as hydropower and biofuels require large amounts of water as well. Regions with low rainfall are dependent on artificial irrigation for the cultivation of plants for food and energy. Even with large solar power plants, water supply in desert areas is a critical issue. Overall, the water demand for energy generation is estimated to rise twice as much as the demand for energy (Beisheim 2013).

Climate change affects this nexus in many ways and increases the competition between water, energy, and food. For instance, nuclear power plants are vulnerable because they are dependent on the flow of cooling water. Warming of the water or long periods of drought or floods affect power generation, leading to critical situations when cooling water is no longer available or water in power plants is below the critical level (Beisheim 2013: 24). If water levels in rivers and lakes are diminishing during

4 Ice storm blackouts frustrate tens of thousands; at: http://www.cbc.ca/news/canada/ice-storm-blackouts-frustrate-tens-of-thousands-1.2476866, last accessed 3 March 2020.

droughts, transportation of coal, oil, or biomass may become difficult or impossible, as was the case during the hot summer in Central Europe in 2018 (Olk and Witsch 2018). Storm surges and inundation place a substantial pressure on the entire transportation infrastructure. In 2005, Hurricane Katrina temporarily disabled more than a quarter of total offshore oil production in the Gulf of Mexico. This amounted to almost a fifth of total natural gas production and almost half of the available refining capacity, as well as important oil pipelines, thousands of oil rigs, and a large proportion of rail and sea transport (for an overview, see Kumins and Bamberger 2005). In 2013, Typhoon Haiyan destroyed part of the Philippines' supply of renewable energy (Bradsher 2013). Since renewable energy sources (bio-, hydro-, wind, and solar energy) depend on the given meteorological conditions, they are affected by climate change.

The cultivation of bioenergy plants as part of a climate change mitigation strategy has intensified global resource competition as large amounts of water and land are needed that are then no longer available for food production (Scheffran 2010). With a shortage of resources due to climate change, market prices tend to increase, making the expansion of agricultural production more attractive. The rising demand for production factors such as water, energy, pesticides, and fertilizers in turn increases environmental pollution and a growing demand for land (Beisheim 2013). On the other hand, rising food prices have adverse effects on poor populations (see below). To some extent, competition can be mitigated by synergistic effects, e. g. when hydropower plants achieve an optimal trade-off between water and energy use, solar energy is used for water desalination, organic waste is used in food production for energy purposes, and new jobs are created that contribute to development in rural areas.

It is difficult to make supply networks more resilient to climate change impacts if disruptive events occur in rapid succession that have multiple effects, which hit a system simultaneously, either with short time delays or in a narrow geographical area. With the increasing intensity and frequency of climate-related events, the question arises as to when the capacity limits and resilience of infrastructure are reached and whether existing safeguards and adaptation measures are sufficient.

Economic and financial crises

Assets and economic processes such as global freight and trading, financial markets and prices that regulate the exchange between supply and demand are also exposed to climate change. Financial transactions and pricing information represent virtual transfer mechanisms, which link different events with each other – both globally and within a very short period of time. If these processes are disturbed by climatic change, production losses, bankruptcies of companies, or a sharp decline of the stock market may propagate across global networks and markets.

The economic crisis of 2008 demonstrated the instability of the complex interconnected global economy. Driven by reckless speculation and lending practices of financial institutions and shortsighted human behavior, local events and individual responses escalated, pushing the global financial system to the brink of collapse. After a critical limit was exceeded, self-reinforcing mechanisms were triggered, leading to losses of hundreds of billions of Dollars and Euros worldwide. Public investment and regulatory policies were initially unable to compensate for the short-term fluctuations. The interaction between rating agencies and government responses led to a highly unstable situation. In Europe, the global economic crisis was followed by a crisis in Ireland, Iceland, and southern Europe, most dramatically in Greece.

Although other factors were at work here, weather extremes and economic crises may also interact and lead to a downward spiral. According to the Stern review, abrupt and extensive changes in the climate system could wreak havoc in global trade and financial markets (Stern 2006). Risk cascades are possible due to multiple linkages between disasters and financial markets (Haas 2010; Onischka 2009). In addition to direct economic damages, global impacts are possible through reduced production, supply shortages, and price increases for valuable goods, an overload of the insurance industry, flooding of major harbors, and the interruption of transportation networks and other components of the global supply chain. Through these connections, extreme events in one country can induce production losses in another country, and these can spread through global supply chains (Levermann 2014). While the direct damages and costs of weather extremes have been frequently studied, the indirect economic consequences are still poorly understood. Some issues have been raised in the context of the indirect effects of bioenergy, particularly as in some parts of the world prices and yields of cereals have been affected by bioenergy production (Scheffran 2010), e. g. in the so-called "tortilla crisis" in Mexico in 2007.

In the energy sector, various risks (natural disasters, infrastructure problems, strikes, riots, wars, political interventions) may lead to constraints on supply and market variation. High oil prices, as in 2008, are a driver for recession and social risks, or affect the willingness to accept a high level of environmental risk (Beisheim 2013). Relevant questions can be raised if production losses are observed after extreme events in a country that is a food supplier. Such events include the heatwave and related fires lasting several weeks in Russia in the summer of 2010, which resulted in an export ban on wheat (FAZ 2010). The droughts in the USA in 2011 and 2012 and in China in 2010–2011 were associated with price increases in food commodities as well. For poorer countries, the consequences of integration into the globalized economy can be as instantaneous as the direct effect of domestic local events. Even in developed countries such as Germany, the impacts of extreme events on consumers are noticeable. Europe is not immune to the adverse impacts if negative developments in the Mediterranean lead to a spiral of escalation. An economically weakened southern Europe is more vulnerable to climate-related risks and would have a lower potential for adaptation. In general, problems of water and food supply could hit tourism and agriculture, lead to conflict and migration, affect neighboring countries, and spread across continents. Some examples are discussed below.

Floods in Australia 2010–2011

In the wake of tropical cyclone Tasha, Queensland and New South Wales were affected by heavy rainfall in 2010 and 2011. The worst flooding in fifty years inundated an area equivalent to the size of Germany and France combined; it included seventy cities, thirty-five people lost their lives and 200 000 people were evacuated, including from parts of the metropolitan area of Brisbane. According to media reports, the damage was of the order of AUS$1 billion and the loss to GDP stood at AUS$13 billion, which had a significant impact on the economic performance of Australia. Furthermore, about forty coalmines were temporarily closed or operated at reduced power due to flooding, so that the production capacity of the largest coal exporter in the world was severely impaired. Coal mining in Queensland fell by thirty per cent; coal production fell from 471 million tons in the previous year to 405 million tons. At times, the domestic coal industry was losing more than €70 million per day (Oldag and Walterlin 2011). Since the cost of raw materials amounts to more than eighty per cent of the production cost of steel, this triggered price hikes and supply bottlenecks in the steel industry. The chain of events was also felt in Germany and had an impact on car production, mechanical engineering, and other industries (Spiegel 2011).

Flood in Thailand 2011

Thailand was hit by an unusually long-lasting monsoon in October and November 2011, resulting in the worst floods in fifty years, which affected nearly twelve per cent of the country. The consequences were almost 400 deaths, property damage of more than €11 billion, substantial loss of economic growth, temporary drops in tourist numbers, and massive crop losses. The neighboring countries of Cambodia and Laos were also affected. In addition to the regional consequences, the disaster had an impact on the world economy. Supply failures in electronic components led to bottlenecks in the international electronics and computer industry and an increase in prices of e. g. hard disk drives in Germany (Feddern and Schnurer 2011). German companies such as Volkswagen had problems with the delivery of important parts. Japan's automobile companies suffered repeated losses in production, shortly after the Fukushima disaster. Although the Thai electrical and electronics industry was severely impacted by the flooding, the industry has recovered faster than expected (Gärtner 2011).

Drought in China in 2010 and 2011

In November 2010, a once-in-a-century drought in China's eastern wheat belt threatened the winter wheat crop, which accounts for twenty-two per cent of the harvest of the world's largest producer and consumer of wheat. An area of 1.6 million hectares and more than 300 million people were affected. The severe drought hit the domestic and agricultural water supply and led to the closure of parts of the Yangtze River for navigation, as well as to the drying-up of water resources and to reduced hydropower generation. In early 2011, more than 2.2 million people and 2.73 million units of livestock nationwide suffered from lack of water. Utilizing experience from past famines (1958–1961), the Chinese government has taken measures to reduce the risk of crop failure. They have invested in the water infrastructure and bought wheat on the international market to compensate for the losses from the drought (Sternberg 2013). As a significant proportion (between six and eighteen per cent) of annual global wheat production is traded across borders (Lampietti et al. 2011), the decline in supply led to an increase in wheat prices and serious economic impacts in the import-dependent countries of North Africa and the Middle East (Sternberg 2013; see the following section).

Social and political destabilization

Directly or indirectly through the integration of physical, economic, and geopolitical risks in a globally interconnected world, the impact of climate-related events can also undermine social and political stability in regional and global contexts. Due to globalization, combined with rapid developments in computer technology, in communication, and in transportation systems, people are increasingly globally connected and able to respond collectively and rapidly to local changes. Accordingly, social and political changes in one region can have significant impacts in other regions, and determined groups can set in motion global chains of events that have an influence on international relations. This became apparent with the end of the cold war, the terrorist attacks of 11 September 2001, the Arab Spring in 2011, and the 2015 refugee crisis, each of which had a significant impact on Europe.

Environmental destruction, poverty, and hunger affect social conditions in many parts of the world. Fragile and weak states with social fragmentation and poor governance and management capacity are particularly sensitive, as the core functions of government, such as law and public policy, the state's monopoly on force, welfare, participation, and basic public services in infrastructure, health, and education cannot be guaranteed (WBGU 2008). Climate change may contribute to destabilization, especially if societies are in transition, for instance from authoritarian to democratic regimes. On the edge of instability, natural disasters can undermine the legitimacy and ability of states to protect their citizens from harm. If the agricultural sector of a developing country is severely damaged, the livelihood and existence of many people is at stake. The loss of life, income, wealth, jobs, health, or family or friends provokes opposition and unrest that threaten the social contract and undermine the political order. Some of these processes occur slowly and contribute to the erosion of social and political stability; others happen quickly and overwhelm the problem-solving and adaptive capacity of communities. Various destabilizing processes may intensify in climate hot spots and spread into neighboring regions. With the decay of the social and political order, non-state actors (private security companies, terrorist groups, warlords) penetrate the domains opened up by the power vacuum and trigger spirals of hate, terror, and violence. Countries with low average income and a weak adaptive capacity are particularly at risk, while richer societies have more potential capacity for adaptation. Due to global interdependence, however, destabilization in one part of the world may spread to other parts through complex chains.

Various natural disasters have been associated with a temporary collapse of law and order. Looting and criminal acts have occurred after heavy storms, for instance after Hurricane Katrina in the USA in 2005 and after the 2013 typhoon in the Philippines. After some storms and floods in southern Asia and Central America, the distribution of aid and relief goods was subject to disputes that were partly conducted violently (WBGU 2008; for a differentiated view see Brzoska 2018). In addition to storms and floods with usually temporary and local impacts on the food supply, droughts in major food exporting regions have a direct and lasting impact on global food markets because of their larger spatial and temporal scale. People who are highly dependent on agricultural production and the local availability of water resources are particularly affected. In contrast, the indirect influence of climate-related events and disasters on water, food, and population have an international dimension.

The most significant consequences include food shortages and a subsequent increase in food prices, which undermine the living conditions of poor social groups. This includes recent global food supply crises such as those of 2007–2008 and 2011 when food prices quickly multiplied and the number of hungry people increased by 100 million to 1 billion (Beisheim 2013). For instance, in 2008 uprisings related to food crises caused a change of government in Haiti, while in Cameroon twenty-four people were killed during protests and approximately 1500 were arrested (Sternberg 2012). A particularly noteworthy example is the social and political upheavals in the Middle East and North Africa (MENA) since 2011 (on the food crisis see Smith 2014; Bazzi and Blattman 2014; van Weezel 2016). The series of protests and uprisings in the Arab world affected the entire region and provoked a regime change in several countries (Johnstone and Mazo 2011). Starting with the unrest in Tunisia in early 2011 that forced the president to flee, the revolutionary impulse spread to Libya, Egypt, Syria, and other MENA countries, accelerated and multiplied by electronic media and social networks (Kominek and Scheffran 2012), which enabled the spread of the protest movement and motivated others to join. In the following years, the situation turned violent in some countries, especially in Libya and Syria.

Which role rising food prices played here and to what extent climate change and extreme weather events might have affected these processes is still subject of scholarly debate. At the beginning of the revolts, some media reports suggested a link with the sharp rise in food prices at the turn of 2010 to 2011. A collection of papers published by the Center for American Progress examined the impact of climate change on the upheavals in the Arab world (Werrell and Femia 2013). The argument was not so much that climate change was a primary cause, but rather that in a political crisis the effects of climate change can act as an additional stressor that exceeds a "tipping point". One of the factors that occurred before the crisis was the drought in China in 2010 and 2011 (described above), which exerted pressure on the international market price of wheat and influenced the availability of food products. This coincided with other factors that further increased world food prices, including high oil prices, the development of bioenergy, and speculation on the global food markets (Johnson 2011).

The consequences affected much of the MENA region where the world's nine largest importers of wheat in 2010 were located (based on per capita imports). Seven of these countries experienced political protests. In the MENA region, many households spend, on average, more than a third of their income on food (Sternberg 2013), while people in Western countries spend less than ten per cent. The dependence of Arab states on imported food makes them vulnerable to fluctuations in global commodity markets. Low incomes and high levels of resource imports and spending on food taken together affect food security. Reinforced by the sharp rise in bread prices, the existing public discontent with the government was magnified. In Egypt, the largest wheat importer in the world with a rapidly growing population, three per cent of the national income was spent on wheat subsidies (Sternberg 2013). As early as 1977 there was the so-called "bread intifada" in Egypt, in which seventy-seven people died, and in 2008 there were bread riots. However, no protests took place in Israel or the United Arab Emirates, which have a high per capita income, a smaller food share of income, and better adaptive capacities.

The chain of events before, during, and after the Arab Spring illustrates how extreme events can affect international relations in the interconnected world, mediated through economic, social, and political processes. In this complex pattern of overlapping stressors (Werz and Hoffman 2013), climate change was not the main cause but a contributing factor to triggering a complex chain of events. The political upheavals affected the stability of the Mediterranean region and coincided with the economic crisis in southern Europe. For Europe, these events were quite significant because of the civil wars in Libya and Syria and increasing migration from North Africa, the Middle East, and sub-Saharan Africa (see the following sections).

Environmental migration

According to the Internal Displacement Monitoring Centre (IDMC 2018), 18.8 million people have been displaced in 2017 by natural disasters (which were mostly weather-related), nearly half of the numbers of refugees counted in 2008. In contrast, 11.8 million were displaced by violent conflict in 2017 compared to 4.6 million in 2008. Between 2000 and 2016, floods were the most frequent weather-related disasters (followed by storms) and thus one of the biggest drivers of disaster displacement. For instance, as a result of the 2010 monsoon 15.2 million people in China and 11 million in Pakistan were displaced by floods. Every year millions of people escape from tropical cyclones, in particular in India, Bangladesh, China, the Philippines, Latin America, and the Caribbean. These countries often suffer from the consequences of severe cyclones. High-income OECD countries such as the USA, Australia, and Japan are also located in storm-prone areas. Particularly devastating catastrophes with extreme destructive power include Hurricane Mitch in 1998, Hurricane Katrina in 2005, Cyclone Nargis in 2008, Hurricane Sandy in 2012, Typhoon Haiyan in 2013, Hurricane Irma in 2017, and Hurricane Michael 2018, leaving millions of people homeless. Heat- and drought-related weather extremes reduce the adaptive capacity of social systems and lead to water, food, and health problems. Once traditional living conditions (agriculture and pastoralism) are suffering, long-term large-scale migration is one possible impact (Scheffran 2018).

Such problems are likely to become more important as a result of climate change, although its influence is currently difficult to determine. Thus, estimates of future climate migrants vary substantially in the literature, from fifty million to a billion people. All reported numbers are disputed (Jakobeit and Methmann 2012; Foresight 2011). The IPCC Special Report of 2012 on extreme events and disasters states that climate extremes will have a larger impact on migration in the future

(IPCC 2012). And the Fifth Assessment Report finds evidence for increased mobility in seventeen cases of observed or projected mobility associated with weather-related extremes or impacts of longer-term climate change while decreased mobility was found in six cases and socially differentiated changes in mobility patterns in five (IPCC 2014: 769).

Changes in the environment cannot only promote but also inhibit migration by increasing poverty in rural populations and thereby limiting their opportunities to escape (trapped populations). Environmental impacts and vulnerabilities can increase if people migrate to ecologically fragile and conflict-affected regions, including coastal cities that are affected by storms and sea level rise. In Europe and the United States, climate migration is often regarded as a security issue and conflict factor, possibly leading to ethnic, religious, and political tensions between the local population and immigrants. One contributing factor is competition for scarce resources such as arable farmland or pasture, housing, water, jobs, and social services. Media coverage of events such as the drought in Somalia, boat people in the Mediterranean, and refugee movements along the Balkan route reinforce threat perceptions in Europe. With the establishment of the European Agency for the Management of Operational Cooperation at the External Borders (FRONTEX), the "defense" of and against refugees – including environmental and climate migrants – has been expanded and continues to grow. One response to the refugee crisis of 2015 was to increase border controls.

So far, climate or environmental factors have not been identified as major contributions to international South-North migration. The majority of people affected by precarious environmental conditions remain in their home region or migrate to nearby urban areas. For weak and marginalized people, it is more difficult to overcome long distances or other barriers (e. g. language and cultural barriers) than it is for the privileged. It is subject of debate to what extent migration can be proven to trigger political instability and conflict (Barnett and Adger 2007; Reuveny 2007). Response patterns in security policy narrow the scope of action to the symptoms, with the risk of triggering a "chain reaction" between increasing migration pressure and countermeasures (such as enhanced border protection, as observed during the "refugee crisis" of 2015–16). Adaptation strategies and international cooperation can help to overcome risks and even develop migration into an important measure of adaptation to climate change (Foresight 2011), strengthening the resistance and resilience of the affected communities. Migration networks can contribute to resilience and stable structures between source and destination countries, such as the transfer of remittances, knowledge, and technology (Adger et al. 2002; Scheffran, Marmer, and Sow 2012).

Industrialized countries also experience environmental migration. The debate on this subject became more important when Hurricane Katrina forced hundreds of thousands of people to flee New Orleans in 2005, among them numerous refugees who never returned. Risk zones vulnerable to flooding in coastal or river areas can also become uninhabitable in Europe and lead to migration, even if a larger number of domestic environmental migrants is not expected in the foreseeable future. In contrast, the debate on the immigration of refugees from conflict areas can provoke internal social conflicts, an issue that become relevant in Europe since the summer of 2015.

A large number of immigrants to Europe originate in the MENA region (especially from Syria and Iraq), Afghanistan, and the Sahel. These regions are directly affected by climate change, which potentially increases the migration pressure there (Bundeswehr 2012). Because of high population growth rates, climate change and resource depletion in large parts of Africa, the availability of drinking water and arable farmland and pasture is expected to decline, potentially increasing dissatisfaction and tensions among millions of people (Schilling et al. 2012, Busby et al. 2013). Water availability in some countries is already below the threshold for water scarcity of 1000 cubic meters per person per year. In Libya, per capita water supply amounted to only approximately 95.8 cubic meters in 2009 and to 356 cubic meters per person in Syria, significantly lower than the figures for 2002 and well below the world average (World Bank 2013). In the years before the rebellion, Syria experienced devastating droughts (Kelley et al. 2015) that hit the main agricultural areas of the country and displaced many people from the countryside to the cities (Werz and Hoffman 2013; see the contribution by Christiane Fröhlich in this volume). Water and food supply in Egypt depends heavily on water from the Nile River, which is increasingly being utilized by upstream riparian states in recent years (Link et al. 2012).

Frustration sparks protests, especially among the young male population, and increases their willingness to leave the country to travel to the North. The problems of North Africa are linked in complex ways to those of the Sahel, which is also affected by climate change. Libya has been the destination of migration routes from the South because of oil revenues and related jobs. After the government was overthrown, tensions with immigrants increased. Some of the armed mercenaries in Libya went to Mali and other countries of the Sahel where they contributed to regional political destabilization. In sub-Saharan Africa, climate change, desertification and scarcity of resources have become connected with economic and social marginalization, political instability and violent conflict, which undermined the livelihoods of farmers and herders and increased the migration pressure (Ionesco et al. 2017).

Climate change and violent conflict

By altering natural and social livelihoods in many regions, climate change represents a potential driver for conflict and related acts of violence. These include civil wars and military interventions that in turn are associated with negative consequences such as famine, economic crises, refugees, resource exploitation, and environmental degradation (WBGU 2008).

There is a widely held assumption that the progressing consequences of global warming will increase the likelihood of conflicts that are associated with the destruction of human livelihoods and resources. In addition, there are potential disputes regarding the adequate strategies for avoiding climate change as well as their financing. Examples include the controversy about the use of nuclear power as a contribution to CO_2 abatement or the debate about the consequences of bioenergy, which also determine the German discourse (Webersik 2010; Scheffran and Cannaday 2013). The same applies to differences on adaptation to climate change and its security implications, such as alternative farming practices, protection measures like the construction of dams, and military operations in disaster management. technical interventions into the climate system (climate geoengineering) to remove CO_2 from the atmosphere or to influence the earth's radiation budget are also conflict-prone. Such measures raise critical issues of technical and economic feasibility, as well as on risks and responsibilities at global, national, and local levels (Brzoska et al. 2012). In all these consequences and responses there are concerns about justice when it comes to the distribution of the costs, benefits, and risks of climate change, which are likely to complicate cooperative solutions.

The potential contribution of environmental change and resource use to violent conflict has been the subject of scientific controversy for more than two decades. While some studies claim that natural disasters and resource scarcity put social systems under stress, threaten their stability, and make violent conflict more likely, others see no clear causal relationship for past events that is detectable by statistical methods. Those researchers emphasize the ability of human societies to deal with resource issues through collaboration and innovation (see reviews in Brauch 2002, 2009). So far, most environmental conflicts have been regional in scope and have presented no threat to international security (Carius et al. 2006). The connections vary substantially regionally and depend on the affected resource type. While scarcity is more likely to be a conflict factor for renewable resources (water, food, biodiversity), abundance is more likely to lead to conflict for non-renewable resources (fossil fuels, uranium, diamonds, coltan). In both cases, violent conflicts consume resources, which can drive or restrain a spiral of violence (Scheffran et al. 2014).

Debates that are more recent have addressed the links between climate change and violent conflict. This issue was raised in the fifth IPCC Assessment Report (IPCC 2014; Gleditsch and Nordas 2014). Some studies looking at long historical periods have found significant correlations between climate variability and violent conflicts, particularly in the Little Ice Age in Europe between the fifteenth and the nineteenth centuries. Research on more recent periods has produced mixed results, which depend in a complex way on the regional context and on the conflict situation (see reviews in Scheffran, Brzoska et al. 2012a, 2012b). Studies using selected data and studies on the relationship between climate change and violence over all historical periods, world regions, forms of violence, and causal mechanisms (Burke et al. 2009; Hsiang et al. 2013) have exacerbated the scientific controversy (Buhaug 2010; Buhaug et al. 2014).

Regardless of the interpretation of historical data, the impact of future climate change goes beyond previous experiences, leaving space for scenarios, plausibility considerations, and speculation. It is indeed possible that societies have been able to adapt to moderate climate change in history but they may be overwhelmed in the future by rapid and strong climate change that exceeds their adaptive capacities. There is a wide range of possible conflict constellations (WBGU 2008) associated with the effects of climate change on rainfall and water scarcity, land use and food security, migration and refugee movements, extreme weather events and natural disasters. These processes can become conflict factors individually or in conjunction. In addition, the effects of climate change on infrastructure and social destabilization may trigger societal "tipping points", leading to social unrest, riots, violence, crime, and armed conflict.

The vulnerability of agrarian societies with a high level of population growth and a low level of development is particularly pronounced (Raleigh and Urdal 2007). Pastoralists, for whom migration is part of their traditional way of life, suffer from long periods of drought that threaten the supply of water and grass to their cattle herds. Deviation from their usual routes can create tensions among herders or farmers, especially in regions with severe water shortages, such as West Africa and the Horn of Africa, the Middle East, and Central Asia.

Whether climate change acts as a "threat multiplier" and creates a "climate of violence" depends largely on how people and societies respond to change, and on whether their adaptive capacities and institutional structures are adequate for maintaining stability. While rich industrialized countries are not spared by climate change, they may benefit from advanced economic and institutional conditions for problem solving and conflict management. Potential issues of conflict in Europe include tensions over territorial claims and natural resources in the Arctic and the Mediterranean. The melting of polar ice sheets affects the strategic interests of Europe, Russia, and North America. Efforts between Europe, the Middle East, and Northern Africa to build a power grid based on renewable energy open up the possibility of converting the Mediterranean from a region dominated by oil interests towards a region of cooperative security (Scheffran and Brauch 2014), provided that the utilization of energy is sustainable and promotes development, peace, and justice.

As an example, the importance of climate change for conflict in North and East Africa is discussed. In the wake of the Arab Spring, Syria and Libya experienced bloody unrest that led to a coup in Libya, and in the case of Syria to a civil war, in which the contribution of climate change is disputed (Kelley et al. 2015; Selby et al. 2017; see chapter by Christiane Fröhlich). Similar to other MENA countries, both countries are facing water problems that compromise the supply of this elementary good (Schilling et al. 2012).

For several decades, Sudan has experienced political instability and violent conflicts, reinforced by national power games, regional struggles, and global geopolitics. Peripheral regions such as Darfur are characterized by marginalization and exclusion, and this leads to disintegration and secession. The complex nexus of problems includes population pressure, unsustainable exploitation of land and forests, declining agricultural productivity, food insecurity, and the spread of diseases such as malaria. Associated problems are environmental changes and resource degradation, which cause water shortages and the deterioration of pasture in the northern Sahel following drought and desertification (DeJuan 2005). This exacerbates competition for resources between herders and sedentary farmers. The expansion of mechanized agriculture continues to deprive nomadic people of their traditional migration routes, to dispossess peasants, and possibly lead to serious tensions.

The role of climate change as a conflict amplifier in Darfur is controversial. While some observers classify Darfur as a "tragic example of a social collapse as a result of an ecological collapse" (UNEP 2007: 12–13), others are concerned about the oversimplification of the Darfur conflict (Butler 2007). They criticize the government of Sudan for exploiting the climate argument to distract from its own responsibility (Verhoeven 2011). Overall, climate change is one of many conflict factors in Darfur that reinforce each other in a complex way (Scheffran et al. 2014). A recent expression of the climate-conflict nexus is the humanitarian crisis in the Lake Chad region. Environmental and climate stress from rainfall variability, droughts, and declining water and arable land in a shrinking Lake Chad aggravates multiple vulnerability conditions and contributes to livelihood risks and tensions between farmers, pastoralists, and fishermen who may become the target of recruitment by non-state armed groups such as Boko Haram. Resource conflicts contribute to destabilization and displacement, fueling the region's fragility (Vivekananda and Born 2018).

Governing complex crises and climate risks

The "complexity turn" in international relations (Urry 2005) is characterized by multi-level crises constellations linked through global connectors such as globalized financial markets, infrastructure and supply chains, media and social networks,

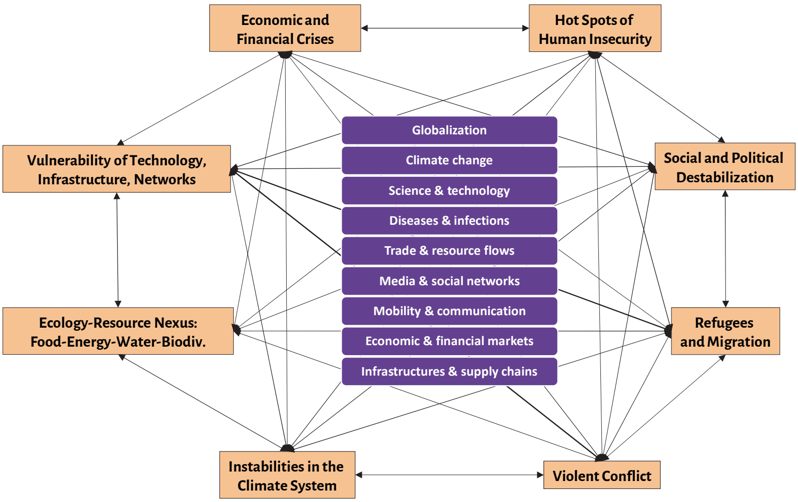

Figure 2: Compound events and global connectors in complex crises landscapes. Source: adapted from Scheffran 2017a.

communication and transportation systems, as well as resource flows and climate change (Figure 2). When everything is interconnected, changes in one part of the world can have significant impacts elsewhere and propagate through systemic networks like a domino effect or chain reaction (Scheffran 2017a). Growing complexity provokes opposing trends of over-simplification, populism, nationalism, religious fundamentalism, illiberalism, anti-globalization, and anti-science attitudes that fail to address the underlying mechanisms. Without adequate management or reduction of complexity, the world may continue on a slippery slope of destabilization. Instead, stability may be achieved by adapting the complexity of policies to the complexity of the systemic processes that they regulate. The challenge is whether humanity can anticipate and avoid hazardous pathways by counteracting forces that slow down and change course within the planetary boundaries of the Anthropocene (Rockström et al. 2009). Throughout history, Homo Sapiens was able to overcome constraints on resources in crises and to expand into new spaces by applying problem-solving capabilities and developing technical and social innovations that stretched the limits of growth, allowing more wealth to be generated on a shrinking base of natural resources. The question is whether humanity will succeed again facing today's complex world or whether disasters destroy any chances of success.

Operating in a multi-risk environment requires taking a whole-system approach to analyzing and measuring compounding risks (Mishra and Vivekananda 2015). Although risks from individual processes like climate change may be relevant,

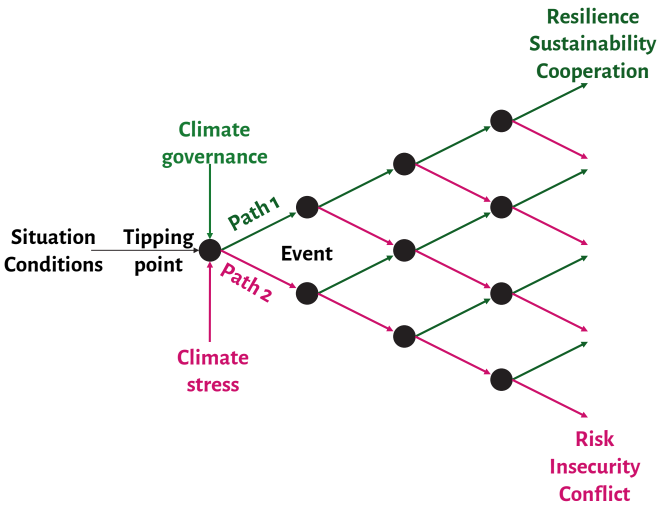

Figure 3: Pathways, tipping points, and cascades of transitions between conflict and cooperation. Source: adapted from Scheffran 2016c

their impacts may be hard to prove. It makes sense to identify criteria for stability, determine thresholds when transitions to instability occur and identify factors and mechanisms that facilitate the transition across thresholds. Regarding climate-conflict linkages, the question is how stable a certain level of conflict or cooperation is when an escalation between levels occurs and which role climate change can play in these transitions. This is not a single-stage process but a continued interaction between climate stressors and governance mechanisms driving the dynamics through a sequence of decisions and tipping points between conflict and cooperation. Whether climate stress fuels a cycle of violence or climate governance facilitates a cycle of cooperation and sustainable peace depends on the effectiveness of human and societal responses (Scheffran et al. 2014).

Strategies for sustainable and adaptive governance range from climate mitigation, adaptation, and the building of social networks to new capabilities of disaster management, crisis prevention, conflict resolution, and environmental peacebuilding to stabilize human interaction. Various measures can support the adaptive capacity of ecosystems and their human values, including the establishment of nature reserves, sustainable land use, preservation of endangered species, and the protection of terrestrial carbon stocks. Within limits, ecosystems can adapt to climate change. To be sustainable, consumption of natural resources should not exceed their carrying capacity, given by their limited regeneration and absorption abilities (Scheffran 2015a). Stabilizing human-environment interactions becomes a major challenge in international relations and global governance but there is little experience with integrative approaches in science and politics to understand and manage such level of complexity. Stabilization may be achieved by concepts of adaptive and anticipative governance that addresses and diminishes the complexity of the systemic processes. Integrative and interdisciplinary knowledge helps to avoid dangerous pathways, influence critical decision points and develop collective adaptive strategies and interventions towards a more sustainable, peaceful, and viable world (Scheffran 2016c).

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3 Agrofuel expansion and black resistance in Brazil

Energy landscapes as materialized unequal power relations

Martina Neuburger, Rafaela Rau, and Tobias Schmitt

Abstract

In recent years, energy crops have become one of the most important strategies towards a sustainable economy in order to avoid the use of fossil fuels. In a way, Brazil can be seen as a pioneer since already during the oil crisis of the 1970s sugarcane ethanol was promoted there through extensive state programs. The associated expansion of sugarcane and other energy crops, though, is largely driven by large-scale agro-industrial enterprises, with the result that indigenous groups and quilombos *are increasingly displaced. Understanding landscape as a materialization of power relations, we analyze socioeconomic dynamics in the municipality of Pompéu in the Brazilian state of Minas Gerais as case study region.*

Doing so, we show that landscapes in general and energy landscapes more specifically represent the arena of socio-political negotiation on development pathways and models in their specific regional and historical context. Unequal power relations result in practical, symbolic, and discursive dominance of the most powerful land use, economic logic, and social life by delegitimizing, marginalizing, and disregarding alternative ideas. These processes are embedded in postcolonial entanglements and constitute (energy) landscapes within a globalizing world.

KEYWORDS: *Energy landscapes, agrofuels, black resistance, power relations, Brazil.*

Introduction

In recent years, energy crops have become one of the most important strategies towards a sustainable economy in order to avoid the use of fossil fuels. In a way, Brazil can be regarded as a pioneer, since already during the oil crisis of the 1970s sugarcane ethanol was promoted there through extensive state programs – at that time, however, in order to reduce dependence on expensive oil imports. The associated expansion of sugarcane and other energy crops, though, is largely driven by large-scale agro-industrial enterprises, with the result that population groups that are not integrated into these forms of production are increasingly displaced. Especially indigenous groups and *quilombos* suffer from these developments. That means that the expansion of energy crops not only stands in conflict with food production and livelihoods of these people but jeopardize their food security and sovereignty as well.

In the following, these conflict constellations and displacement processes will be the focus of our interest as they are clearly reflected in the landscape of the region in question. Here, we understand landscape as a materialization of power relations, as they were already structured in the colonial period in Brazil and are still relevant in political, economic, and social processes (Mitchell 2003, Crosgrove 2017). Using the Pompéu region in the Brazilian state of Minas Gerais as an example, it becomes clear how colonial and global power relations are being inscribed into the landscape at the local level through practices, discourses, and symbols.

After a brief outline of the main political, institutional, and socio-economic conditions in Brazil (section 2) and a presentation of the case-study region (section 3), we analyze the efficacy of power relationships that were already established in colonial times and their materialization in the Pompéu landscape to show the underlying dynamics (section 4). This finally serves as the basis for a new look at energy landscapes in Brazil (section 5).

Colonial power relations in the Brazilian present

Even before the conquest there were already indigenous groups inhabiting the northeastern coastline of the present Brazilian territory. They practiced a production system similar to peasant agriculture. With the onset of the colonial era in Brazil – dating back to the arrival of the Portuguese in 1500 – the systematic displacement of the indigenous groups and the destruction of any evidence of their presence began (Dean 1996). Portuguese landowners, who received large estates from the Portuguese crown, cultivated sugarcane at a large scale, as the "white gold" brought about substantial revenues in Europe. The "sugar barons" thus established themselves not only as economic but also as political elite. These so-called *coronéis* had extensive power in the region and controlled not only the fortunes of all humans on their sugarcane plantations – most of whom were enslaved and abducted from Africa – but also the events in the Portuguese colony from the former capital, Salvador. Neither the later economic cycles in which cocoa, cotton, and coffee had become the dominant export products, nor the attainment of Brazilian independence from the Portuguese crown in 1822 brought about any fundamental change in the unequal power relations, in which landlords had the controlling power due to shared interests and personal unions with government bodies (Schmalz 2012, Dietz 2016).

This is reflected to this day by the fact that the interests of sugar producers are directly or indirectly protected by the state. During the Great Depression in the 1920s, sugar prices fell dramatically but the state subsidized sugar production. In the early 1970s, the state set up the ProÁlcool program, which was designed to reduce dependence on expensive oil imports (Kohlhepp 2008, Chilcote 2006, Prado Jr 2017). These subsidies essentially benefited the large-scale sugarcane producers as well as the sugar or rather ethanol factories. Thus, they contributed to the preservation of power of the former sugar barons. These subsidies were reduced in the context of the neoliberal economic reforms of the 1990s. However, the global and national bioenergy debate has given rise to new opportunities to legitimize subsidies for sugarcane (Amman et al. 2011). Therefore, the agricultural oligarchy was able to maintain its dominance and power over many centuries based on a discourse on progress, growth, and – more recently – climate protection.

This development is closely linked to the history of Afro-Brazilian groups in Brazil who have been affected by discrimination and racism since their enslavement on the sugarcane plantations (Zeuske 2013, Ribeiro 2015). The inhumane working and living conditions on the plantations led to escape attempts by many slaves. Some succeeded in escaping and thus settlements of escaped (former) slaves emerged in remote and inaccessible areas. Despite the expansion of the Portuguese and later colonist settlements into the hinterland, some of these settlements, now called *quilombos*, have been able to survive even though the living conditions there are mostly poor (Reis 1996). Even with the end of their persecution with the abolition of slavery in 1888, racist worldviews and discrimination continue to exist so that the Afro-Brazilian population is disadvantaged in almost all sectors of society – education, health, income, etc. (Telles 2004; Da Costa 2016). It was only 100 years after the abolition of slavery – which can be seen as a success of long-standing struggles by black social movements in Brazil – that Article 68 of the Brazilian Constitution established the right to land and self-determined life for *quilombolas* and thereby allowed for their recognition as a distinct category of "traditional" communities (Farfán-Santos 2016). In order to carry out the recognition and award procedures, the Fundação Cultural Palmares was founded in 1988, which is subordinate to the

Brazilian Ministry of Culture (Boaventura Leite 2015). To be recognized, the communities must demonstrate their traditions, how they are linked with their past, and their relationship with the land. Additionally, they must show that their lifestyle differs from that of the majority (Boaventura Leite 2015: 1227). Nevertheless, the continuity of structural racism remains evident to date, with over 3000 communities recognized as *quilombolas*, while only 248 of the territories were officially ascribed (CPISP 2015, Ventura 2018).

The dynamics presented below, which are relevant to the present expansion of sugarcane cultivation and the formation of energy landscapes, must be considered in the context of these historical processes. Sugarcane cultivation was and is still dominated by large-scale production, while the history and current situation of *quilombolas* were and remain closely related to it.

The region of Pompéu as a place of negotiation of different development models

Located in the heart of the state of Minas Gerais, the Pompéu region forms an interface between colonial precursors and current dynamic processes. It was not until the 18th century that Portuguese exploration troops expelled the indigenous population to establish extensive cattle-pasture farming, using the natural pastures of Cerrado vegetation to supply the southern gold-mining areas with leather, meat, and livestock (López and Vértiz 2015, Garcia de Almeida 2014). With industrialization in the early 20th century, Minas Gerais became the most important heavy industry site in Brazil. The small- and medium-scale agriculture had specialized in milk production so that particularly the central region of the state was considered the milk basin of Brazil. However, the mostly cooperatively organized dairy-cattle-industry experienced a severe crisis in the 1990s due to neoliberal agricultural policies. The subsequent land concentration was accompanied by the expansion of sugarcane cultivation and the displacement of dairy-cattle-farming. Today, Minas Gerais is considered one of the states, in which the (neo-) extractivist model with the exploitation of raw materials as well as the expansion of sugarcane cultivation and focus on export is spreading the fastest.

The municipality of Pompéu, with about 30 000 inhabitants (Prefeitura Municipal de Pompéu 2011, p. 16), is located in the current northern expansion zone of the sugarcane cultivation area. Accordingly, dairy producers continue to be an important group of players, even though they have become less important over the past twenty years as large-scale resident farms either enter sugarcane production themselves or lease their land to interested investors for the same purpose. Since the

2000s, sugarcane cultivation has been promoted through national bioenergy funding programs. Correspondingly, the area used for sugarcane cultivation in the Municipality Pompéu has expanded dramatically since the 1990s (Schmitt 2007).

The expansion of sugarcane has led to competition with other agricultural sectors – especially cattle farming for dairy products and beef – which also depend on access to land and water. At the same time, these dynamics deprive subsistence-based production and forms of life organization in rural areas of their living conditions. Thus, different players following specific logics compete for the same natural resources in Pompéu:

Modern sugarcane cultivation

The large-scale sugarcane producers are integrated into a neo-liberal growth- and market-oriented economic model, which follows profit maximization and exploitation of the natural resources of land and water. This model also includes various agro-industrial companies. Agropéu, founded in 1981 as part of the second phase of the ProÁlcool program, is based in Pompéu and grows its own sugarcane or buys from large landowners.

Territorially rooted *quilombola*

During the colonial era, enslaved people fled from the southern gold mines to the Pompéu region to settle in mainly inaccessible terrain. As a result of the expansion of agricultural holdings, these settlements now lie in the middle of the area of land that large landowners have acquired over the centuries. As an example, the Comunidade *Quilombola do Saco Barreiro* is mentioned. Forty-eight families belong to it. The community has received its official status as *quilombo* in 2007 but has not yet been awarded the demanded land (see Fig. 1). The *quilombola* operate a diversified form of agroforestry for subsistence but due to the extremely small areas, they have to earn additional income through wage labor working for the neighboring large-scale landowners or through occasional jobs in the town of Pompéu. At present, only 17 families live in the comunidade itself. The remaining families moved to the city because they had school-age children or to the nearby settlements of Assentamento Paulista due to the availability of larger areas of land there.

Hence, in the Pompéu Municipality various actors are spatially and socially in direct contact and in competition for access to natural resources, land, and water, as well as for the social recognition of their ways of life and economic organization. The

Figure 1: Territory of the *Comunidade Quilombola do Saco Barreiro* surrounded by sugarcane and eucalyptus plantations. Source: Carolina Panzera and Christiano Sena 2014.

corresponding struggles and strategies can be analyzed based on the respective specific practices, discourses, and symbols, which are integrated into a variety of power relations and inscribed in the landscape in their historical entanglements.

The following statements are based on empirical research carried out in September 2014 in the municipality of Pompéu. In total, three expert interviews were conducted with representatives of relevant state institutions and companies. In the Assentamento Paulista, there were eight guideline interviews with settler families, which were supplemented by observations and use- and resource mappings to adequately describe the peasant model. In the *Comunidade Quilombola*, the explanations are based on participatory observations and on five narrative, biographical, and go-along interviews, as well as on a collective mapping process and GPS mapping of the claimed territory. All interviews were transcribed and a critical discourse analysis was developed to identify and extract relevant data.

Strategies of domination and resistance: practices, discourses, symbols

The following actors are embedded in specific contexts of economy, society, and state. They follow corresponding ideas of development, which in turn require a certain way of appropriating nature. The form of appropriation is directly reflected in the landscape through the application of practices in agriculture, in farm-sized structures, and in the use of technology and cultivation methods. Discourses legitimize such practices, establish social recognition, and facilitate political support. Finally, material and immaterial symbols such as built structures, statues, museums, history books, and narratives form representations of the respective specific development model and make it visible and comprehensible to all. The different practices, discourses, and symbols, however, are not based on an equal footing. Rather, prevailing power relations determine which logics prevail and become dominant elements in the landscape. At the same time, existing acts of resistance by various actors mean that these dominant relationships are subject to a continuous process of social negotiation and that the landscape of a region thus merely reflects a snapshot of current debates. On the one hand, this conceals numerous processes through spatial displacements. On the other hand, however, it clarifies the direct entanglement of the different development models in their spatial constitution.

Practices as a powerful strategy of dominance and resistance

The specific practices of certain actors, individuals, and groups are embedded in historical and social contexts that are in competition with one another. At the same time they produce manifold overlaps and entanglements, contradictions and conflicts, which in turn are permeated by hierarchies and power relations.

Practices of modern agriculture in sugarcane cultivation

Sugarcane cultivation is one of the most important economic sectors in the Pompéu region. It is cultivated in monocultures in large agricultural enterprises and is integrated into market- or export-oriented processing and marketing structures. For example, Agropéu, which was founded at the beginning of the 1980s by two large-scale landowners in the region, produces more than 1 million tons of sugarcane in a largely mechanized process on its own 20 000 hectares of land. Depending on the respective world market prices, the sugarcane is processed into either sugar or ethanol in the company's own industrial plants. In addition, land is leased from neighboring large landowners in order to flexibly increase production depending on the expected price development. Land use, cultivation methods, the use of technology, and labor are all oriented towards maximum profit and economic efficiency. Thus, above all, mechanizable arable land that provides available water from springs or streams is used for sugarcane cultivation; machines are used to cultivate the plantations, which yield

Figure 2: Sugarcane cultivation directly adjacent to the gardens of the *quilombolas*, Photo: Langer 2014.

approximately 75 % of the harvest. Besides a few permanent workers, almost exclusively seasonal workers are contracted for the period of the harvest. The owners, managers, and large part of the workforce live in the small town of Pompéu in order to maintain a relatively urban and modern lifestyle. In addition to sugarcane producers, sugar and ethanol producers, intermediate-product companies, and upstream and downstream service providers, these growth- and market-oriented logics also involve state agencies that support the interests of the relevant actors through support programs (e. g. ProÁlcool), the provision of infrastructure (e. g. transport routes, agriculturally oriented educational institutions), and advisory services (e. g. state agricultural advisory agency Emater).

Continuous spatial and economic expansion is a constitutive element of this capitalist-neoliberal growth logic. On the one hand, the expansion of the cultivated areas takes place through the appropriation of apparently unused areas, which, however, serve so-called traditional groups for collecting, hunting, and cultivation purposes, though without their formalized title of ownership. In Pompéu, for example, large-scale landowners extend their sugarcane cultivation areas into the territory of the *Comunidade Quilombola do Saco Barreiro* and plant sugarcane up to the border of the *quilombo* gardens (see Fig. 2). They intimidate and threaten the *quilombolas* or spread agricultural poisons by air over their gardens in order to push them to abandon their land. On the other hand, *quilombolas* are offered jobs in the harvest or contract cultivation of sugarcane in order to integrate them into the neoliberal economy and thus subtly break down their resistance.

The power of market-oriented actors lies in their ability to penetrate the regional economy via the size of the land area they farm, their technological dominance, and their economic potential – due to broad business networks and jobs – to align their processes with their logic. With the support of government agencies, companies and large-scale landowners can thus secure the most agriculturally attractive areas with sufficient water availability. Furthermore, jobs and production contracts create dependencies that make it difficult for *quilombolas* to evade the growth-oriented logic. However, these practices remain socially contested because, on the one hand, the local dairy industry insists on its economic performance and competes with sugarcane cultivation for the same agricultural land. On the other hand, the legally guaranteed land rights of *quilombolas* face unrestricted expansion.

Practices of the quilombolas in the Comunidade Quilombola de Saco Barreiro

In the practices of the *quilombola*, agricultural production and small-scale livestock farming are carried out on very small garden-like plots and in subsistence farming, with the sale of the surplus at the weekly market in Pompéu. The cultivation takes place on common land. Additionally, part of the food consists of game, fish, and collected berries and fruits. The work is organized collectively and regular meetings, activities, and celebrations in the community house structure the life in the comunidade. The families of the *quilombos* live in clay buildings made of local materials that are surrounded by gardens. The long settlement history of the *quilombos* in this area, the diverse use of the ecosystem, the close interlinkage of the place of living and working, and the emphasis on collective associations have embedded both the relationships between humans and nature and the territorial references to identity in holistic perceptions.

The logics of life and economy of the *quilombolas* are essentially based on securing their survival, in which collectivity, territoriality, and their related identity form central elements. However, the expansion of sugarcane plantations and pastures threatens their way of life as these industries reach closer to their gardens and houses due to the lack of demarcation of their respective territories. This goes hand in hand with the pollution of river water, the destruction of the gardens, and serious health damage to both humans and animals due to the application of agricultural chemicals by air. In addition, the banks of the streams on which the *quilombolas* live are to be declared a nature reserve. This would criminalize their traditional way of life and make the forced resettlement of the families likely. Numerous *quilombos* families already live in the Assentamento Paulista or in the town of Pompéu due to this difficult situation, to enable their children to have access to schooling, and to make healthcare facilities accessible to their families.

On the one hand, the practices of the *quilombolas* are protected by state regulations that secure their right to a self-determined life and their territorial claims. However, even after their official recognition as a quilombo has been achieved, the families are still fighting for their territory and are networking with powerful actors such as the state university UFMG (Federal University of Minas Gerais) in Belo Horizonte, which supports them with legal competencies and political actions. On the other hand, local authorities systematically delay the implementation of the legal requirements, and even use nature conservation laws to put further pressure on the *quilombolas*. Despite their emigration and the threats to their way of life, the *quilombos* maintain their community by gathering all member families, regardless of their place of residence, into the comunidade on weekends to exchange information on current developments and new strategies.

Power of practices and practices of power

In the context of Pompéu, the practices associated with the different models show a variety of degrees of assertiveness. While *quilombolas* can draw on legal rules and support programs, they are hampered in their efforts. The local powerful actors – especially state authorities – in coalitions of interest with market-oriented actors undermine their effective implementation. In the context of these unequal power relations, which can be traced back to (post-) colonial discrimination and racism, the expansive force of neoliberal logics is additionally promoted and lifestyles designed to secure livelihoods are increasingly suppressed. The one-sided dependencies of the *quilombolas* on agro-industrial jobs and urban supply structures also reinforce this dynamic. At the same time, everyday and collective practices of the *quilombolas* develop a resistant force that challenges the unimpeded expansion of sugarcane cultivation.

Discursive (de-) legitimization of practices

Discourses that support the respective logics essentially serve to legitimize one's own actions and at the same time attempt to delegitimize all practices attributed to the other. It is not only relevant what and how something is said but also by whom and from what position because through all these criteria hegemony and dominance may be established. Resistant counter-discourses break these dominance relations and question their legitimacy.

Discourses on growth and development

The discourses, which follow neoliberal logics, are primarily supported by agro-industry, large-scale landowners, and sugarcane and eucalyptus producers. They are also supported by state institutions such as Emater, INCRA, and the municipal administration. Representatives of these actors legitimize the expansion of agro-industrial forms of production with reference to ideas of modernity and progress, economic growth, and – through the creation of jobs – associated prosperity for the entire population. Global discourses on climate change and food security for the world's growing population are also incorporated by emphasizing the use of renewable energies for climate protection and the efficiency of modern agricultural production. In addition, concerns about social and ecological costs are alleviated with appropriate compensation measures: the Agropéu Company, for example, has set up a welfare and social assistance department and runs a tree nursery to reforest ecological compensation areas. The local environmental council, which also includes Agropéu and large-scale landowners, approves the clearing of forests for production purposes and determines the scope of the necessary compensation measures.

The logics of production of the *quilombolas* are delegitimized in conversations in which attributions such as poor, underdeveloped, backward, unsustainable, and unviable are used. Thus, the corresponding ways of life and logics are not only denied their right to exist but every form of support is also declared backward looking and meaningless. Accordingly, representatives of Emater, INCRA, and the municipal administration question the respective funding programs and state regulations by not implementing them, or doing so only very hesitantly, and by withdrawing state-funded institutions such as schools, hospitals, public transport etc. from the Comunidade *Quilombola de Saco Barreiro*. Furthermore, the legitimacy of state recognition as a *quilombo* – i. e. as a "traditional" community – is called into question since some families have accepted jobs outside the *quilombos*, are living in the city, in the Assentamento Paulista, or in modern stone houses. This form of delegitimization is based on colonial-racist discourses that on the one hand construct extensively used land – by indigenous or *quilombo* groups – as uninhabited and colonizable and on the other hand explicitly declare "traditional" groups to be underdeveloped and, implicitly, uncivilized.

Discursive resistance of the comunidades quilombola

In the discourses of the *quilombolas*, the cultural identity and common history of the comunidade members are emphasized as central elements. Collective, quasi-indigenous knowledge of the ecosystem as well as cultural peculiarities are written down in the comunidade's book, which was created in the course of the process of their recognition as a *quilombo* by collecting from remembered events and places. The land used productively and extractively by the comunidade is understood by the *quilombolas* as a territory linked to their own history, traditions, and way of life. Accordingly, country and identity are understood as a unity in the discourse of the *quilombolas* and thus cannot be considered separately. The demand for their previously used land is based on the notion – also supported by state laws – that without that territory their ways of life, traditions, and cultural diversity are endangered.

The delegitimization strategies of *quilombolas* accordingly aim at the fact that both the agro-industry, with its occupation of the *quilombo*-territory, and the state authorities, with their refusal of support, violate legal defaults. In addition, they deplore the endangerment of their health and the destruction of their livelihoods through the application of agrochemicals. By linking their territory directly to the survival of the comunidade, the observable displacement processes are transformed into a question of human rights; they are not limited to only ecological and social issues, and thus gain greater social importance.

The discourses, which are essentially carried by the *quilombolas*, have a very weak political power of assertiveness at the local level since despite legally imposed support the local actors refuse them, which in turn can be traced back to racist structures in Brazilian society. Nevertheless, they are supported in their political demands and in legal proceedings by socially accepted actors such as UFMG scientists.

Consolidation of power relations through discourses

The combination of discourses on progress and development together with the silence about racism and discrimination make the capitalist-neoliberal discourse extremely effective. It gains power by being represented and propagated by powerful actors such as landowners and agribusinesses, and also by state institutions such as Emater, INCRA, and the municipal administration of Pompéu. Power relations that are based on access to resources, institutional regulations, and practices are thus discursively reproduced and consolidated.

Symbols of representation

The presented practices and discourses, which follow their individual logics, are additionally represented in the landscape through specific symbols. The individual material elements not only represent the respective model but also form points of identification for the individual actors. Their size and positioning make them visible or invisible and fill certain places with symbolic meanings.

Symbols for development and progress

The symbols of development and progress are an integral part of agro-industrial forms of production. Large harvesting machines, modern manufacturing plants, company signs, wide and well-maintained streets, and large monocultures dominate the landscape throughout the entire environs of the capital of the municipality (see Fig. 3). These symbols of success and growth form points of identification for all those who are part of the agro-industrial production.

The town of Pompéu is intended as a place of identification for the whole population, and its history is closely linked to that of Joaquina Bernarda da Silva de Abreu Castelo Branco, or Dona Joaquina do Pompéu in short. She was born in 1752 and was the wife of a large-scale landowner who raised livestock on the entire area of the present municipality. From 1784, she ran the business of the "Fazenda do Pompéu" and is considered the founder of the town. A bust of Dona Joaquina in a central square in the city, a main street named after her, a cultural center bearing her name, and a museum in which her life is portrayed as a heroic story represent the dominant narrative about the development and civilization of the area of Pompéu, which until then had been defined as uninhabited. Today, this narrative is associated with the concepts of development and progress by representatives of the agro-industry, large-scale landowners, authorities, and municipal administration. In the narratives of the *quilombolas*, however, Dona Joaquina is remembered as a cruel slave-owner – a narrative not heard in the dominant society.

Symbols of quilombolas *for oppression and resistance*

The symbols of the *quilombolas* are strongly linked to the history and identity of the community (see Fig. 4). The central identification element is the community book, in which the head of the community wrote down the history of the *Comunidade Quilombola de Saco Barreiro*. This collectively compiled narrative formed the basis for their state recognition as a *quilombo* in 2007 and thus represents the success of their resistance. Clay houses and ovens, gardens, small plots of land used for agroforestry, and a village square with a communal house stand for lifestyle and traditions, while abandoned and dilapidated houses point to the emigration of numerous families. Solitary mango trees, so-called memorial trees, located several kilometers from today's settlement and in the middle of pasture or sugarcane areas of the neighboring large estates, testify of former living quarters of the *quilombolas*, remind the community of ancestors, and symbolize the displacement processes they suffered in the last decades. The cemetery near the settlement, with its division into a "white" and a "black" area, and the regular desecration of the latter, represents the racism in the region, which is still powerful today. In addition, religious symbols such as the Black Madonna refer to the historical consequences of enslavement and missionary work.

Figure 3: Agropéu factory and machinery – symbols of development and progress. Photo: Neuburger 2014.

Power and visibility of symbols

The symbols displayed represent their respective models and provide them with everyday presence or absence in the city and landscape. The symbols of the neoliberal logics are visible to all due to the size of the objects and their placement in central locations, thereby developing their dominance in the narratives of the local society. In contrast, the elements and artifacts of the *quilombolas* are found almost exclusively in marginal places, and thereby become invisible and easily negatable. Thus, mechanisms of discrimination that work in practices and discourses are reproduced through symbols. *Quilombolas*' stories about everyday abuse and insults in the city illustrate the racist structures in Brazilian society that are still effective today.

Energy landscapes of post-colonial conditions

The present landscape of the municipality of Pompéu constituted by power relations and historical dynamics (Mitchell 2003, Gailing and Leibenath 2015) is largely dominated by sugarcane plantations, whose monocultures represent a modern society oriented towards growth and development. Through the size of the areas and machines, the buildings and other artifacts belonging to them, and their placement and

Figure 4: Identification element of the *quilombolas*: Community book on the history of Saco Bar-reiro. Photo: Langer 2014.

symbolic charge, they represent the powerful position of neoliberal logic. Thus, the large plots of energy crops – and thus the entire agro-industrial sector – appear on the satellite images of the region (see Fig. 1) as the only relevant economic sectors. Only with very attentive and detailed observation do other forms of life and economies, such as the *quilombo* with its small plots and mixed cultures, become visible in this energy landscape.

This configuration of the landscape is the result of a long historical process, which is permeated by colonial and post-colonial power relations. The dominance and expansion of latifundia in general and of large-scale sugarcane cultivation in particular goes back to the displacement of indigenous groups and the conquest of today's Brazilian territory by the Portuguese crown in the 16th century. Since then, the economic and political elites have emphasized export-oriented large-scale agriculture as the driving force for the colonial and later national economy. This has created the legitimacy for state support programs and the expansion of cultivation areas. Moreover, the claimed civilizational character of this social and economic model and the associated idea of its development justify not only the displacement of indigenous groups but also the clearing of forests. Following the idea of modernization theory, all other forms of life organization and economic activity are declared traditional or inefficient and, thus, must be modernized and integrated into the market-oriented sector. By discursively linking these practices to progress, prosperity, and development, their hegemonic position in Brazilian society is strengthened.

Landscapes in general and energy landscapes more specifically represent the arena of socio-political negotiation on development pathways and models in their specific regional and historical contexts. Unequal power relations result in practical, symbolic, and discursive dominance of the most powerful land use, economic logic, and social life by delegitimizing, marginalizing, and invisibilizing alternative ideas. These are embedded in postcolonial entanglements and constitute the foundation of these (energy) landscapes within a globalizing world.

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4 Interaction between wind energy, climate vulnerability, and violent conflict in Northern Kenya

Janpeter Schilling and Luise Werland

Abstract

Wind energy is a key technology in efforts to decarbonize the global energy system. Generally, the exploitation of wind resources is seen as a silver bullet in the fight against climate change. Negative effects and conflict implications of wind energy projects are often dismissed as negligible. The paper aims at challenging this belief by analyzing the implications of wind energy for local communities in northern Kenya. Specifically, the paper explores how the recently completed wind park in Marsabit County affects the vulnerability of the local population to climate change and how the project influences existing and new conflict dynamics. The paper first reviews the state of knowledge on renewable energy projects in developing countries and particularly on the African continent. Second, the main results of the field research conducted between 2016 and 2018 are presented and discussed in order to draw conclusions and give policy recommendations in the final part of the paper.

KEYWORDS: *Wind, energy, renewables, conflict, climate change, vulnerability, Kenya.*

Introduction

Global climate change is one of the key challenges humanity is facing in the 21st century. To effectively mitigate climate change, it is important to significantly increase the global share of renewable energy production. Particularly wind energy plays an import role (REN21 2017). In 2016 renewable energies had an installed capacity of 921 gigawatt (GW) while wind energy accounted for more than half of it (REN21 2017). Projections suggest that the currently installed capacity of 487 GW will increase to 817 GW by 2021 (GWEC 2017). Until now, most wind parks have been built in middle- or high-income countries like China, USA, and Germany (REN21 2017). However, in the future it is expected that the installation of wind energy will grow faster in developing countries (GWEC 2017; Wiser et al. 2011).

While there is little doubt about the importance of wind energy in transitioning to a global low-carbon energy system, the local effects of wind parks on communities in developing countries are hardly studied. The present paper addresses this research gap by asking the following research question: How do wind parks impact local communities in northern Kenya? More specifically, we ask: How does the recently completed Lake Turkana Wind Park affect the vulnerability of the local population to climate change and how does the park influence existing and new conflict dynamics? The wind park is the largest wind power project on the African continent (ADB 2017). It was completed in June 2017 and consists of 365 wind turbines with a total capacity of 310 Megawatt (MW) (LTWP 2017c). The Lake Turkana Wind Power (LTWP) project is the "single largest private investment in Kenya's history" (Kenyan Wall Street 2017). The wind park is the second major source of renewable power after hydropower (CIA 2018). The people living in the proximity of the wind park are mostly Turkana. Other groups in the region include Samburu and Rendille. The area has a history of violent conflicts, fought between the three groups over livestock, water, and land (e. g. Pike et al. 2010). The county of Marsabit, where the wind park is located, is among the most marginalized ones in Kenya in terms of income per capita, education and health, and road infrastructure (GoK 2014; UNDP 2006). Northern Kenya is characterized by a semi-arid climate that is expected to get warmer and receive more unreliable rainfall as a result of global climate change (Schilling et al. 2014).

This paper is structured as follows: The next section provides a review of the literature on wind parks with an emphasis on key benefits, externalities, and conflict implications for local communities. Section 3 then gives a brief overview of the methods and concepts used to generate the results of the Kenya case study presented in Section 4. The final section concludes the paper with reflections on implications for the broader debate, future research, and actor-specific recommendations.

Local Benefits, externalities and conflict implications of wind parks

The majority of the installed wind power capacity is currently located in developed countries in Europe, Asia and North Africa while emerging countries like China, Brazil and South Africa have high potential and growth rates (REN21 2019). Hence most of the literature focuses on the local implications of wind parks in these regions and countries. So far, there are hardly any studies availably that are carried out in developing countries where the exploitation of wind energy is a fairly new phenomenon (Schilling et al. 2018). However, it is possible to draw on studies from developed and emerging countries to anticipate what the effects in developing countries may be.

Wind parks can create new jobs and other sources of income and development (Aitken et al. 2008; Ellis et al. 2007; Gamboa and Munda 2007; Hirsh and Sovacool 2013; Karydis 2013; Rand and Hoen 2017). Further, wind parks can become a possibility for public participation (Becker et al. 2016; Karydis 2013; Rand and Hoen 2017). Wind energy can contribute to the development of decentralized electricity production systems (Gamboa and Munda 2007). Because of the fairly short time needed to build wind parks, a growing local demand can be met quicker than with conventional energy sources and with a lower economic risk (Hirsh and Sovacool 2013).

Despite these benefits, opponents reject wind parks because of their local externalities. Particularly in developed countries, studies find the impact on the landscape and environment to be the main reason for opposition to wind parks (Ellis et al. 2007; Hirsh and Sovacool 2013; Karydis 2013; Rand and Hoen 2017; Weber et al. 2017; Wolsink 2007). These concerns include negative impacts on the biodiversity, hydrology, and geology (Aitken et al. 2008; Becker et al. 2016; Hamilton et al. 2018; Karydis 2013; Weber et al. 2017). Concerns about impacts on wildlife such as birds and bats are often raised (Aitken et al. 2008; Hamilton et al. 2018; Petrova 2013; Reusswig et al. 2016).

Local stakeholders may oppose wind parks because of their visual and aesthetic impact on the landscape and a perceived reduction of the quality of life (e. g. Rand and Hoen 2017; Schwenkenbecher 2017). Sometimes, communities fear a loss of cultural landscape and national heritage (e. g. Reusswig et al. 2016). Others consider wind parks to be intruders into their familiar surroundings and assume their local identity is threatened (e. g. Wolsink 2007). Some studies point to the negative impact on tourism (e. g. Gamboa and Munda 2007; Karydis 2013). Others indicate concerns about noise (e. g. Saidur et al. 2011) and health risks (Petrova 2013; Reusswig et al. 2016). Ultrasound and low frequency sound are caused by the rotor blades (e. g. Ellis et al. 2007; Schwenkenbecher 2017) and this noise can lead to the development of Vibro-Acoustic-Disease (Karydis 2013). Further emissions consist of shadow flicker, which may produce psychological stress (Hirsh and Sovacool 2013; Karydis 2013). There can be an impact on human health from electromagnetic fields (Karydis 2013).

Some authors have argued that the postulated economic benefit may actually be rather poor, for example because the created jobs are just temporary (Karydis 2013; Rand and Hoen 2017). Electricity prices can increase, affecting everyone connected to the grid (Schwenkenbecher 2017).

Wind parks can cause conflict and undermine the social contract, for example, when local community members perceive the siting process as unfair or feel that they were unable to participate in and influence the overall process (e. g. Ellis et al. 2007; Froese and Schilling 2019; Rand and Hoen 2017). Particularly if concerns are ignored or being perceived as being ignored, the likelihood for local opposition to wind parks grows (Petrova 2016; Reusswig et al. 2016; Wolsink 2007). Misinformation (Ellis et al. 2007; Karydis 2013) and lack of distributive justice can cause conflict as well (Rand and Hoen 2017; Reusswig et al. 2016; Zografos and Martinez-Alier 2009). Insufficient or unfair distribution of compensation of landowners and other local stakeholders can cause intra- and inter-community conflict (Rand and Hoen 2017).

Methods

This study is based on qualitative field research conducted in February and March 2017, and in March 2018. In total 81 people were interviewed in individual and small group interviews. These interviewees were mostly community members. Representatives of the wind park and different levels of government were interviewed as well. The research was carried out in Marsabit County, Kenya, and specifically in the town Loiyangalani, the fishing village Komote at Lake Turkana, and the village of Sarima, which had been relocated in 2015 by about two kilometers because of the wind power project (see Fig. 1).

There is no official number of the population of Sarima. One participant of a small group discussion in Sarima suggested a population of 2000. However, based on observations of the research team this seems to be a rather high estimate. Approximately 1000 people appears to be a more realistic estimate. This estimate is broadly in line with the figure of 1180 given in the Resettlement Action Plan (cited in Danwatch 2016).

Vulnerability is the key guiding concept of this article. The latest definition of the IPCC is used, which describes (climate change) vulnerability as “the propensity or predisposition to be adversely affected [by climate change]” (IPCC 2014:1775). According to the IPCC, vulnerability is a function of sensitivity and adaptive capacity (IPCC 2014). We suggest to defining sensitivity as the availability and importance of the affected resource and adaptive capacity as the knowledge and financial and technical means to adapt to climate change (see IPCC 2014; Schilling et al. 2012a). Hence income opportunities and a formal job in particular strengthen the adaptive capacity.

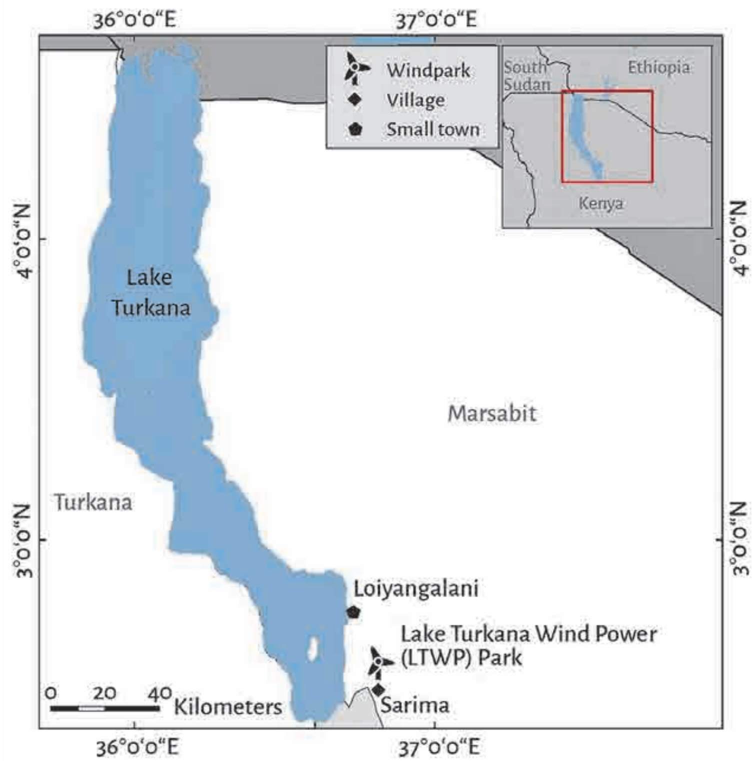

Figure 1: Location of Lake Turkana Wind Park in northern Kenya.
Source: Zulfiqar Ali Shah for the authors.

We understand conflict as a situation, in which at least two actors consider their goals to be incompatible with each other. In a violent conflict, at least one actor is using force to achieve an aim or to directly damage the other conflict party (Scheffran et al. 2012).

Results

Similar to the literature review (Section 2), this section first describes the local benefits, externalities and conflict implications of the wind park before the results are interpreted with respect to their impacts on the climate change vulnerability of the local communities.

Local benefits

Employment

The extent of employment varies greatly across the project phases. According to the website of the Lake Turkana consortium, 2500 people were employed in the project during the construction phase between October 2014 and March 2017. Three quarters of the workers came from Laisamis Constituency, to which Loiyangalani belongs. After installation of all turbines in March 2017, the number of people employed declined to 911 people, "of whom 81 % were local". However, it is not further specified what "local" refers to exactly. During the operation phase, 250 people are expected to be employed, with three quarters being "locals" (LTWP 2017b). These official numbers are hard to verify on the ground but the sharp decline in employment was reflected in the interviews. According to the Deputy County Commissioner of Loiyangalani, around 1000 people have been employed in the project, "mostly people from around here". He further explained that "right now [March 2017] there is less employment but initially there were a lot of people employed"[1]. The assistant chief of Loiyangalani adds that particularly the youth was employed during the construction phase[2]. A woman in a small group interview in the relocated village of Sarima gave the following statement: "When the project started, it employed many people, but now [March 2017] the number reduced and we were told the remaining jobs were for the skilled. We can't blame them [the ones in charge of the project] for that because none of our children are trained or skilled"[3]. During the time of our research, the construction of the turbines was almost completed and only one man out of the 19 people interviewed in Sarima was still working at the wind park. He was employed as a security guard. Other jobs community members of Sarima and others in the surrounding area of the wind park occupied during the construction phase of the project included cooking and cleaning in the LTWP camp, digging holes and mixing cement for the fundaments of the towers, clearing the way for roads, and rarely technical work. According to several members of the Sarima community, a casual laborer received 520 KES (4.9 USD) per day. Based on a small group interview with women, the income was mostly spent on school fees and food for the family[4].

1 Interview with J. Kihora, Deputy County Commissioner Loiyangalani, Loiyangalani, 28 February 2017.

2 Interview with P. Lesas, Assistant Chief Loiyangalani, Loiyangalani, 28 February 2017.

3 Interview with Group of Women, Pastoralists, Sarima, 28 February 2017.

4 Interview with Group of Women, Pastoralists, Sarima, 28 February 2017.

Road infrastructure

In Marsabit, the road infrastructure improved because of the wind project. According to the Deputy Subcounty Administrator of Loiyangalani, Paul Machan, the new roads promote the mobility of people in Loiyangalani. However, he also stressed that it was unfortunate that LTWP paved the road connecting Sarima with Laisamis rather than improving the road between the county capital Marsabit and Sarima, a route LTWP initially used. However, even the road to Laisamis improved the accessibility of Loiyangalani leading to a strong influx of people, particularly when the demand for laborers was high during the construction phase.

Water

In addition to employment, water was the second key issue for communities in Marsabit. For Sarima, a borehole was drilled that allowed the community to access groundwater. "The white man [referring to Nick Taylor, a LTWP manager] from the project came and gave us water" states a woman from Sarima[5]. The appreciation by the community members in Sarima for the borehole was obvious, particularly because of the severe drought that affected the area at the time of the research. Observations by the research team confirmed that the borehole was functioning and being used by the community in Sarima. However, the desalination unit was not functioning during our second research visit in March 2018.

Electricity

Some community members in Sarima stated that they were promised to be connected to the wind park and the electricity grid. However, at the time of the research, no other indication for such plans was found. The energy generated in Marsabit is fed into the national grid and subsequently sold to the customers (Star 2017). LTWP rejects its supposed responsibility to provide the local communities with energy (LTWP 2017a). Instead, LTWP stresses that this is the responsibility of the Kenya Power and Lighting Company and the Rural Electrification Authority. "LTWP only has a license to generate power not for distribution" (LTWP 2017a). The 428 km-long power line between the wind park and the substation in Suswa has faced several delays. The power line was finally completed in September 2018 (LTWP 2018).

5 Interview with Group of Women, Pastoralists, Sarima, 28 February 2017.

Local externalities

Loss of income

A key challenge for communities in the region of the wind park is the highly fluctuating need for casual labor resulting in sudden losses of employment and household income. During the height of the construction phase, community members from Sarima and Loiyangalani got used to the regular income from the wind project. When casual laborers were laid off, community members and government representatives described it as a "shock". One woman from Sarima explains that "it has really affected us, [...] those who were employed are now sacked, the life is hard for them because this was like a family income"[6]. The loss of income often came at times when community members were losing large numbers of livestock due to drought as well.

Relocation

For community members in Sarima, the second key externality of the wind project was that they had to be relocated. While only a few interviewed community members complained about the small amount they received as compensation for having to relocate, the fear of having to relocate again was widespread. "We hear that the wind power [project] could want to move us again", a man from Sarima recounts in a small group interview[7]. The research team followed up on those rumors but could not confirm or falsify them. When asked about further relocation plans, the Deputy Sub-county Administrator of Loiyangalani only said that "there will be need for new roads to pass"[8].

Loss of land and water resources

Loss of access to land and lack of financial compensation for local communities was among the key concerns in Marsabit. Several community members in Sarima and Loiyangalani complained that LTWP received a lease for 40 000 acres but "they [LTWP] have taken more than 110 000 acres"[9]. A lawsuit by local actors against the size of the project and how the land was acquired, resulted in a ruling by the High Court in Meru in November 2016, which allowed the project to continue but confined it to 87 500 acres (Daily Nation 2016). While members of the Sarima community did not seem to have received any financial compensation for the land given to the wind project, the turbines are not fenced and the area surrounding them was still accessible to the community members at the time of research.

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6 Interview with Group of Women, Pastoralists, Sarima, 28 February 2017.

7 Interview with Group of Elders and Youth, Pastoralists, Sarima, 28 February 2017.

8 Interview with P. Machan, Deputy Sub-County Administrator, Loiyangalani, 1 March 2017.

9 Interview with Group of Elders, Diverse backgrounds, Kiwanja, 1 March 2017.

Environmental pollution

At the time of the last research phase in March 2018, the rotors were not moving but the rotors had changed the appearance of the landscape. Once the rotors start turning, (limited) pollution can be expected in terms of noise emissions, flicker, and light reflections. Further, accidental killings of birds by rotors are likely as previous studies suggest (Voigt et al. 2015). The interviewed community members in Sarima knew little about the environmental effects of the turning turbines but some raised concerns. These "turbines we see, could kill our animals", stated one woman in Sarima[10].

Local conflict implications

In Sarima, a few community members and the Assistant Chief of Loiyangalani reported that a couple of times access roads to the wind farm had been blocked by community members, for instance near Sarima and South Horr. The Deputy County of Loiyangalani mentioned that roadblocks were frequent around May 2016. Several women from Sarima reported that "the road [leading to the wind park] was closed even yesterday and today"[11]. These roadblocks are generally set up by young men. The key driver of these community roadblocks was unmet community demands for employment in the wind project. To a lesser degree, unmet demands for water play a role and the Deputy County Commissioner of Loiyangalani added community frustration over "payment of little amounts of money" by the wind project as another reason. According to one woman in Sarima, a roadblock in February 2017 led to the employment of three Turkanas and four Samburus in the wind project[12]. The Deputy County Commissioner of Loiyangalani explains "people from Samburu say the land is theirs, the Samburu, the Rendille all of them say the land is theirs"[13]. A member of the Sarima community made this observation: "they [the Samburu] saw this project has come, they saw the Turkana will benefit from it, let us chase them and go to their land"[14]. Employment opportunities were named as a source of inter- and intra-communal disputes. "These people [from LTWP] don't employ us, they only employ the Samburu" states a community member in Sarima. Many interviewees in Sarima were particularly angry when jobs as security officers were given to Samburus[15]. The "heads of G4S [the security company] are all Samburus", complains one member of a small group interview in

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10 Interview with Group of Women, Pastoralists, Sarima, 28 February 2017.

11 Interview with J. Kihora, Deputy County Commissioner Loiyangalani, Loiyangalani, 28 February 2017.

12 Interview with J. Kihora, Deputy County Commissioner Loiyangalani, Loiyangalani, 28 February 2017.

13 Interview with J. Kihora, Deputy County Commissioner Loiyangalani, Loiyangalani, 28 February 2017.

14 Interview with Group of Elders and Youth, Pastoralists, Sarima, 28 February 2017.

15 Interview with Group of Women, Pastoralists, Sarima, 28 February 2017.

Sarima[16]. "We have our own Security to handle conflict", declares the Managing Director of the wind project to further explain that "we also employ KPR". KPR are members of the Kenya Police Reserve who are people in charge of protecting the communities. This means that the wind project is using security personnel that is meant to protect communities rather than a private project. "The police even comes to us for information because we know more than the police"[17].

Implications for the vulnerability of local communities

Figure 2 summarizes the key implications of the wind park for the climate change vulnerability of the local communities, specifically the village of Sarima. The employment opportunities offered by the wind project generally increase the adaptive capacity of community members in Sarima as income means that people can buy food during times of drought and are more likely to send children to secondary schools. However, the income effect was mostly limited to the construction phase of the project, which is now completed. Currently, only few income opportunities exist in form of security guards and casual laborers (cooks, cleaners, etc.) working in the LTWP camp. The accessibility of goods has improved for Sarima as a regular bus service between Marsabit, Sarima, and Loiyangalani has been set up. This has further created business opportunities. Hence, it increased the adaptive capacity and reduced the vulnerability of Sarima. The borehole drilled by LTWP has improved the water accessibility of community members in Sarima at least for livestock, which are less sensitive to the salinity of the water than humans. Therefore, the wind project has generally reduced the climate sensitivity of Sarima.

In contrast, a loss of land would increase the sensitivity of Sarima. However, the actual area inaccessible for the communities is the LTWP camp itself. Access to it is restricted to people working in the camp. The externalities are hard to evaluate at this point as the power line has not been completed at the time of the field research and therefore the negative effects described in section 2 (flicker, ultrasound, etc.) have not (yet) occurred. Given the close proximity of many of the 365 turbines to Sarima, the turning turbines will likely add stress to the community members of Sarima and potentially also the community's livestock. To our knowledge, there are

16 Interview with Group of Women, Pastoralists, Sarima, 28 February 2017.

17 Interview with Phylip Leferink, LTWP Main Station, near Sarima, 7 March 2018.

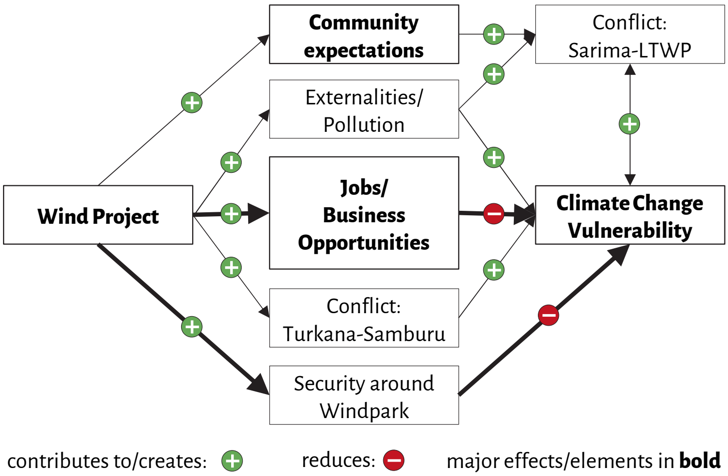

Figure 2: Implications of the wind project on local climate change vulnerability

no studies available analyzing the effects of wind turbines of the type of sheep, goats, and cattle kept by the community of Sarima. However, negative effects on animal health and meat production have been documented for geese and pigs (Karwowska 2015; Mikolajczak et al. 2013).

The violent conflicts between Sarima and groups of Samburu and to a lesser degree Rendille are a key driver of vulnerability as they undermine the adaptive capacity and lead to inefficient use of resources (see Schilling et al. 2012b). In that sense, the wind project has reduced the greatest challenge to adaptive capacity, namely the security situation. Both community members of Sarima and the manager of the LTWP camp stated that attacks and raids on Sarima have become less frequent. While this certainly is a positive aspect, LTWP has taken over a key role of the government: the provision of security. This is a critical issue as community members no longer rely on the state to provide security but rather on a private company.

Conclusions

The aim of this paper was to analyze the implications of wind energy for local communities in northern Kenya, particularly with respect to the communities' vulnerability to climate change and conflict dynamics. Several positive local effects that the literature on wind parks in developed and emerging countries have identified, can also be found in Kenya. For instance, there can be little doubt about the fact that the project has brought development to the community of Sarima. The road, a borehole and temporary employment opportunities have improved the adaptive capacity and reduced the sensitivity and vulnerability of the community to climate change. Furthermore, the security situation has improved for Sarima as more security forces are present in and around the wind park. However, the notion of wind energy as a silver bullet in the fight against climate change needs to be challenged. The employment effect is temporary and it has the potential to aggravate existing conflict lines. Additionally, a company has taken over the role of the government in providing security. The wind company has absorbed community security forces to protect the wind park while these forces are likely to be missing elsewhere. This impact on the security dynamics is similar to what Schilling et al. (2015) have found in the case of oil exploration in northern Kenya (see also Schilling et al. 2018). Land is another issue that has led to a court case, in which community members claim that insufficient compensation has been paid to the community.

A few conclusions can be drawn from this study for key actors and further research. For companies operating in conflict-affected and underdeveloped areas such as northern Kenya, it is advisable to carefully consider its distribution of resources (jobs, infrastructure, financial incentives, etc.) within the communities as this has an impact on inter-communal relations and how the communities perceive the operating company. For the government, it is important avoid letting a private company taking over government responsibilities in terms of providing security, infrastructure, and development to the communities. It is further important to connect the communities and local towns to the wind park. Otherwise, Kenya increases its production of renewable energy while the communities around the wind park only face the externalities of the project (such as the flickering effect) and "sit in the dark". Communities need non-violent channels and mechanisms of communicating their expectations and discontent to the wind park operators.

For researchers it is promising to continue the research on the wind park in northern Kenya to explore how the perception of the community in Sarima has changed and how the conflicts have developed, now that the wind park is in operation and the rotors are turning. More generally, the question remains why communities oppose or welcome wind parks in developing countries. Particular attention should be paid to the employment and security effects.

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5 The roadmap to energy security in Egypt

Mostafa Shaaban

Abstract

In response to the increasing demand of electricity in Egypt, I introduce a new approach to dynamic temporal and spatial sustainability assessment modeling of technologies for electricity planning with an analysis of the decision-making process of multiple actors in the energy sector and its impact on climate change. I use a novel approach of integrating multi-criteria decision analysis, spatial geographic information system data analysis and agent-based modeling.

KEYWORDS: Electricity, multi-criteria decision analysis, GIS, agent-based modeling, GHG emissions.

Introduction

With growing concern about the consequences of environmental change and their close relationship to energy development, the concept of sustainable development has been introduced, in addition to the need to involve key stakeholders, including end users, in the decision making process. Throughout the last three decades, there has been a major worldwide concern about sustainable development and the identification of indicators for sustainable energy assessment by many national and international organizations. The International Atomic Energy Agency defines sustainable energy development as "provision of adequate and reliable energy services at affordable costs, in a secure and environmental manner, and in conformity with social and economic development needs" (Vera and Langlois 2007).

In 2011, the ex-UN Secretary-General Ban Ki-moon launched the Sustainable Energy for All (SE4A) Initiative and shared his vision for how governments, businesses, and civil society can make sustainable energy for all a reality by 2030 if working in partnership. "Energy is the golden thread that connects economic growth, increased social equity, and an environment that allows the world to thrive", said Ban Ki-moon (SE4All 2011). The initiative is concerned with renewable energy sources as a key technology offering clean electricity, heating, and lighting solutions to people who mainly depend on conventional energy sources. Nevertheless, these technologies still face a range of social, economic, and structural challenges, requiring not only further technological development but also a deeper understanding of both the success factors and the barriers to accomplish a widespread dissemination (Terrapon-Pfaff et al. 2014). In 2015, world leaders, at a historic UN Summit, have adopted 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development. These goals came into force on 1 January 2016, aiming at accelerating efforts worldwide to end all forms of poverty, fight inequalities, and tackle climate change while ensuring that no one is left behind. The SDGs extend the success of the Millennium Development Goals (MDGs) and look to go further to end all forms of poverty in all countries while protecting the planet. The seventh goal of these SDGs is to ensure access to affordable, reliable, sustainable, and modern energy fostering the objectives of the SE4A-Initiative (United Nations 2016).

Energy security implies a concept of ensuring the availability of supply that could meet the demand. Some studies support the concept of separating the term security of supply from other policy objectives, e. g. economic efficiency and sustainability, and to restrict the definition to the continuity of supply relative to demand (Winzer 2012). However, in this study it is crucial to link the term security to sustainability. In a dynamic complex system, it is not wise to focus on a single dimension of an alternative while performing applicability assessment of that alternative. A negative impact on other neglected dimensions would hinder the continuity of the provision of the resource. Thus, I identify energy security as a provision of relatively efficient, harmless to human beings and the environment, affordable, and socially acceptable supply that covers the basic demands of the community. In this study, I focus on electricity security as one of the most vital forms of energy in this era.

Egypt has experienced frequent electricity blackouts during the last eight years because of a growing demand, natural gas supply shortages, aging infrastructure, and inadequate generation and transmission capacity. About 70 % of the electricity in Egypt is fueled by natural gas, 19 % by petroleum, and 11 % by renewable energy, which is mostly hydroelectricity (9 %). Recently, Egypt suffered from natural gas shortages, particularly during the summer months. As a result, it imports fuel oil and diesel fuel to cover the shortages (US EIA 2015, EEHC 2014). So far, no previous studies of the sustainability of electricity technologies in Egypt have been conducted. Based on interviews with energy experts in Egypt during February and April 2015, most of the electricity planning is pursued by assessing only the technical and economic aspects as outlined by the study project "Technical Assistance to support the Reform of the Energy Sector" (TARES).

Literature review

Going through the literature, I found that different methodologies have been applied to evaluate the complex energy system from different perspectives. Liu (2014), Singh et al. (2009), and Ness et al. (2007) provide an overview of various approaches to sustainability assessment including a composite index and a general sustainability indicator for renewable energy systems, as well as approaches to apply formulation strategies, scaling, normalization, weighing, and an aggregation methodology. Pohekar and Ramachandran (2004), Wang et al. (2009), and Abu Taha and Daim (2013) evaluate different multi-criteria decision making (MCDM) models for sustainable energy planning and analysis (see Section 3). Doukas et al. (2012) assesses energy sustainability of rural communities using the principal component analysis (PCA), which is one of the MCDM models. Troldborg et al. (2014) develop and apply a multi-criteria analysis (MCA) to a national-scale sustainability assessment and ranking of eleven renewable energy technologies in Scotland and critically investigate how the uncertainties in the applied input information influence the result. Evans et al. (2009) assess renewable electricity generation technologies with respect to sustainability indicators. Islam et al. (2014) examine the current energy-mix, present energy crisis, and possibilities to overcome such scenario by utilizing alternative energy sources such as biomass, solar, wind, and small-scale hydropower energy in the context of Bangladesh. Góralczyk (2003), Pehnt (2006), and Varun et al. (2009a) investigate a dynamic approach towards the life cycle assessment (LCA) of renewable energy technologies. Scheffran (2010) discusses principles and criteria for establishing and evaluating a sustainable bioenergy lifecycle covering all dimensions of sustainability. Demirtas (2013) studies the best selection of renewable energy technology for sustainable energy planning using the analytical hierarchy process (AHP) methodology, another MDCM method. There are many other studies that are concerned with the evaluation of the sustainability of energy systems for future energy planning and decision-making processes.

Research approach

This study aims at answering the following research question: What would be the rational future energy-mix scenario that could secure a sustainable electricity supply in Egypt until 2100? In order to answer this question, this study investigates conditions, scenarios, and strategies for future planning of energy in Egypt, with an emphasis on alternative energy pathways and a sustainable electricity supply mix as part of an energy roadmap until 2100. A novel approach is developed of integrating multi-criteria decision analysis (MCDA) with agent-based modeling (ABM) and geographic information system (GIS) visualization to integrate the temporal and geographic factors to assess the transformation of energy landscapes in Egypt. Different electricity supply technologies are investigated and compared regarding multiple assessment criteria and multiple agents to achieve a comprehensive sustainability assessment covering technical, social, economic, and environmental aspects of these technologies (Shaaban 2017).

The research is guided by the underlying hypothesis that a comprehensive sustainability assessment supports a transformation from the fossil-based energy system in Egypt towards alternative pathways developing the enormous renewable energy potentials of North Africa. Starting from an understanding of the obstacles and lock-in effects of the current energy situation, the assessment aims at going beyond technical and economic fixes of established structures towards expanding the range of criteria and agents to reflect sustainable development in its multiple dimensions. Scenario-based modeling and simulation represent the shifting priorities of agents that shape the evolving energy landscape in Egypt.

I use the open source ABM software "NetLogo" to explicitly represent spatial agents across space and time as they decide on different energy pathways, taking into consideration environmental factors that vary across the landscape and create non-uniform environments for each energy type. I selected seven principal technologies based on their potential resources in Egypt and the intention of the government to involve them in their future planning. These technologies are coal-fired power plants, natural gas-fired power plants, wind, concentrated solar power (CSP), photovoltaics (PV), biomass, and nuclear power plants.

Exploring previous studies, I found numerous energy indicators that have been used for the sustainable development assessment. The United Nations Commission on Sustainable Development (UNCSD) derived 58 indicators from a working list of 134 indicators for applications worldwide (Singh et al. 2009). Neves and Leal (2010) proposed a framework of 18 local energy sustainability indicators to be used both as an assessment and as an action-planning tool. I collected a list of 72 indicators from a sample of 30 studies to be used as a pool of indicators, from which I then selected the most suitable ones for my case study. Based on a particular selection procedure (Shaaban and Scheffran 2017), I selected 13 indicators as shown in Table 1 for the sustainability assessment of the technologies.

Since the indicators have different measuring units, I apply a min-max normalization method as shown in the formulas below to obtain normalized values of the indicators while having the same relation of evaluation with regard to sustainability, for which some indicators are directly proportional to sustainability while others are inversely proportional to sustainability, where v is the value of the indicator, v_{max} and v_{min} are the maximum and minimum value of the indicator across the technologies, respectively. In order to avoid zero values of the indicator, the formula has been modified by reducing v_{min} by 10 % in the first equation and increasing v_{max} by 10 % in the second equation.

$$\frac{(v-(0.9 \times v_{\min}))}{(v_{max}-(0.9 \times v_{min}))} \tag{1}$$

$$\frac{((1.1 \times v_{max})-v)}{((1.1 \times v_{max})-v_{min})} \tag{2}$$

The initial input data of the model have been identified through a questionnaire that has been communicated to stakeholders in the energy sector through interviews with the objective to determine the initial preference of different electricity supply technologies and the preference order of the sustainability assessment indicators in the evaluation of these technologies. Then I used these input data to deduce the weights of the indicators. The initial preference values of the technologies by each actor represent the setup values of the priorities of the technologies. I categorized the participants into four groups of actors representing experts, policy-makers, investors, and young-researchers according to their affiliations. Another virtual actor that I use in this study is based on a sustainable scenario, in which it represents equal initial preferences of all technologies and its progress while using equal weights of the sustainability dimensions.

Category	**Indicator**	**Measuring Unit**	**Sustainability target**
Economic	investment cost	USD/kW	minimize
	job creation	jobs/MW	maximize
	cost of electricity	USD/kWh	minimize
	operation and maintenance cost	USD/kW	minimize
Environmental	CO_2 emission	g/KWh	minimize
	NOx emission	g/KWh	minimize
	SO_2 emission	g/KWh	minimize
Social	safety risks	fatalities/GWeyr	minimize
	social acceptability	ordinal scale	maximize
Technical	efficiency of energy generation	%	maximize
	resource potential	TWh/year	maximize
	reliability of energy supply	%	maximize
	water consumption	kg/kWh	minimize

Table 1: The selected assessment criteria. Source: Based on Shaaban and Scheffran 2017.

Methodology

The multi-criteria decision analysis

The multi-criteria decision analysis MCDA is based on comparing different alternatives by identifying a set of evaluation criteria that are applicable to all of these alternatives. The values of these criteria are then normalized and their weights are determined according to the relative importance of the criteria. The main objective of MCDA is to integrate the weights and the normalized values of the criteria so that each alternative is associated with an integrated value that reflects its ranking (Wang et al. 2009). It plays an important role in energy systems planning, especially since the concern about environmental protection has increased. I apply two MCDA approaches in the sustainability assessment of the technologies, the analytical hierarchy process (AHP) and the weighted sum method (WSM).

The analytical hierarchy process (AHP) is based on the decomposition of a complex problem into a hierarchy with an objective at the top of the hierarchy, indicators and sub-indicators at levels and sub-levels of the hierarchy and decision alternatives at the bottom of the hierarchy as shown in Figure 1 (Pohekar and Ramachandran 2004).

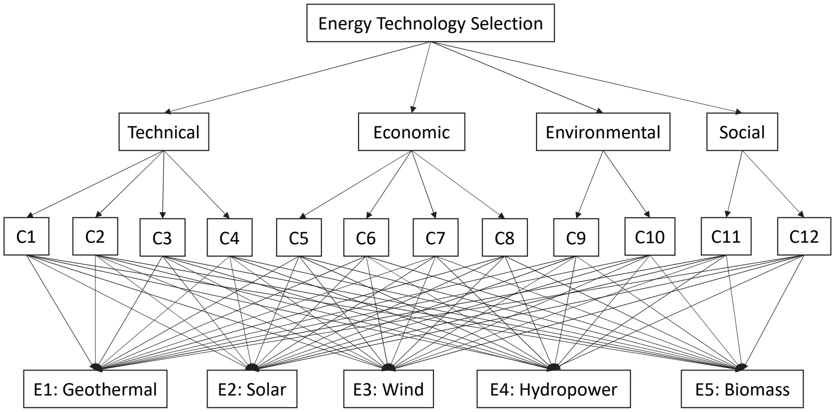


Figure 1: Illustrative scheme of the AHP network. Source: Demirtas 2013.

Scale	**Degree of preference**
1	equal importance
3	weak
5	strong
7	very strong
9	extreme importance
2, 4, 6, 8	intermediate values

Table 2: Scoring scale of AHP and its interpretation. Source: Wang et al. 2009.

I evaluate the weight of the indicators in a pairwise comparison using the scoring system presented in Table 2, based on their importance regarding energy technology selection according to the perspectives of the stakeholders who have been interviewed.

The weighted sum method (WSM) is the most commonly used approach in sustainable energy systems (Wang et al. 2009) that satisfies the following expression:

$$A_i = \sum_{j=1}^{n} \left(a_{ij} w_j\right), \text{ for } i = 1,2,3,\ldots\text{m} \tag{3}$$

where A_i is the WSM score of alternative i, n is the number of decision indicators, m is the number of alternatives, a_{ij} is the normalized value of the jth indicator in terms of the ith alternative and w_j is the weight of the jth indicator that has been obtained from the AHP. The total value of each alternative is equal to the sum of products, which is ultimately used to rank, screen, or select the alternative with the maximum score. From this step, I can obtain the ranking of the technologies, which corresponds to the general integrated sustainability index as calculated through the WSM.

GIS-based spatial data analysis

The second part of the model evaluates the influence of some important spatial factors that represent the local conditions on the selection of an energy pathway. I selected seven spatial factors: resource potential, population density, primary roads availability, water availability, grid availability, political stability, and the negative impact potential on crops. I designed these data sets as layers of raster data. Then I applied the WSM to get an integrated value for each site location for ranking.

Agent-based modeling (ABM)

The third component of the model is the agent-based model reflecting the temporal dynamics of the decision-making process based on cost benefit analysis. In comparison with variable-based approaches using structural equations or system-based approaches using differential equations, agent-based simulation is a bottom-up modeling approach that offers the possibility of modeling individual heterogeneity, representing explicit agent decision rules, and situating agents in a geographical or other type of space (Billari et al. 2006, Gilbert 2008). An agent-based model consists of a set of agents, their relationships, rules of behavior, and a framework for simulating agent behaviors and interactions. Here, the ABM consists agents who act by adjusting their priorities (p) for action pathways (A) in response to the change in the marginal values of the pathways as a function of costs (C) and value preferences (V) as well as environmental conditions (E) that change in space and time as shown in Figure 2 (for a description of the VCX model framework see Scheffran and Hannon 2007). I modified and expanded this ABM approach by including value functions based on the MCDA assessment models as well as expert evaluations and the projected future electricity demand to compare different energy pathways used in electricity mix scenarios and scenarios of sustainable land use.

The multi-criteria assessment is applied to classify typical agents characterized by weighted priorities for certain criteria sets. These types of agents are then used in

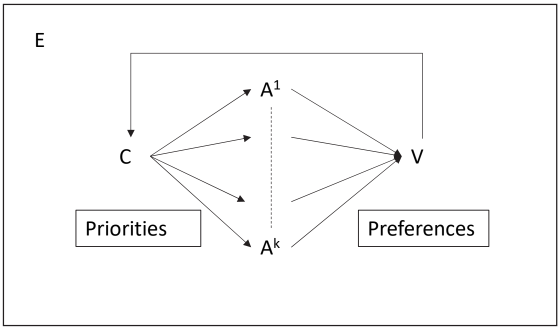


Figure 2: An illustrative diagram of the agent-based model. *Note: The figure describes the allocation of priorities (p) of investment (C) to action pathways (A), affecting value preferences (V) under changing environmental conditions (E). Source: Based on Scheffran and Hannon 2007.*

agent-based models where agents follow these priorities to select energy pathways that meet the desired criteria. Agent decision-rules are applied to a GIS-based spatial (cellular) model landscape, taking into account spatially specific environmental and socio-economic conditions.

The dynamics of changing action priorities for energy pathways describes agents that iteratively shift their action pathways towards large marginal value-cost preferences by comparing the marginal value of one pathway with the weighted average marginal value including all pathways. This is given by the following evolutionary equation of shifting priorities for action pathway k of actor type q in spatial cell (agent) i:

$$\frac{\Delta p_{iq}^{k}}{\Delta t} = \alpha_{iq} p_{iq}^{k} (v_{iq}^{k} - \sum_{l} p_{iq}^{l} v_{iq}^{l}) \qquad (4)$$

- $\frac{\Delta p_{iq}^{k}}{\Delta t}$ is the change in action priority p of actor q for energy pathway k in spatial cell i for time period Δt, which is one year in my case.
- α_{iq} is the adaptation rate of actor q in spatial cell i (in this study I apply the same adaptation rate for all actors).
- v_{iq}^{k} is the marginal value of energy pathway k for actor q in spatial cell i, which is a function of the value and the weight of the spatial factors and the assessment indicators.
- $\sum_{l} p_{iq}^{l} v_{iq}^{l}$ is the sum of weighted marginal values (average) including all energy pathways l.

$$v_{iq}^{k} = \frac{\left(\frac{(\sum_{m=1}^{o} s_{mi}^{k} \times h_m)}{\sum_{i=1}^{z}(\sum_{m=1}^{o} s_{mi}^{k} \times h_m)}\right) \times (\sum_{j=1}^{n} a(t)_{kj} \times w_{jq})}{\sum_{k=1}^{l}\left[\left(\frac{(\sum_{m=1}^{o} s_{mi}^{k} \times h_m)}{\sum_{i=1}^{z}(\sum_{m=1}^{o} s_{mi}^{k} \times h_m)}\right) \times (\sum_{j=1}^{n} a(t)_{kj} \times w_{jq})\right]} \tag{5}$$

- s_{mi}^{k} is the value of spatial factor m influencing spatial cell i, which is for some factors specific to energy pathway k as in case of the resource potential, where z is the number of spatial agents.
- h_m is the weight of the spatial factor m, where o is the number of spatial factors.
- $a(t)_{kj}$ is the value of the assessment indicator j for energy pathway k, which is a function of time for some indicators.
- w_{jq} is the weight of the assessment indicator j of actor q, where n is the number of the assessment indicators.

In this study, I am concerned with the interaction between four categories of actors who represent energy planners selecting from energy system technologies that could meet the growing electricity demands. In one of the investigated scenarios, which I call the game scenario, as well as in the sustainable scenario, each of the four types of actors (experts, policy-makers, investors, and young-researchers) jointly ranks the technologies in each spatial location. The dominant actor is the one with the maximum priority of technologies following their marginal value preferences. The other actors can modify their evaluation preferences afterwards to get the maximum priority technology in future time steps. Figure 3 shows a schematic diagram summarizing the principle of integrating the three methodologies in this technology assessment. Further details about the model can be found in Shaaban et al. (2019) and Shaaban et al. (2018).

Results and discussion

Comparison of energy landscapes transitions

Figure 4 compares the adaptive changes in the average priorities of the technologies over all spatial cells for the four simulated kinds of actors (experts, investors, policy makers and young researchers), the sustainable scenario and the game scenario for the time period 2015 – 2100 (i. e. time steps 0 – 85 in NetLogo). In the scenario of "experts", the model starts with the highest average priority for CSP, followed by PV, wind, and NG. Nuclear and coal are of almost zero priority throughout the simulation period of the model for both experts and investors. However, in the policy

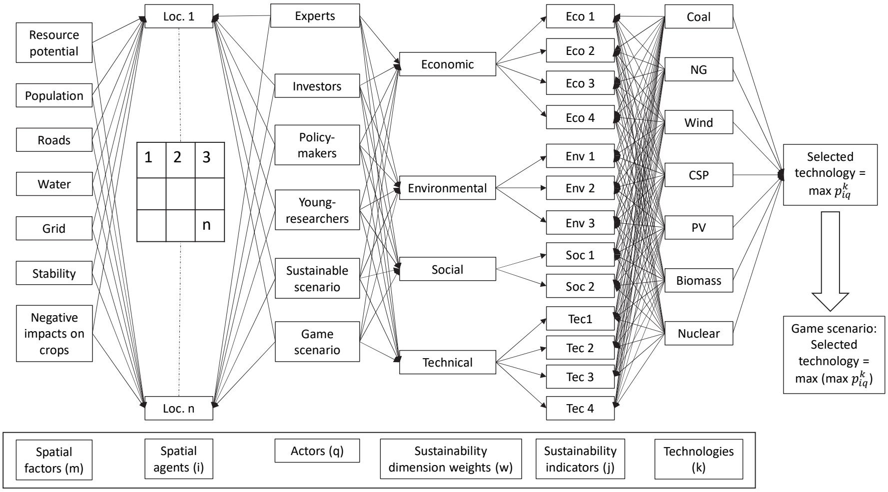


Figure 3: A schematic diagram describing the principle of the integrated assessment.

makers and young researchers' scenario these energy sources are initially at a small level above zero but subsequently diminish drastically approaching zero. In general, there is a gradual increase in the priorities of both wind and NG, which starts to decrease again after approximately 40 years with a pattern that is opposite to both CSP and PV. This implies that the potential tendency towards both CSP and PV will start after2050, when less attention is paid to wind and NG by these actors. However, this changing pattern exists at different levels between actors. In the scenario of "policy makers", the priority of wind is higher than that of other actors, showing more affinity towards this technology. This scenario also shows a lower priority curve of NG han that of CSP and PV. In the sustainable scenario, the priorities of wind and NG are almost coinciding, whereas the priorities for CSP and PV start bifurcating halfway through the simulation period. This points to an increasing trend of CSP and a decreasing trend of PV but at a lower rate than that of CSP.

The map visualizations of the energy landscapes for three scenarios at year 2015 and 2100 are presented in Figure 5. The maps illustrate the spatial DMs (cells) with the maximum priority technology in one of the four tested actor scenarios, the sustainable scenario, and the game scenario at two different points in time. In the "experts" scenario, CSP starts to have a predominant priority in most of the spatial DMs, the rest being distributed between PV, wind, and NG. This highlights that PV coverage exceeds that of wind. As the model runs, the coverage of CSP and PV decreases whereas wind and NG coverage increases. In the sustainable scenario, the landscape starts with a balanced mix including all technology types except coal. This

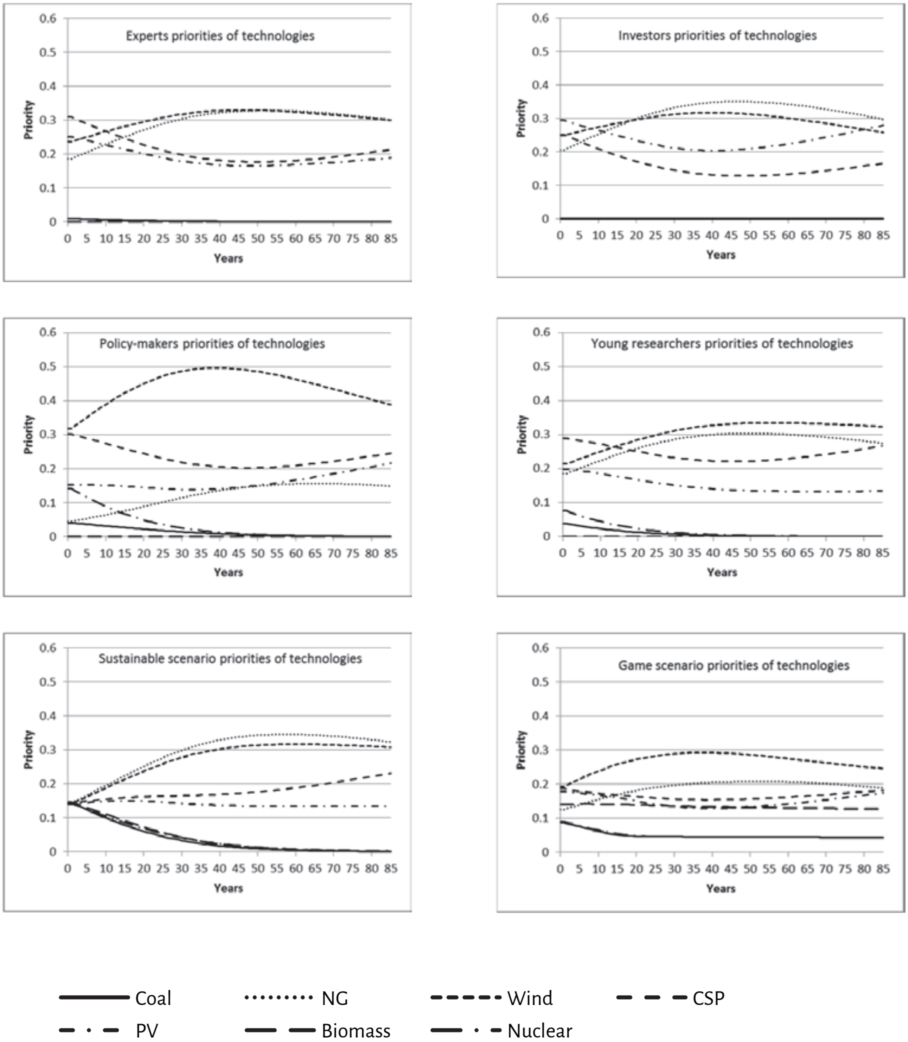
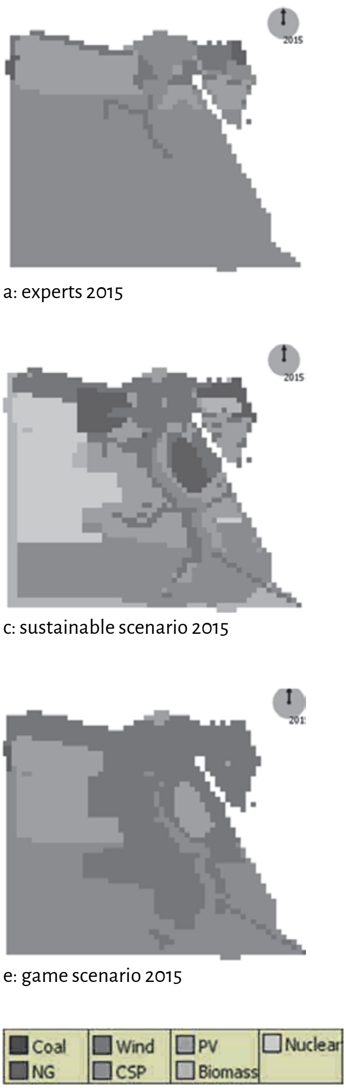


Figure 4: The average priorities of the technologies per actor type changing with time.



a: experts 2015

b: experts 2100

c: sustainable scenario 2015

d: sustainable scenario 2100

e: game scenario 2015

f: game scenario 2100

Figure 5: Energy landscape transition displaying the maximum priority technology in each scenario in 2015 and 2100.

is because the priorities are affected only by the spatial factors without including the technology assessment through the MCDA during the model setup. However, this distribution changes drastically after the model runs. There is an abrupt drop of biomass, PV, and nuclear coverage leaving the landscape with major coverage of NG, wind, and CSP. In the game scenario, the landscape starts with major coverage of wind and CSP at equal proportions and the remainder being covered by PV. As the model runs, NG coverage replaces that of CSP and PV in some cells.

In the game scenario, each actor sets up an initial preference of the sustainability dimensions and plays the game with the target of achieving the maximum value of the maximum priority technology in each spatial cell relative to the other actors. In order to control the compliance of each actor's strategy with the results in the game scenario, there are several possibilities. The first is to compare the average priorities of the technologies of each actor with those in the game scenario. The second is to compare the landscape coverage of each technology by each actor with that in the game scenario. In each step, each actor can observe how much deviation exists from his actual plan. These checks are useful to ensure conformity with the main target of the game that is concerned with selecting an energy technology, in which the winning actor could select the same technology as another actor who "loses" the game because of a lower priority of that technology. According to this logic, conflicts between the actors can be avoided. For the future, other game scenarios are possible based on collective decision-making representing a majority or joint benefit decision rules.

Future projected energy-mix

The following part presents the predicted electricity-mix scenarios based on the preferences made by the actors and the dynamic assessment of the technologies. Based on the average priorities of the technologies that are presented in Figure 4, I calculate the future projected energy-mix. In 2015, I use the actual energy-mix in Egypt of 2014 based on the energy generated not on the installed capacity, which are shown in Table 3. I use the predicted future electricity consumption that is shown in Figure 6 and calculate the amount of the predicted electricity demand during each period. The priority-mix of the technologies for each actor is multiplied by the amount of the predicted electricity demand, yielding a new distribution of energy sources. For instance, if 30 TWh (Terawatt hours) of electricity are needed to be supplied between 2015 and 2020, the priorities will be distributed among the different sources for this amount and then it will be added to the previously supplied amounts of each source. I assume that the old systems remain included in the energy-mix and are not substituted or decommissioned.

	hydropower	NG	oil	wind	solar
TWh	13.4	119.3	34	1.3	0.02
% TWh	7.9	70.9	20.3	0.8	0.01

Table 3: Electricity mix of Egypt in 2014. Source: EEHC 2014.

The values of the energy-mix in percentage are shown in Figure 7. In 2020, coal ranges between being completely absent in the energy-mix as preferred by investors to about 2 % in the sustainable scenario, which corresponds to 0.8 GW. Approximately 0.5 GW would be accepted by all actors according to the game scenario. In 2100, coal would be accepted if it did not exceed 4 % of the energy-mix with an installed capacity in the range of 5 GW. For NG, which currently constitutes about 70 % of the energy-mix, the share is expected to decline to about 60 % with an installed capacity of about 23 GW in 2020. There is no big difference in the prediction levels of NG between actors in 2020. However, in 2100, the gap increases between actors regarding this technology, which ranges between shares of 25 % and 40 % in the energy-mix, corresponding to a predicted installed capacity ranging between from 36 to 58 GW.

The share of wind energy is predicted to average approximately 5 % with a range of 3.5 – 7 % and an installed capacity of about 5 GW in 2020. In 2100, there is also a big difference between actors' predictions. The share of wind energy ranges between 20 – 35 %, which corresponds to an installed capacity range of 70 – 113 GW. For CSP, the share initially ranges between 2.7 – 5 % with an installed capacity ranging between 5.5 – 10.5 GW. In 2100, the share of CSP is expected to rise to a range of 12 –

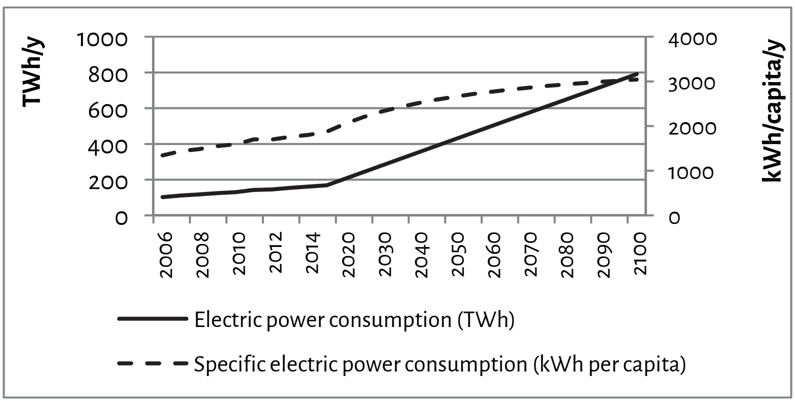


Figure 6: Electricity consumption in Egypt (past, current, and future trend). Source: The World Bank 2014a, b.

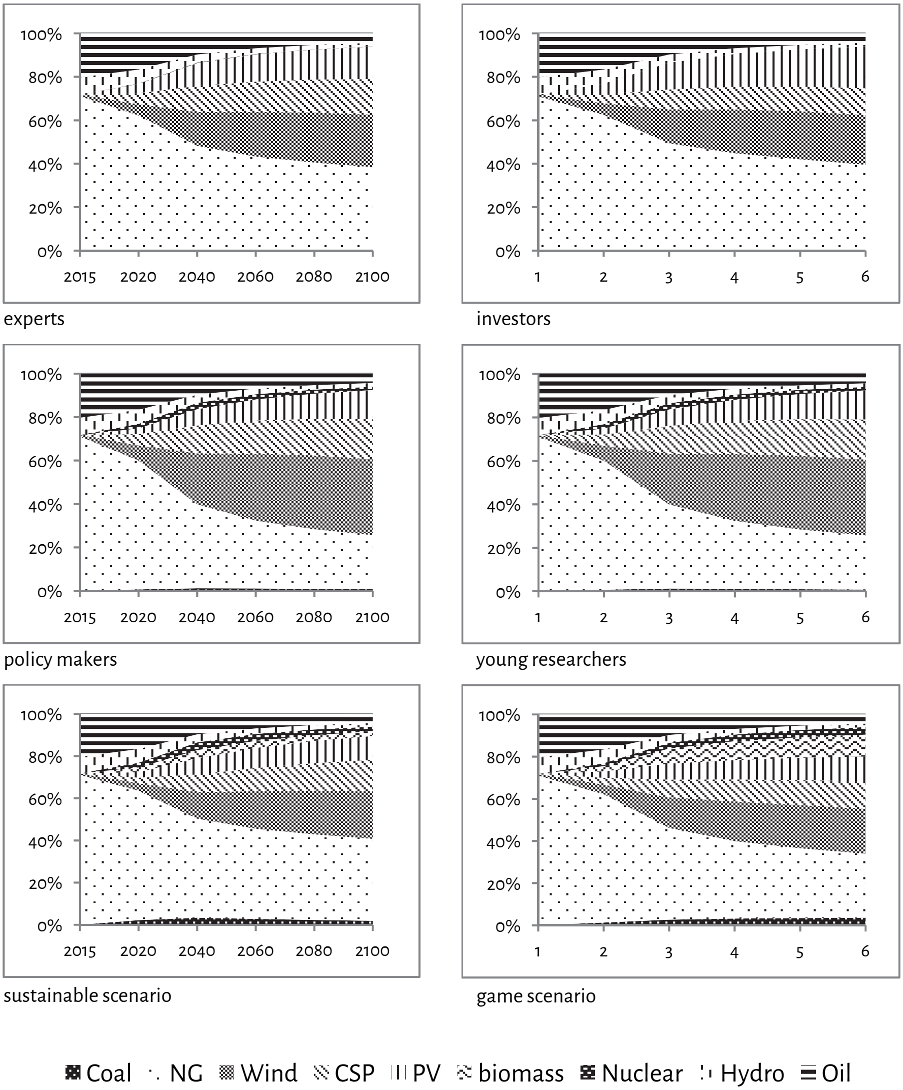


Figure 7: Predicted energy-mix for Egypt in percent according to actors' priorities.

20 % with an average installed capacity of about 120 GW. The PV share is expected to have the same range like that of CSP in 2020 and 2100, which is in accordance with the preferences of different actors. Moreover, the installed capacity will be in the range of 3 – 6 GW in 2020 and about 50 – 85 GW in 2100, which differs from that of CSP due to the differences in the full load hours. According to the sustainable scenario, it is desirable to include a share of 2.2 % of biomass in 2020 and 2100 as a diversification of technology security. The same applies to nuclear technology, which initially ranges from 0 – 2.2 % in 2020 with an average installed capacity of 0.4 GW. Although the range of shares is preferred to remain unchanged, however, the installed capacity will be increased to an average of 2 GW in 2100.

GHG assessment results

An important output of the model is the comparative assessment of the contribution to climate change and global warming from the different energy-mix scenarios as obtained from the analysis of the decisions made by actors in the simulations. Figure 8 illustrates this comparison in two graphs, where the left graph represents the GHG relative emissions based on the average priority-mix of the technologies while the right graph shows the GHG emissions in million tons of CO2 equivalents (Mio tons CO2 eq.) from the energy-mix, estimated by each actor over the whole simulation period. The proposed energy-mix scenario by policy makers emits fewer GHGs compared to the other scenarios while the sustainable scenario depicts the highest level of GHG emissions due to the inclusion of biomass and a higher share of coal. However, the emissions of the sustainable scenario approach those of the other three actors. I can conclude from these graphs that the average GHG emissions would double by 2100, which is likely to negatively contribute to climate change.

Summary and conclusion

According to the results obtained from the simulations presented in this paper, I conclude that, the decision making process in the energy sector to secure future electricity supply for the coming generations is a complex process. It involves a multidimensional analysis of all possible potential technologies by means of evaluation of indicators whose values change over space and time. Moreover, the actors involved

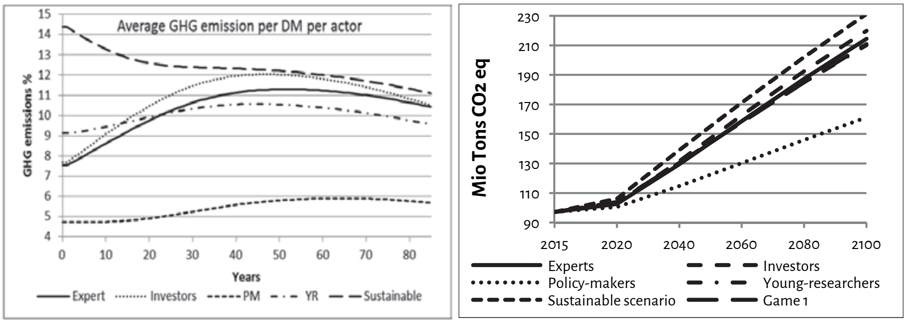


Figure 8: Comparison of the GHG emissions of the priority-mix and the energy-mix of the technologies.

in the decision making process have different preferences for these indicators and their decisions could be affected by the decisions of other actors. Although the sustainable scenario constitutes a normative decision approach with an unbiased affinity towards any of the sustainability dimensions – making it a target for all countries in their energy planning – in practice, there are many actors who decide differently and interact with each other. Therefore, I cannot confirm that the energy-mix obtained from any of the single actors including the sustainable scenario is "the" best. Instead, a balanced energy-mix resulting from the interaction of the actors in the game scenario could represent a realistic and better approach of predicting an acceptable, sustainable, and secure future energy-mix in Egypt. The results of the game scenario indicate how important it is for the Egyptian government to show more concern for renewable energy projects and the transition of the energy landscape from fossil fuel-fired energy systems to renewable ones. Energy diversification, through the inclusion of other resources like coal or nuclear in a limited amount, adds more security by gaining knowledge and experience from their operation and reduces the potential of conflicts.

It is recommended to extend the model by including a higher number of assessment indicators, spatial factors, and other actors. Moreover, the spatial factors should be analyzed at a higher resolution and should exclude the locations that cannot be used for the installation of power plants at all. As more variables, in terms of indicators, spatial factors and actors, and a higher resolution are included in the model, the accuracy of the results is likely to improve considerably. Therefore, this model could be used as a building block for future projects through changing the alternatives, the assessment indicators, the external spatial factors, the country of study, and the actors.

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6 Water allocation in transboundary river systems in times of climate change

P. Michael Link

Abstract

Rivers are the lifelines for large shares of the global population Now climate change adds uncertainty to water availability in many transboundary river systems, making it hard or impossible for some countries to comply with existing treaties and affecting societal stability. In our research within CliSAP, we have developed a theoretical framework for the assessment of water conflict and cooperation in times of climate change. The framework links environmental change to altered water availability. This in turn has effects on individual human wellbeing in the riparian countries.

One case study that has been our particular focus is the Nile River Basin. Results indicate that Egypt's water allocation goals can not be met in a business-as-usual scenario, increasing the likelihood of the downstream countries engaging in conflicting strategies with their upstream neighbors.

KEYWORDS: *Transboundary rivers, water management, climate change, Nile River Basin, agent-based modeling.*

Introduction

Since the beginning of civilization, humans have settled close to rivers to use their water for consumption, agriculture, provision of food, and as means for transportation. The first cities have developed along large rivers and even today, transboundary rivers are of particular economic and strategic importance. However, pronounced growth of metropolitan areas along rivers has created challenges in recent decades that have made water a scarce resource in some river basins, particularly where other sources of freshwater are lacking. This has led to diminishing per capita water availability, a trend that is presumably intensified by the effects of climate change, which impact the water availability in river systems by affecting precipitation patterns and evaporation rates (Field and Van Aalst 2014; Stocker et al. 2014)

The necessity to share river water among several riparian countries creates additional caveats as downstream countries are dependent on sufficient fresh water inflow from the upstream riparians both quantitatively and qualitatively. There are 263 transboundary river systems in the world that serve as freshwater source for more than 40 % of the world's population (Wolf 1998). Adequate water allocation schemes usually require some kind of agreement between riparians and indeed agreements exist for practically all transboundary river systems. Nonetheless, conflict potentials remain if the riparians have distinctly different water use interest and histories of conflict and distrust.

Water conflicts can be caused by a variety of factors, including unilateral utilization of water by upstream countries (Bernauer and Siegfried 2012; Fischhendler, Dinar, and Katz 2011) or generally increasing water stress (Wolf 1999b). However, it has to be noted that despite recurring tensions and disputes over water resources in transboundary rivers, there has been only one interstate war over water in recorded history, which already dates back several millennia (Wolf 1998). Currently, water disputes are usually embedded in tensions and disagreements about other political or economic issues, so they play only a marginal role at the interstate level. Instead, cooperative use of water resources may benefit all riparians and could serve as foundation for cooperation with regard to other aspects as well (Conca 2002).

In order to be able to assess the interaction of physical and socio-economic aspects of water use in transboundary river systems, we have developed an integrated conceptual framework of water conflict or cooperation that takes into account issues of water management and changes in environmental conditions. It is applied exemplarily to the Nile River Basin, one of the key case study areas in the work of the Research Group Climate Change and Security on water resources. Possible development pathways can be identified not only by theoretical analyses but also by model simulations. Key insights are discussed and summarized in the conclusion.

Management of transboundary river systems

The distribution of river water among the riparians is no trivial matter in many of the world's transboundary river systems. History shows that conflicts have arisen in all river basins that could only be solved by some kind of agreement. The Transboundary Freshwater Dispute Database contains information on historic water conflicts and allows for detailed assessments of causes and consequences (Wolf 1999a).

With regard to the case study area, the Nile River Basin, it becomes evident that there is no simple relationship between the various physical and socio-economic drivers, water availability, and the potential for conflict. Environmental change can lead to altered resource abundance affecting economic wealth, which in turn could translate into a higher potential for conflict onset (Link et al. 2012). First of all, climate change is an external forcing that impacts the availability of key resources such as water or land for agricultural production. This affects human wellbeing and – due to the transboundary nature of the river basin – interstate relationships, which can be affected either cooperatively or in a conflictive manner. The likelihood of conflict onset can be limited as long as all riparians have an adequate adaptive capacity to deal with the external change.

Already existing agreements on water use can provide a useful setting for further cooperation among riparians or be a burden as in the case of the Nile River, where water agreements are outdated and neglect a majority of the riparians of the river basin. Egypt has historically established itself as a hydro-hegemon, requiring the majority of the river water (Zeitoun and Warner 2006). Because of substantial external support by Great Britain in colonial times, Egypt became the dominating country in the region with regard to power and exploitation potential, offsetting its inferior geographic position.

Current water allocation in the Nile River Basin is based on two key treaties, one from 1929 between the colonial United Kingdom, Egypt, and Sudan (Cascão 2009) and one from 1959. The latter became necessary due to the construction of the Aswan High Dam and allocated practically all water of the Nile River to the countries of Sudan and Egypt, implicitly leaving no water to the upstream countries. This agreement has sparked substantial disputes between the upstream countries, particularly Ethiopia, and the downstream countries that want to maintain this agreement as long as possible (Link et al. 2012).

Strong economic development in the upstream countries of the Nile River Basin and the construction of the Grand Renaissance Dam in Ethiopia are substantial challenges to Egypt's status as hydro-hegemon. After completion, the reservoir can take up considerable amounts of water from the Blue Nile, potentially significantly reducing Nile water flows downstream (Link and Scheffran 2015). Furthermore, energy production from the dam is supposed to make Ethiopia less dependent on energy from the surrounding countries and it should provide Ethiopia with additional income from energy sales to its neighbors. Egypt strictly opposes any reductions in water availability but it is unlikely that this dispute will cause a war for water, as such a military conflict could not be financed by Egypt and the result would be questionable at best (Gebreluel 2014). Instead, the shift in power balance in the Nile River Basin could be a basis for new kinds of cooperation. Initially, a new agreement considering the capacities of all reservoirs could be drafted, which could be subsequently extended for further cooperation among riparians (Bastawesy 2014).

In other transboundary river systems, challenges to existing power structures have generally led to increased efforts for cooperation as well. It will be interesting to see whether this trend can be upheld if water stress increases considerably by possible reductions in supply due to climate change – by effects on precipitation and evaporation – and concurrent increases in demand due to population growth and further economic development.

Implications of climate change

Changes in environmental conditions in transboundary rivers occur as a combination of impacts of climate change as well as economic development and demographic change in many parts of the world, not only affecting water supply and demand but also water quality (de Stefano et al. 2012; Schellnhuber et al. 2013). Global warming may not only limit the water supply to river systems but also increase demand by affecting the amounts needed for human consumption and agricultural irrigation (Tir and Stinnett 2012). Increased evaporation with concurrent reductions in rainfall is likely to cause declines in river flows, reduced percolation into aquifers, and degradation of soils. In the long run, the frequency and amplitude of extreme events such as floods or droughts is expected to increase, which places an additional strain on the adaptive capacities of countries to cope with such changes (Field and Van Aalst 2014). Particularly, the melting of glaciers affects the water balance of rivers, increasing their flow in the coming years while declining substantially afterwards.

When water availability changes as a consequence of climate change, impacts will not be homogeneously distributed among all riparians of transboundary rivers. Countries with a geographic disadvantage, i. e. the downstream countries, are likely to be affected to a larger extent than their upstream neighbors. Already existing conflicts about water distribution may be aggravated, possibly increasing the frequency and intensity of disputes. Nonetheless, it is still possible for riparians to cooperate on water utilization, particularly if the necessary institutional setting is already in place (Brochmann and Hensel 2011; Mianabadi, Mostert, and van de Giesen 2015; Tir and Stinnett 2012). These include new approaches in the design of water treaties, which include adjustable allocation strategies, the focus on water quality as well as on quantities, strategies to address extreme events, review procedures, and joint institutions for water management (Cooley and Gleick 2011).

However, it has to be noted that the interactions in the water-security nexus are complex and climate change adds to already existing fears of growing water scarcity in many transboundary river systems. This may prompt a continued securitization or militarization of water resources, eventually inducing new water conflicts in the future (Feitelson, Tamimi, and Rosenthal 2012; McDonald 2013). In contrast, it is also conceivable that policy makes use of climate change in general – regardless of the actual regional impact on the hydrological setting – to promote cooperative measures among riparians by fostering trust, mutual understanding, and reconciliation (Amster 2013; Ide and Scheffran 2014).

Framework for the assessment of water conflicts

A conceptual framework of the water-security nexus can be a helpful tool to assess the complexity of the interactions between the physical and socio-economic aspects of water supply and the political and institutional dimensions of water use. All of these affect societal stability and possible conflict onset at multiple scales (Scheffran et al. 2012a, 2012b). The framework developed by the Research Group Climate Change and Security considers the linkages between environmental and demographic change, their impacts on water resources, the relationship between water stress and human security, the responses of key actors, and the institutional setting of water management and conflict resolution (Link, Scheffran, and Ide 2016). Key pathways and cascades of effects connect the three main compartments that are interlinked by causal relationships and feedback loops (Fig. 1). Based on the development of the physical drivers on water resources that interact with socio-economic drivers, impacts on security are assessed. This includes both individual human security as well as international security. The framework also addresses how water security actually translates into effects on the relationships between societies or countries, which may range from full scale war to neutral behavior to major cooperation.

Drivers of water availability

Water supply in a given watershed depends on the hydro-meteorological setting and geographic characteristics, such as precipitation patterns, evaporation rates, aquifer recharge, soil characteristics, and drainage to the sea. These are affected by climate

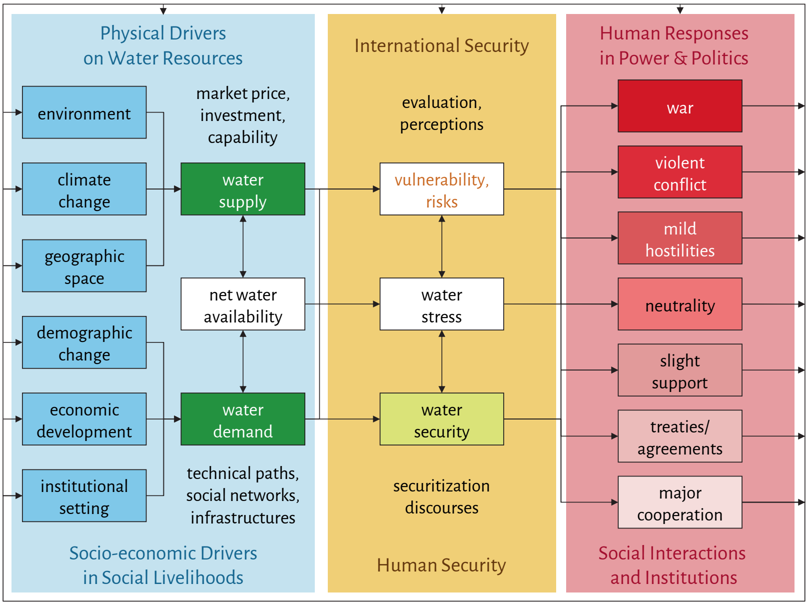

Figure 1: The conceptual framework of the water-security nexus. Source: Link, Scheffran, and Ide 2016.

change. On the other hand, socio-economic variables like economic development, demographic change, water-related infrastructure, and the institutional setting in a given river basin drive water demand and water-related investments.

Of course, both demand and supply need to remain balanced. Trends in livelihoods such as population growth and changes in human needs have a profound influence on the amount of water withdrawn in a given geographic location (Gassert et al. 2013). The technical potential to withdraw and store water and the economic setting with regard to water use govern the degree to which countries can actually fulfill their own water needs and thus the level of water stress experienced by the given riparian.

Water stress and water security

Human perceptions and values determine whether the amount of water allocated to a riparian is considered to be abundant, sufficient, or scarce. Different actors can have substantially differing perceptions, which may give rise to heated political debates (Harris and Alatout 2010). Furthermore, water also has symbolic meanings, connecting water to religious ideas such as purity, or concepts of national development or state building (Fröhlich 2012; Hansson 2001; Jacobs 2002).

It is not clear whether increasing water stress and insufficient supply raise security concerns. This depends on the agents involved and their value perceptions, individual vulnerabilities, and security concepts applied. The security dimensions in the framework range from concerns about individual human security to national security threats to risks for international relations (Zeitoun 2011). Water stress can drive political decisions or discourses that aim at increasing water availability to reduce potential dissatisfaction and security concerns. There are numerous examples of research on the securitization of water, in which the amounts of water allocated to the riparians, water development projects, or the causes of water problems have led to heavy disputes among politicians, scientists, engineers, and local people (Murtinho et al. 2013; Waintraub 2009).

Conflictive and cooperative human responses and social interactions

The third part of the framework addresses the collective responses and social interactions to the given state of water security, which may lead to either conflict or cooperation. The perception of water scarcity, together with increasing levels of insecurity and the securitization of water, can create an environment that is dominated by fear, anger, and hostilities, increasing the likelihood of onset of violent conflict (Stetter et al. 2011). Depending on the reply to such conflictive behavior, a self-reinforcing cycle of violence may ensue.

Generally, the escalation of conflicts due to water stress requires not only on the motivation of the agents but also on their capabilities and opportunities to act. There are only some examples in the literature, in which a considerably weaker party engaged in violent conflict nonetheless (Assies 2003). Climate change may cause the overall water availability to increase in some parts of the world (e. g. due to glacial melting or altered rainfall patterns). This may relieve some of the pressures of water demand, creating new chances for cooperation on water. In this context, it is important to note that the motivation and opportunity for cooperation (or conflict) are the product of social interaction (Ide and Fröhlich 2015) that is shaped considerably by securitization, identity constructions, and politics of scale.

Cooperation can only be achieved if stakeholders recognize their options that may reduce water stress or increase their economic welfare (Norman, Bakker, and Cook 2012). If people affected by water stress do not act, water issues remain neutral (i. e. they are neither conflictive nor cooperative) as they remain below a critical threshold and thus do not lead to extraordinary responses.

In transboundary watersheds, the political institutions of the riparians have a profound influence on whether water scarcity leads to conflict or cooperation. They have the ability to mitigate possible disputes before they escalate into violent conflicts (Gizelis and Wooden 2010; Tir and Stinnett 2012). Basinwide agreements or adaptation measures offer additional chances for cooperation than individual riparian's responses at the country level, which may become particularly important if environmental conditions become strained under climate change (Pelt and Swart 2011). However, current water management schemes in transboundary river systems are generally only bilateral (Mirumachi 2015).

Linkages within the framework

There are interactions and feedbacks between the three compartments of this framework of the water-security nexus that can affect conflict or cooperation through different pathways. The value-security dimension is at the center of this scheme, connecting the supply-demand balance, which is based on the given hydrological setting, with the resulting societal responses, either leading to conflict or cooperation. The links between the compartments are determined by the political setting. Water security and securitization discourses interact mutually with the vulnerabilities to water scarcity and to conflict, regardless of the causal relationship between the two (Link, Scheffran, and Ide 2016).

Matters are further complicated by the fact that actions to facilitate cooperation on water at the international scale may create a conflictive reaction at the national or subnational scale (Norman, Bakker, and Cook 2012). Water management solutions at the national scale tend to more readily lead to conflict whereas solutions at the watershed level or at the subnational scale are more likely to create cooperation (Feitelson and Fischhendler 2009; Harris and Alatout 2010). An example is the Jonglei channel in the Nile River Basin, which was a cooperative effort between the countries of Egypt and Sudan that led to intrastate conflict within Sudan that eventually eased the secession of South Sudan (Mason et al. 2009).

Despite all these complications the framework allows for a systematic assessment of water-related conflict and cooperation in transboundary river systems. In the following, this framework is applied to the Nile River Basin, which essentially supplies Northeast Africa with water and that is expected to experience increasing water stress due to possibly unfavorable changes in meteorological patterns due to climate change with concurrent increases in population and continuing economic development, leading to considerable growth in regional water demand.

Case study: The Nile River

Northeast Africa and the Nile River Basin have been one of the research foci of the Research Group Climate Change and Security. The Nile River Basin is one of the regions that can be considered a climate hot spot and it is likely that altered environmental conditions will have an effect on the likelihood of conflict onset (Scheffran, Link, and Schilling 2012). With regard to water allocation, based on scenarios of change in water allocation, an agent-based model of the main riparian countries was developed that simulates possible strategies to meet individual countries' goals of water supply (Link and Scheffran 2019). In general, research results point to a substantial increase in water stress and additional societal pressures in the coming decades, which necessitates new and innovative water allocation schemes if conflicts among riparians are to be avoided.

Water availability in times of climate change: The Nile River is the principal water source for more than 230 million people in the region (Nile Basin Initiative 2013). Based on the current trend, more than 300 million people are expected to live in the Nile River Basin in the late 2020s. The downstream countries are particularly dependent on the water from the river as there are practically no other water sources in the country (Link et al. 2012). Currently, approximately 85 % of the water in Egypt originates in the Ethiopian Highlands and flows through the Blue Nile (Arsano 2010). However, Ethiopia now increases its own water use substantially, culminating in the construction of the Grand Renaissance Dam, which will withhold an amount of water equivalent to the annual flow of the Blue Nile from the downstream countries during the time period when the reservoir of the dam is filled (Bastawesy 2014). So far, Egypt can use the share of water allocated to Sudan in the 1959 Nile water agreement, which Sudan does not utilize for itself. But with Sudanese water demand growing concurrently as well, the remaining share for Egypt is likely to stagnate at best (Taha 2010), making it difficult for Egypt to meet its own goals.

It has to be noted that the overall amount of water available in the Nile River system critically depends on the long-term development of rainfall amounts in the Ethiopian Highlands. Climate models are still inconclusive about the trend of precipitation in the upstream countries of the Nile (Stocker et al. 2014). In the recent past, the flow in the White Nile has decreased while there has been an increase in the Blue Nile (Bushara and Abdelrahim 2010) but it is unclear if this trend will hold up. Further uncertainties may arise from changes in evaporation in the Sudd Swamps in South Sudan, where the flow velocity of the river is substantially lower than in the rest of the river system.

Water-security discourses in the Nile River Basin: The uncertainty associated with the development of river flow rates and the concurrent increasing demand in all riparian countries makes it harder for the individual countries to meet their own water needs.

If public perception or the views of political decision makers suggest that the national security is threatened because of an insecure water supply, they may turn to protective (conflictive) measures to secure their own interests. The people may pressure the governments to take a tougher stance on water issues, thus making cooperative solutions harder to achieve (Feitelson 2002). The situation is aggravated if harvest failures, insufficient sanitation, declines in water quality or increasing food prices adversely affect human livelihoods (Deligiannis 2012), giving rise to the possibility of uprisings such as the Arab Spring in 2011. At present, Egypt feels particularly challenged by the emancipation of the upstream countries who have formed initial coalitions to secure their own interests against the still-hydro hegemon Egypt. When the Grand Renaissance Dam in Ethiopia is brought into service, this will substantially shift the power relationships between the three main riparians of the Nile River (Egypt, Sudan, and Ethiopia) in favor of the upstream region, making it necessary to devise new agreements between the riparians to avoid an intensification of water-related disputes (Link and Scheffran 2015).

Conflictive and cooperative interactions among riparians: The increasing vulnerability of the downstream countries may cause them to take unilateral actions to secure their share of the Nile waters, thus facilitating the onset of new water-related conflicts (Link et al. 2012). This tendency is countered by a growing effort to increase the combined adaptive capacity of the riparians by fostering cooperative measures. However, there are also developments that are complicating matters: the construction of the Grand Renaissance Dam will lead to a substantial strengthening of the Ethiopian bargaining position in the region (Link and Scheffran 2015), which is likely to force Egypt to give up its hydro-hegemonial status (Gebreluel 2014). Furthermore, cooperative projects that have been launched in the past such as the Jonglei Channel have turned out to be inadequate and have led to increased tensions within the country of Sudan instead of fostering cooperation, ultimately resulting in the failure of the project (Mason et al. 2009).

Nonetheless, the institutional basis for basinwide cooperation has been established with the founding of the Nile Basin Initiative. Cooperative projects in the Nile River Basin have received substantial external financial support from e. g. the USA and the World Bank, i. e. agents who have a strong interest in cooperation in the Nile River Basin mostly for economic reasons (Paisley and Henshaw 2013). One key project of the Nile Basin Initiative has been the drafting of a Cooperative Framework Agreement that has already been signed by six riparians and has been ratified by three.

Linkages within the water-security nexus: The variable climate conditions in the Nile River Basin already pose a considerable challenge to water security. This challenge is likely to substantially grow in the next few decades. Even a favorable development of overall water availability in the river system may be inadequate to meet the strongly

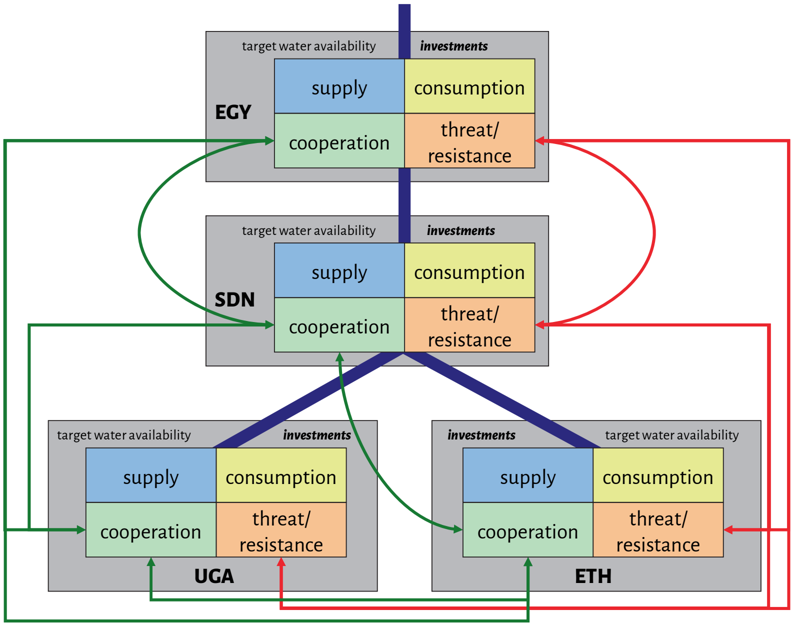

Figure 2: Interactions between the countries in the simulation model.

growing demand for water, particularly in the downstream countries (Link et al. 2012), further increasing the already high vulnerability to climate change in Egypt and Sudan (Brooks, Adger, and Kelly 2005). The Arab Spring has caused the economic and political destabilization of Egypt, reducing its capacity to properly address its water problems. The transition from a quasi-hegemonial system to a state with three more or less equally powerful riparians (Egypt, Sudan, Ethiopia) in the region may create new chances for durable cooperation in the Nile River Basin as it will become necessary to negotiate and sign new fundamental agreements on the allocation of water and energy from hydropower in the region.

Modeling of possible water allocation schemes

The interactions of the main riparians of the Nile River Basin with regard to fulfilling their own water needs can be simulated in a simulation model that focuses on four key riparians (Egypt, Sudan, Ethiopia, and Uganda). The countries may invest financial resources in strategies to increase water supply, make water use more efficient,

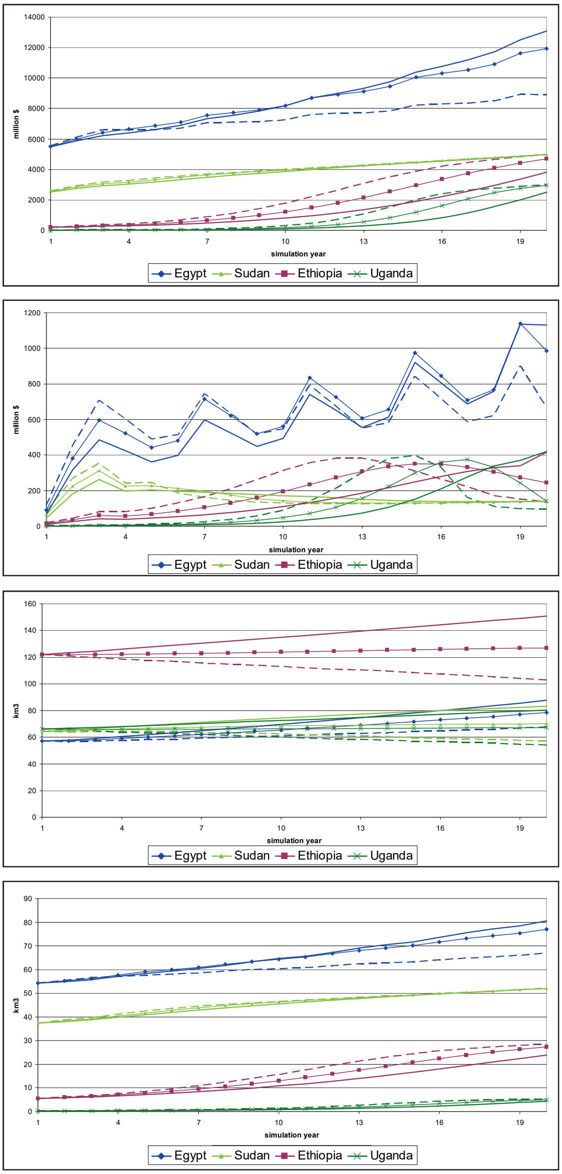

Figure 3: Total investments into water resources (first panel), investments into the acquisition of additional water resources (second panel), water supply (third panel), and water consumption (fourth panel) in each country. *Note: The thick solid lines denote the case of a climate change induced overall increase of water resources of 20 % by the end of the simulation period, the dashed line a decrease of 20 %. The lines with symbols denote a reference scenario with no climate change.*

engage in cooperative measures, or threaten neighboring riparians to use less water (who may then resist that threat). Figure 2 shows a scheme of possible interactions.

Interactions between the countries are simulated for a time period of two decades, in which the overall water availability in the river system either increases or decreases due to effects of climate change. Link and Scheffran (2019) provide a detailed model description and simulation results for an extended model version that focuses on five countries.

The results show that the countries' strategies are highly dependent on the long-term trend of overall water availability. Investments are intensified in times of increasing water scarcity (Fig. 3, first panel). The marked increase in total investments for Egypt in the scenario of an expansion of water availability is caused by the particularly pronounced growth of water demand in this scenario that is attempted to be met. Since water use is already close to total supply, additional growth causes an increase in consumption costs, leading to such uncharacteristic trend in total investments.

The oscillations in Egyptian investments into new water resources are related to switches between cooperative and conflictive strategies (Figure 3, second panel). The fact that investment costs are much higher in times of conflict leads to a decline in the incentive to threaten and makes the country turn towards cooperation instead. In case of a more pronounced difference in unit costs between conflictive and cooperative strategies, Egypt would refrain from the conflictive strategy as there would be too little reward for the effort put in.

The expansion of water supply generally follows the underlying climate scenarios (Figure 3, third panel). Without climate change, there is hardly any expansion, as this would be fairly expensive to realize. In contrast, the climate effect is much more pronounced: if there is more water available in the Nile River Basin, supply can grow substantially without great efforts while it shrinks more than can be offset by investments into any new resources if water generally becomes even scarcer in times of climate change. However, consumption in the upstream countries is largely unaffected by climate trends (Figure 3, fourth panel), mainly because water use is initially quite low and water goals are substantially higher. So investments are made regardless of the overall development of water availability. Consumption in Egypt is much more sensitive to changes in the hydrological system and any negative changes in environmental conditions are practically impossible to offset even by massive investments into the expansion of water infrastructure.

Summary and conclusions

The assessments regarding water allocation in times of changing environmental conditions show that the water-security nexus consists of numerous complex interactions and that there are not merely simple relationships. In the past, water conflicts have often not only had an environmental and an economic dimension – very often other aspects such as culture and religion have been important, highlighting the vital role of water for people in transboundary river systems all over the world. Water stress is likely to increase as a consequence of the joint effects of climate change, population growth, economic development, and growing inequities in water distribution. This may give rise to new conflicts as disagreements among riparians on water-related issues mount.

The conceptual framework of the water-security nexus considers the important security pathways and reflects the diversity of water conflicts for all possible spatial extents. Not only does it look at the physical conditions for water disputes, it also addresses the possibility of feedbacks between social change and the environmental system, the role of institutions affecting water use, and possible strategies to deal with growing water scarcity. This framework can be translated into agent-based research models to study the effects of concrete scenarios of environmental change on the ability of individual riparians of transboundary river systems to meet their own desired goals of water consumption.

Assessments of water-related conflicts indicate that the actual distribution of water is rarely the key issue for water disputes. Often, divergent political views are channeled into concurrent struggles for hegemonial power, energy production, the maintenance of water quality, and the preservation of societal values. Many transboundary conflicts that also involve water could not be solved by merely increasing the overall amount of water available to the conflict parties (Bichsel 2009), as is prominently the case in the water conflict between Israel and Palestine that could not be resolved despite substantial increases in water availability from wastewater recycling and desalination (Aviram, Katz, and Shmueli 2014). Instead, the resolution of water conflicts also requires the recognition of the associated political, economic, societal, and cultural settings and discourses. Recent research on water conflicts has increasingly focused on the latter, broadening our understanding of these parts of the water-security nexus that will hopefully facilitate the increasingly successful mediation of water conflicts despite the additional challenges arising from the impacts of climate change.

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7 Managing water-related vulnerability and resilience of urban communities in the Pearl River Delta

Liang Emlyn Yang

Abstract

Globally, growing concern about disaster risks necessitates the implementation of actions that combine vulnerability reduction and resilience building. This paper applies the concept of vulnerability and resilience to urban communities in the Pearl River Delta along the Southern Chinese coast that are facing climate-related water hazards. The study integrates a reanalysis dataset and model projections with literature results on long-term climate changes, which support a comprehensive risk analysis of both floods and water shortages in the Pearl River Delta within the regional climate change context. A flood vulnerability assessment indicates that pre-existing vulnerabilities are exacerbated after flood impacts. The main factors influencing the vulnerability of coastal communities are related to economics, institutional capacity, and the accessibility of knowledge for local community-based organizations. Many communities have been able to reinforce their resilience through local initiatives, including investing in infrastructures, sharing responsibilities, diversifying engagements, network recoveries, and water security nets for the most vulnerable ones. To ensure that the delta's communities are well adapted to climate and water threats, it is clear that investing in building community resilience and safety nets is important. This paper further highlights that community efforts, government supports, and external assists should be better organized to reinforce the abilities of the people at the local level.

KEYWORDS: *Climate change, flood risks, vulnerability, community resilience, water security, Pearl River Delta.*

Introduction

Currently, concerns are increasing that climate change would increase disaster risks like droughts, floods, and storms, which pose security problems to human societies (IPCC 2012), especially in coastal urban areas. Among many disasters, the concerns about climate-related flooding have led to increasing interest in understanding the interactions between climate, flood, and human responses (Yang et al. 2015). Several decades of research have produced a considerable understanding of the complex interacting factors contributing to social vulnerability to natural hazards. Despite these insights and the efforts of the disaster risk reduction and humanitarian organizations to reduce hazard vulnerability, natural hazards remain a considerable challenge to poverty reduction and development in many countries around the world and particularly in fast developing Asia (Nitivattananon et al. 2012).

Cities are dynamic social systems: their future developments are shaped by many interacting forces, including changes in the environment. With a projected sea level rise of up to 0.6–1.6 m by the end of this century (Jevrejeva, Moore, and Grinsted 2010), many of the world's large coastal cities are at increasing risk. Besides sea level changes, climate change is likely to increase rainfall variability, drought intensity and duration, and damages on water-related infrastructure by extreme weather events, which all increasingly threaten the local water availability (Schewe et al. 2014). Water supply is becoming more complicated due to population growth, economic development, and difficulties in response/management (Yang, Chan, and Scheffran 2018).

In particular, cities in the highly populated Asian coastal areas will increasingly face complex inter-related problems associated with greater intensity and frequency of climate extremes (Dewan 2013; Yang et al. 2015). Impacts affect both urban and rural communities along the coast including housing, infrastructure, and economic facilities. Some of the key challenges in Asia related to climate change are: impacts of extreme weather events (i. e. floods, storm surges, sea level rise); identification of social vulnerabilities to multiple stressors during climate and environmental change; and adaption strategies concerning agro-technology, water resources management, and integrated coastal zone management (Nitivattananon et al. 2012). Disasters and climate change impacts as well as increased water demand pose serious risks to the provision of sustainable urban water services, e. g., drinking water, sanitation, and safe drainage, especially in cities (Zhang et al. 2009; Li 2009). These challenges call for a transition toward improved water management, including vulnerability reduction and resilience building.

While there are different meanings of the term vulnerability depending on the scientific discipline, the IPCC has clarified its meaning for the climate and disaster communities: Vulnerability is comprised of exposure, sensitivity, and adaptive capacity

(IPCC 2012). However, vulnerability assessment alone is not able to support information on probability, extent of, or recovery from a disaster event. Thus, there is a need to integrate local vulnerability into disaster risk analysis and resilience enhancement by means of regarding climate change impacts. As Whittle et al. (2010) argues, resilience can somehow be considered as the flip-side of vulnerability. However, this relationship is not always straightforward. The truth is that different definitions of resilience have emerged across a wide range of disciplines (Meerow, Newell, and Stults 2016; Liao 2012). In spite of this, evidence was found of nine core elements of community resilience that were common among all definitions, including local knowledge, community networks and relationships, communication, health, governance and leadership, resources, economic investment, preparedness, and mental outlook (Patel et al. 2017).

There can also be very large differences in the capacity of city authorities, households, and organizations to take measures to mitigate risk and ensure rapid, effective responses to disasters (Nitivattananon et al. 2012), and thus differences in resilience. There is a lack of consensus in the literature about what constitutes vulnerability and resilience and how to measure these phenomena. While some important work has focused on the long-term effects of coastal hazards on economic growth, little has been done to understand, in quantitative terms, the extent to which coastal communities may be vulnerable to such hazards and, if so, whether they can be resilient (Patel et al. 2017). A focus on these local communities may be more productive than attempting to define and study community resilience as a distinct concept.

The objective of this paper is to undertake a comprehensive, systematic analysis of the climate-related hydrological risks as well as the vulnerability and resilience of local communities in the highly urbanized Pearl River Delta (PRD) in South China. While specific strategies for vulnerability reduction and resilience building are still one of the challenges faced by local, state, and national agencies, this paper provides a framework to improve comparative identifications of disaster resilience at the community level. Some priority measures will be discussed to enhance the capability of urban communities in coping with climate- and water-related threats.

Climate change and water risks in the Pearl River Delta

The Pearl River Delta

The Pearl River Delta (PRD) is formed as a 42 657 km^2 sedimentary plain of the Pearl River with its three branches, namely the West River, the North River, and the East River (Figure 1). The PRD is dominated by a sub-tropical monsoon climate with

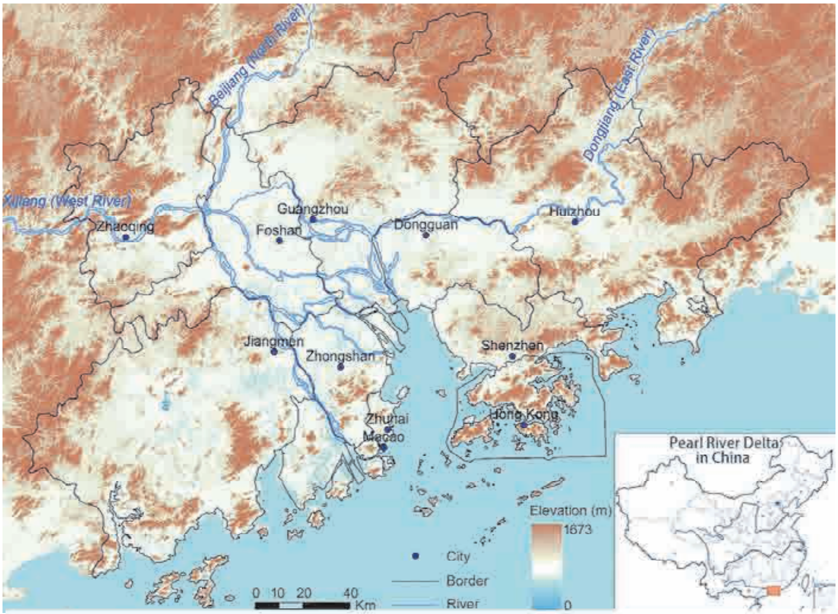

Figure 1: Topography, the river system, and the eleven cities of the Pearl River Delta, China.

abundant precipitation. The long-term annual mean precipitation is approximately 1800 mm and about 85 % of the precipitation occurs between April and September. The topography of the PRD has mixed features of crisscrossing river networks, channels, shoals, and river mouths (so-called "gates" in Chinese). Water flow at the estuary is influenced by both the river runoff and sea tide, with water level variation between 0.86 m and 1.63 m with a half-day return period.

The PRD includes eleven cities, nine in the Guangdong Province (Shenzhen, Dongguan, Guangzhou, Foshan, Jiangmen, Zhongshan, Zhuhai, and parts of Zhaoqing and Huizhou) plus Hong Kong and Macau (Figure 1). Comprising 81.61 million inhabitants in 2016, the PRD is rapidly urbanizing and is now among the most prosperous metropolitan areas of the world. The GDP of the PRD cities reaches roughly 1428 billion US$ in 2016 with an average annual growth rate of 16.2 % in the first decade of this century. This rapid development is accompanied by intense land use change, e. g. built-up areas increased from 4.14 % in 1988 to 20.61 % in 2008 (Ye et al. 2012), and this trend is still continuing.

The natural environment of PRD is sensitive and variable due to the strong monsoon, the dense river network, and significant effects of erosion and deposition. Rapid economic development and population growth have further intensified the fragmentation of the natural environment. The combination of these factors makes the PRD prone to natural disasters, of which floods are the most serious. Although increasing hydraulic engineering (mainly reservoirs and dams) in the upstream area prevent certain fluvial floods for the PRD, local extreme weather and poor drainage in the context of climate change and urbanization still make the flood threat a substantial concern for the government and stakeholders (Peng et al. 2008; Chan et al. 2012).

Climate change and impacts on the water system

Flood risks

Flood implications of climate change trends are pronounced in most of the cities in the PRD. The frequency and intensity of extreme weather and climate events have triggered some significant change – together with continuing development in flood-prone areas, which increase both the scale and degree of urban flood risk. Climate change is expected to lead to increases in extreme rainfall, especially in places where mean rainfall is already expected to increase. Such extreme precipitation will threaten many areas, buildings, infrastructure, and people and is likely to result in great losses.

Flooding in the Pearl River basin is caused primarily by local or upstream rainstorms during the rainy season from May to September in the year. The stream flow variations show remarkable relations with precipitation changes in the West and East River basins, implying a tremendous influence of climate change on hydrological processes (Zhang et al. 2009). Large-scale flood impacts (economic loss and population flooded) coincide well with the occurrence of intense precipitation most of the years, while low precipitation means fewer flood impacts. However, floods are not only related to total precipitation but also to extreme rainfall. In 2003, the total precipitation was relatively low but the population flooded was substantial because a devastating typhoon (Dujuan, with international No. 0313) hit the PRD directly with extreme rainfall and strong winds (Yang et al. 2015).

The principle also applies to typhoons. What usually matters more is the intensity rather than the typhoon frequency. As previously stated, annual precipitation, extreme rainstorms, and typhoons are all projected to continue to become more frequent in the PRD area during this century, thus the probability of flood occurrence is expected to increase accordingly.

Flooding in cities is also called waterlogging in local areas, which occurs frequently in PRD cities like Guangzhou, Shenzhen, and Hong Kong. Heavy rainfall over a short period of time is the main reason for waterlogging. In addition, large parts of land

Figure 2: Photographs showing the rapid development and urbanization in the low coastal areas of the PRD. Source: Photos taken by Liang E. Yang in November and December, 2011.

are covered by buildings and concrete, which increases the surface runoff and rainwater accumulation for waterlogging. PRD cities have experienced rapid development and urbanization in the low coastal areas and this is not slowing down in recent years (Figure 2). In the context of expected extreme precipitation and continuing urbanization, waterlogging is increasingly possible for city centers due to fast rainwater accumulation and in old city areas due to poor local drainage.

While the eastern areas of the PRD face many local small-scale floods caused by intensive rainfall, the western and northern parts suffer more from river flooding. River flooding is usually caused by large-scale precipitation. A sharp increase in precipitation would require further water storage capacity for flood control along the river, while unexpected precipitation reduction would affect the impoundment. Indeed, the decrease in flood frequency and increase in flood-affected population or assets in the Pearl River basin during the last decades have been noticed by Chen, Zhang, and Chen (2012). Given that the frequency and intensity of extreme weather have shown significant change, tremendous influence on hydrological processes can be expected and further basin-wide flood risks are implied.

Water shortage

Water resources are unevenly distributed throughout the PRD. The highly urbanized PRD area gets relatively little water compared to the upstream areas, based on per capita water availability. In addition, not all cities can easily take advantage of using the Pearl River water as cities such as Hong Kong and Shenzhen are not located near the river mainstream. Both cities rely highly on natural rainfall and regional water transfer and are therefore more vulnerable to the impact of weather factors. Uneven patterns of precipitation also cause droughts in certain subareas. Higher drought risk can be observed in the lower Pearl River basin and lower drought risk in the upper Pearl River basin (Zhang et al. 2012). Due to the uncoordinated distribution of water resources and population, the highly urbanized PRD area is under higher pressure when drought and water shortage occur. Projected climate change is expected to aggravate the uneven pattern of precipitation, which will bring about further water stress.

In the context of global climate change, the sea level is expected to keep rising in the future, which would increase saltwater intrusion, the invasion of seawater into inland freshwater systems. Saltwater intrusion affects the quality of river water, resulting in reduced availability of freshwater resources. The river water level declines due to reduced surface runoff, which therefore allows sea-water to intrude and spread in the Pearl River inland river channels. The situation deteriorates when tides occur and tidal water intrudes further into the costal river system, thereby creating a super saltwater intrusion. In addition, a rising sea level would push saltwater into inland groundwater systems. If there were not enough surface runoff injected to groundwater system, ground water would eventually become unusable.

Large amounts of rainfall in the wet season help to take away or dilute water contaminants significantly. However, less water will lead to a higher concentration of water contaminants. As wastewater and sewage are increasing rapidly in the PRD cities along with fast population growth and urbanization, climate-related water shortage would aggravate water pollution. Serious water pollution would deteriorate the aquatic environment and cut down the amount of useable water. Natural and human made water pollution can spread with transboundary water diversion. Research shows that increased depositions of cadmium, copper, and zinc in Hong Kong's reservoirs are positively correlated with their depositions in the downstream of Dongjiang River during the period of 1994–2001. There are also many other substances transported to Hong Kong through the water supply project, which may cause health problems (Ho, Chow, and Yau 2003).

The impact of climate change on available water resources, including the quantity, quality, and distribution, is very complicated and often unclear. Furthermore, the development, utilization, and planning of the local water facilities are also involved, which adds a lot of exposure to climate change impacts. Long term and severe droughts could cause failures of water supply facilities. Extreme hot weather can depreciate the entire social infrastructure including water supply, flood control, and pollution treatment. In addition, floods are a major initiator in destroying human facilities and welfare. And finally, the health sector may be also affected by damages in water supply facilities and sewage systems of the PRD basin, mainly in form of an increase in the incidence of water-related diseases and may influence the cities and their people.

Vulnerability to climate-related water hazards

Flood vulnerability of PRD cities

Flood risks emerge from the interaction of flood hazards and vulnerability (Merz et al. 2010). The vulnerability to flood hazards can be identified by its three components: exposure, sensitivity, and adaptive capacity. In this study, the methodology consists of a vulnerability indicator system with 15 indicators to quantitatively evaluate the PRD cities' vulnerabilities, as introduced in Yang et al. (2015).

Primary data for the vulnerability assessment were collected from the Statistical Yearbooks of Guangdong Province (2002–2011), statistical yearbooks of each city (2002–2011), the sixth census of each city (2010, except Hong Kong and Macau), and government publications and news reports in related cities in 2010. It has to be mentioned that a few indicator values (e. g. economic sector and drainage system) are not exactly comparable due to different statistical criteria of individual cities. A more appropriate approach is to describe the three components of vulnerability in detail and also combine them into one flood vulnerability index. Of all the eleven cities examined, Zhongshan, Dongguan, and Macao are the three most vulnerable cities in this area (Figure 3) while Hong Kong, Shenzhen, and Guangzhou rank in the middle. Therefore, even though the exposure and sensitivity indicators are still significant in the most developed cities, flood risks and potential damages can be mitigated greatly by improving flood-control measures (i. e. the adaptive capacity).

The results suggest that the exposure and sensitivity of Hong Kong, Macao, Shenzhen, and Guangzhou are very high because of highly exposed populations and assets located in lowland areas. However, the potential vulnerability and risk can still be low due to high adaptive capacities with regard to both hard and soft flood-control measures. A novel framework on flood responses is proposed to identify vulnerable links and response strategies in different phases of a flood event. It further suggests that the flood risks can be reduced by developing an integrated climate response strategy, releasing accurate early warning and action guidance, sharing flood related information to the public, and applying the advantages of social network analysis.

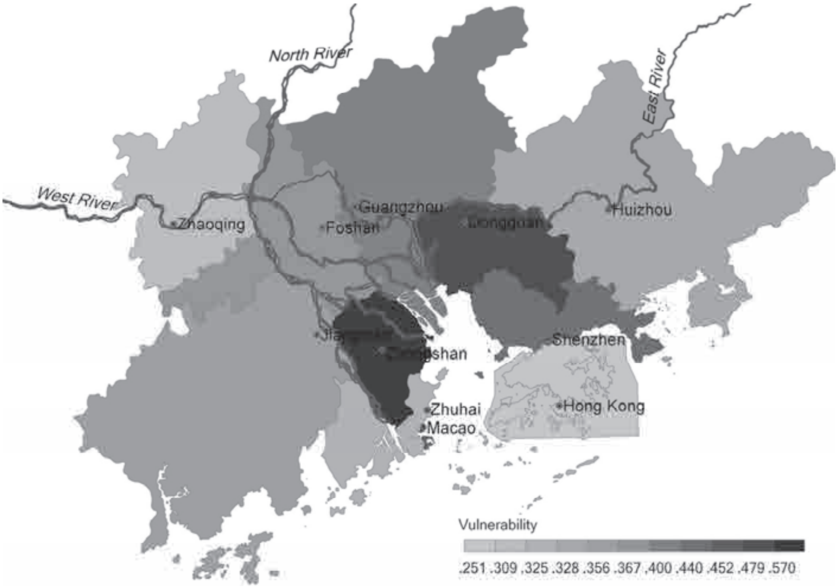

Figure 3: Relative flood vulnerabilities of PRD cities. Source: Yang et al. 2015.

As a river delta, the PRD has frequently suffered from flooding in the past. Urban settlements in the PRD are typically located and developed along shorelines and the river estuary, putting them at particularly high risk of flooding and an expansion of the water's edge. At the macro level, the PRD has a higher frequency of floods and a more severe flood risk in general because it is highly impacted by the combination of urbanization effects and climate-related changes in the future. Adding to this is the fact that a large number of existing tidal flood defenses are below the standard set by the provincial government (Chen and Chen 2002), increasing the probability of flooding of the local population. If the PRD region fails to take precautions, it will suffer multiple serious impacts of inundation, storm surges, dike failure, and drainage difficulties.

Climate-related impacts are not the only causes of flood hazards in the PRD area. Since 1980, the coastline of PRD has undergone extraordinary changes due to urbanization and economic development. Such developments also increase the likelihood of flooding due to human-induced hydrological changes, which include:

– Urbanization changes land surface characteristics, thus altering the rainfall-runoff relationship, which leads to increased and earlier flood peak flow, shorter flood duration, and increased flood volume.

- In order to meet the water demand of an increasingly dense population, excessive exploitation of groundwater in the PRD has led to land subsidence, making the delta more vulnerable to flooding (Huang, Zong, and Zhang 2004).
- Rapid urbanization drives significant riverbed dredging for construction materials. Although river dredging could potentially increase the channel cross-section and reduce the flood risk, intensive dredging and abnormal riverbed excavation exacerbates river bank erosion and therefore increases the probability of riverbank outburst (Luo et al. 2007).
- The growing population occupies an increasing river beach by land reclamation along the Pearl River estuary, which seriously narrowed the river channel and reduced the river's natural capacity for draining and regulating floodwater. Flood threats will very likely increase in this situation if no remedial action be taken. Moreover, natural floodwater storage has been sacrificed, as seen in the drainage of large natural wetlands for urban development around the Shekou Peninsula in Shenzhen.

Vulnerability to water shortage

The Pearl River Delta is quite often portrayed as a subtropical area with abundant water resources. However, this is only part of the full picture of the complicated water issues. Although the current water supply system supports the water demand effectively, water shortage is still of general concern in this area (Gu and Yang 2005). Furthermore, global climate change adds new challenges from another dimension, together with population growth and development activities, making water supply issues more complicated. Water system management is both complex and politically difficult, requiring the best expert knowledge available for decision-making (Hunt et al. 2007). In order to enrich the adaptive capacity in the PRD area, it is necessary to understand the characteristics of the water supply system and the associated risks.

The usable river water in the PRD originates in the upstream part of the river and is influenced greatly by any changes in quality or quantity. Although the absolute amount of water available to the PRD seems sufficient, per capita water availability is relatively small considering the intense population and economy (Yang 2014). Especially, the East River has been nearly fully developed to serve the water demands of cities along it. It is hardly possible to increase supply. Taking into account potential droughts and increasing upstream water consumption, the further development of water supply has become one of the most important and urgent tasks facing PRD city governments. Accelerated urbanization also dramatically changes water use patterns. During 1980–2003, the share of agricultural water consumption with respect to the total annual amount of water consumption declined from 87.6 % to 54.3 % (Yang 2014). During the same period, the share of industry water consumption increased from 12.4 % to 44.5 %. This altered pattern exposes further contradictions in water supply and demand: agricultural water consumption shows seasonal, temporary features and therefore can be well prepared for peak demand period while urban water consumption is constant at a certain high amount. Thus urban water supply is more sensitive to climate-related water fluctuations and there is a significant potential that it is threatened by droughts (Liu, Liu, and Wang 2005).

Extensive water consumption contributes to a large amount of wastewater, which pollutes the river system and reduces the usable fresh water. This can be considered a vicious circle of the water system because the expansion of the sewage treatment system significantly lagged behind the pace of urbanization. According to a water resource report, the characteristics of the PRD are the worst water quality, highest water consumption, and largest sewage volume in the country (PRWRC 2011). About half of the PRD streams are polluted, with river water quality classified as IV, V or worse than V (I to V indicates best water quality to worst). Zhu and colleagues analyzed the water environment and pollution sources in the PRD and point out that domestic sewage is the main source of water pollution (Zhu et al. 2002). Although the estimated amount of pollution-caused water loss seems negligible throughout the PRD, the situation in certain sub-areas is worse (Gong 2012). In addition, seasonal salty-tidal brings saltwater and marine pollution to the inland parts of the river system, which aggravates already existing water pollution. Furthermore, contaminants deposited in the riverbed could be transported to other areas by water transfer and pose potential risks in the destination areas as well (Ho, Chow, and Yau 2003).

The most severe impact of water shortage and drought is its disaster-chain effect (Liu, Liu, and Wang 2005), which considers not only a lack of water as a primary effect but also many indirect consequences such as pests, diseases, forest fires, ground subsidence, crop reduction, and even social instability (Figure 4). First, water shortage is a disaster for the environment. As the river water level drops during a drought, saltwater intrusion occurs more readily and pollutes the already stressed freshwater resources; thus, the drought situation is further exacerbated. Moreover, water shortage reduces human-wellbeing due to difficulties in the drinking water supply. In addition, some infectious bacteria and viruses have a strong biological activity in arid environments and may disperse diseases among humans if there are water shortages. For example, the warm and long-lasting dry spell benefited the spread of SARS (Severe Acute Respiratory Syndrome) in 2002/2003 in Guangdong province (Chen et al. 2004). The emergence of diseases not only affects people's physical and mental health, it is also likely to cause social panic: severe water shortage or drought leads to huge economic

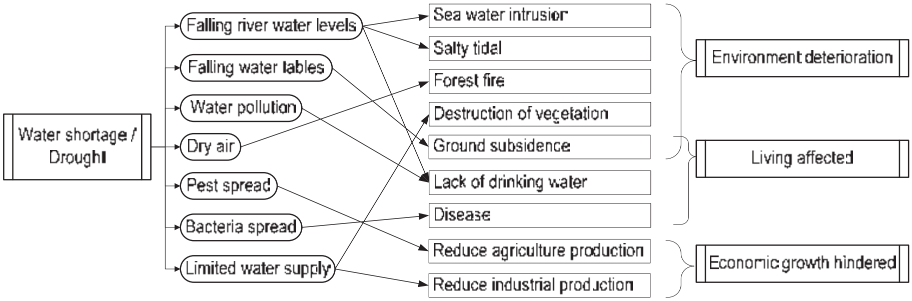

Figure 4: Disaster chains of water shortage and drought. Own representation based on Liu, Liu, and Wang 2005.

losses. Drought-introduced pest infestations are the most direct harm to agricultural production. Severe drought also affects industrial production, by reducing production or discontinuing it. In 1991, the drought forced most of the food, beverage, and textile factories in Shenzhen to shut down their production totally or partially, causing a direct loss of about 200 million Chinese Yuan (37.59 million US Dollars) (Liu, Liu, and Wang 2005).

Furthermore, changes or a reduction in water availability may cause, bring back, or prolong social conflicts between municipalities or between people and authorities on access to water, water use, or water consumption (Yang, Zhang, and Ngaruiya 2013). Three main reasons have been identified as critical factors influencing the occurrence of water related social conflicts: 1) aggravation of water shortages, a trigger that strains the competition for the resource; 2) public rejection of government decisions that may be perceived as unpopular (e. g. reduction of subsidies, increase of tariffs, scheduled reductions in water supply); and 3) additional causes related to local (geographic or sectorial) circumstances, e. g. recurrent drought periods affecting local agricultural activities, lack of infrastructure, or inequitable supply (Brun 2007).

Framing the community resilience in the PRD cities

Community resilience to natural hazards in general

To ensure the delta's communities can adapt well to climate and water threats, it is clear that it is important to invest in building community resilience for the most vulnerable. The essential issue in this respect is that social and ecological vulnerability to disasters and long-term consequences of any particular extreme event are influenced by the buildup or erosion of resilience (Adger et al. 2005). Specific studies explored resilience from both theory and methodology perspectives and in doing so moved beyond looking at resilience merely in terms of vulnerability, risk, and capacity. Recently, the concept of resilience was increasingly explored to offer a more systemic and cross-cutting approach to disaster risk reduction. The Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework) further promoted the studies since it set forth "investing for resilience" as one of the four main priorities for action at different levels (UNISDR 2015). Although the study is prosperous, the identification of standards and metrics for measuring disaster resilience is still one of the challenges faced by local, state, and federal agencies (Paton and Johnston 2017).

A recent literature review indicated that community resilience is an amorphous concept that is understood and applied differently by different research groups (Patel et al. 2017). In essence, depending on one's stance, community resilience can either be seen as an ongoing process of adaptation, the simple absence of negative effects, the presence of a range of positive attributes, or a mixture of all three (Patel et al. 2017). Although expressed differently, community resilience generally emphasizes the capability to absorb, adapt, and transform in the face of hazards, shocks, and stresses (Zakour and Swager 2018). Evidence was found of nine core elements of community resilience that were common among the definitions used in different studies, which include local knowledge, community networks and relationships, communication, health, governance and leadership, resources, economic investment, preparedness, and mental outlook (Patel et al. 2017).

Building on these elements, community resilience aims at solving the root causes of vulnerability and at evolving the systematic stability of functions. The connotation of community resilience is the inherent state and structural characteristic, in which the community itself exists before a disaster occurs. In summary, the approach here is to understand community resilience in terms of relationships and action processes of individual, household, and public services in a community. In other words, "resilience" is not so much a response to a given hazard itself but is an emergent characteristic of the way, in which the responses and subsequent recovery processes are managed (Whittle et al. 2010).

Understanding vulnerability to enhance resilience

In the context of climate change, vulnerability is a function of "systemic exposure, sensitivity, and adaptive capacity" (IPCC 2014). Vulnerability research can help us understand where people and places are at risk and propose strategies for adapting governance. Social vulnerability and community resilience can be viewed as separate but often linked concepts. Vulnerability speaks to the inherent qualities of a social system that contribute to the amount of risk of exposure as well as the degree of harm, while resilience refers to the conditions that help social systems to absorb, cope with, and adapt to hazards and disasters (Cutter et al. 2008). While numerous scholars note the conceptual links between these two indices, few have empirically investigated the relationship between community resilience and social vulnerability (Bergstrand et al. 2015; Sherrieb, Norris, and Galea 2010). Findings indicate a correlation between high levels of vulnerability and low levels of resilience, although not all areas have parity concerning vulnerability and resilience levels.

Studies on climate change impacts increasingly focus on not only assessing the vulnerability of social systems that reflects the negative aspects but also on increasing resilience that reflects the positive and initiative aspects of human societies. The reason for this shift of focus of climate impact research is mainly due to the fact that experts and scholars have noticed that a large number of the published vulnerability research results have not made various mitigation strategies and measures work as expected (Cutter et al. 2008). In other words, the recent findings of vulnerability knowledge are not sufficient to be of practical use for disaster risk management. Enhancing community resilience is thus necessary to fill the knowledge gap. This can be achieved by investigating possible practical measures. Studies indeed have suggested that a strong social resilience can be developed as long as there is a strong relationship in social networks that offers immediate and in-need help when fighting against external disturbances (Chelleri, Minucci, and Skrimizea 2016; Bergstrand et al. 2015). In general, the current sustainable development movement tends to rely on resilience as the main concept if it is based on a well-founded understanding of the associated vulnerability and risks.

As far as the PRD cities are concerned, different communities certainly have different issues and challenges such as flooding, sea level rise, water pollution, ageing of population, new immigrants, or the industrial transition. Some of these issues are internal issues within the communities; some of them belong to a larger scale of socio-economic structural problems. Nevertheless, they all contribute to the vulnerability of the city systems and they must also put efforts to community building and local development in order to construct resilient communities and a resilient society. Climate change impacts are also an urgent problem in the PRD area. An important issue that PRD cities should pay greater attention to is how to identify areas that are highly vulnerable in order to focus on building resilience and impact mitigation there. If local communities can identify specific areas with high vulnerability promptly, then these regions can be used as priority areas to promote mitigation planning and adaptation actions. Consequently, these areas are more likely to be built into resilient communities. Proposing resilience plans will not only reduce vulnerability but also integrate formal and informal networks to respond to the climate change impacts and move towards a true sustainable development.

Increasing community resilience in the PRD cities

The consequences of water-related hazards depend on both the hazard itself and the response behaviors. It is indeed of paramount importance to discuss the resilience building measures in the PRD cities and the necessary improvements based on the flood/water shortage vulnerability and risk analyses. In this context, framework for community resilience building consisting of four phases is introduced that could help to reduce the vulnerability of local communities to water-related hazards. Implementation of such a framework could have direct and indirect positive impacts on enhancing the resilience of urban communities in the PRD. Though many other measures could be considered for community resilience building as well, this study emphasizes specific procedures based on the vulnerability analysis above.

First, precautionary measures should always be considered as basics in building community resilience to water hazards as it is more effective and cheaper to invest in early rather than late actions (Yang et al. 2018). These include:

– Identification of local vulnerability and risk and informing of all community residents. Knowledge of vulnerability and risks in surrounding environments enables community members to identify context-specific adaptation actions and allows policymakers to engage community members in urban resilience planning. The ability of urban communities to remain resilient to water hazards is rooted in their understanding of the potential risks and vulnerabilities. The primarily suggested channels for achieving these aims were school programs and media campaigns.
– Investments into new and refurbishment of existing infrastructure to build community resilience. The primary goal is to strive towards a greener and more resilient city environment and implement standards about the continuity and long-term reliability of infrastructure. Moreover, multi-level, distributed, replicated networks of key facilities should be constructed to distribute risks over space and time. Regarding flood threats, the concept of a Sponge City is a promising option that involves the principle of harmonizing human and water systems in urban conditions (Xia et al. 2017). In addition, diversified drainage methods and redundant storage capacity could enhance the resilience to floods.

- Effective and precise early warning systems are considered to be an important component of disaster preparedness and response. There must be a clear emphasis on improving both the technological "hard" elements of such systems and the "soft" components, such as appropriate mechanisms for the communication and dissemination of early warning information to end-users and the linkages with community-based disaster preparedness activities.
- Finding of effective ways to inform and engage in communities to build resilience. Effective communication and engagement are best carried out through strategies that are appropriate to community needs, create partnerships and trust, and provide continuity of information. Particularly in poor communities, the enhancement of climate resilience requires an understanding of the residents' needs, resources, and capabilities (Yang et al. 2018).

Second, warning with forecasting and guidance is the necessary measure in case disaster strikes.

- Clarify shared responsibilities. To ensure shared responsibilities are equitable and effective, both institutions and communities need a good understanding of their communication and cooperation. This applies to both vertical (between authorities and communities) and horizontal (between community members) cooperation.
- Improvement of the instant warning system with prediction that is more accurate, longer lead-time, and more frequent information release. A flood warning system, which provides timely, accurate, and broad rain coverage warning can reduce flood losses by 30 %-40 % (Yang et al. 2018). To achieve this goal, further research on the mechanisms of rain triggered floods and appropriate channels for the release of warning information are highly recommended.
- Social media networks can be used very well to offer immediate information of any extreme events occurring. Given the rapid development of communication technology, the widespread individual use of cell phones, and the cost effectiveness of text messages to individuals, transparent disaster information and prevention services should be explored in more detail.

Third, relief through emergency management is the most appropriate measure particularly for external agencies to help building resilience of the communities.

- The local government and outside aid should be better organized to reinforce the adaptive capacity of the people in local communities. Random and unorganized response actions help very little to reduce total flood losses.

The relief system of treating flooding as a public problem should stress the increased organizational role in managing relief activities. This includes improving individual capabilities, coordinating their initiatives, and making full use of their efforts in the overall relief systems.

- Emergency response institutions and systems must be readily established and maintained to respond quickly and address the needs at the community level. An emergency plan should have been exercised in advance to ensure that timely and effective disaster relief can be offered in an emergency.

Fourth, post-disaster recovery measures contribute to improving community resilience in general so that the community can better cope with possible future hazards.

- Assessments of damages and remaining property are important to obtain information on the existing conditions and establish a baseline for subsequent steps. This baseline must consider the existing vulnerabilities, the state of recovery, the built environment, and nature itself.
- Repairing and upgrading of the remaining infrastructure, facilities, networks, livelihoods, as well as improving the early warning systems and evacuation procedures according to the observed inefficiencies.
- Investments into and construction of new infrastructure, facilities, and networks based on new information, experiences, and lessons learned from the disaster. These measures not only help in the recovery process but also aim at enhancing resilience with regard to future hazards. It is important to consider the capacity of ecosystems to buffer possible impacts of extreme events.
- Integration of disaster risk reduction into sustainable development strategies. There is an urgent need to develop strategies that integrate, more strongly, disaster risk reduction with water resource management, poverty reduction, and sustainable development. It is significant to incorporate the building of systematic ecological and social resilience to environmental and other shocks with a long-term comprehensive perspective.

Summary and conclusions

This paper presents an integrated analysis and overview on both flood threats and water shortage risks to the Pearl River Delta, China, in the context of climate change. It discusses and further emphasizes assessment methods for climate impacts and social responses (vulnerability and resilience) in urban communities. A comprehensive study on the climate change trends in the area of the PRD indicates increasing mean temperatures by around 3 °C and slightly more precipitation by end of this century while the sea level is likely to rise with an annual rate of 0.33cm to 1cm in the near future. The inter-annual variability of precipitation is much more notable relative to its trend variability, which means that extreme precipitation events occur frequently. These impacts potentially amplify hydrological variation in the PRD, which means an increasing frequency of droughts and floods. Such challenges increase both the vulnerability and the importance of resilience building in the PRD metropolitan area.

On the one hand, the study suggests that earlier investments in disaster responses are more efficient than late activities, and real-time, accurate, and large-scale flood warnings play a significant role in reducing flood vulnerabilities. It is increasingly recognized that the nature of coupled socio-environmental problems such as floodings require innovative institutional arrangements to address the complex physical processes occurring at local, regional, and global scales, while fitting within the economic, socio-cultural, and political constraints of decision making. On the other hand, response measures for coping with water shortages include rainwater harvest, seawater desalination and utilization, wastewater treatment and reuse, and water demand management. Actually, Hong Kong has done very good work in rainwater collection and seawater utilization, which can be considered to be a role model for the other cities. A long-term response strategy may also be implemented to both improve the self-sufficiency rate of water supply and diversify water source options.

The integrative analysis above suggests that the coastal areas of the PRD exhibit the full range of possible combinations of vulnerability and resilience. Therefore, suggestions are made to develop an integrated resilience building strategy, which includes specific measures of precautionary methods, warning with forecasting and guidance during extreme events, external relief through emergency management, and post-disaster recovery measures. It is very important that a chain of various measures must be established to enhance community resilience dynamically and from multiple dimensions.

As experience from history indicates, most cities that have experienced catastrophic damages show strong resilience, continued to exist, and developed even more prosperously. However, for those individuals deceased and suffering because of the disaster, the resilience of the city system is still far from sufficient. Therefore, resilience building includes two layers of meaning: to ensure the individual safety and to maintain system functionality. This is very challenging. In many ways the impacts of climate change are unavoidable up to certain extent. The human-water systems in coastal and delta cities are always subject to anthropogenic stress and all parts of the system adapt to each other to maintain a balanced systematic function. Actually, the stability of a given system is a relative stability in periods of dynamic changes. Therefore, the ultimate goal of water system management of the PRD cities shall be to limit damages as much as possible and recover functions as soon as possible, which is the essential argument for vulnerability reduction and resilience building in this paper.

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8 Challenges and opportunities for historical irrigated agricultural systems in Mediterranean regions

Technical, cultural, and environmental assets for sustainable rural development in Ricote (Murcia, Spain)

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Abstract

Historical irrigated agricultural systems in Mediterranean regions provide a long record of sustainability and adaptation to changing climatic, environmental, and social conditions. These agricultural systems are currently confronted with challenges that may threaten their persistence over the next decades. Here, we propose a first assessment of strategies and opportunities that may contribute to the continued sustainable development of historical irrigated agricultural systems. Our assessment is based on experience gained within the agricultural community of Ricote (Murcia, Southeast Spain), in consultation with local stakeholders and external experts.

KEYWORDS: *Agriculture, irrigation, meteorology, water, GIS, CO_2 emissions, smart rural development.*

Introduction

As climate warming intensifies in Mediterranean regions, historical irrigated agricultural systems are increasingly exposed to water shortages, pauperization, and depopulation (Kummu et al. 2010). Such conditions are threatening the existence of a long tradition of practices for managing water scarcity in Mediterranean irrigated rural contexts (Balbo et al. 2016). The selected case study of Ricote (Murcia, Spain) provides a privileged setting to assess the challenges and opportunities of these historical irrigated agricultural systems. Known as one of the earliest irrigated agricultural system of Andalusian origin in Europe (Puy and Balbo 2013), Ricote has been sustaining the local community for over a millennium, withstanding important climatic (the transition from the warm Medieval Climate Anomaly to the cold Little Ice Age) and social (the Crusades and the industrial and informatics revolutions) events. Within the global trend of irrigation expansion and modernization, insights obtained from the study of such cases as Ricote can help identifying key challenges, strategies, and opportunities in similar contexts. Meanwhile, our contribution expands the richness of international case studies focusing on the sustainability of irrigation-based food systems (Agoramoorthy and Shu 2015; Tabbal et al. 2002; Zhang and Zhao 2013). Specifically aimed at historical irrigated agricultural systems, our case study adds to the enhancement of sustainable development and social inclusiveness in rural regions at large, in line with the principles of the Europe 2020 growth strategy (Copus et al. 2011; Dijkstra and Poelman 2008; EC 2010).

Due to environmental specificities such as its endemic lack of water or the arid and semi-arid climate, as well as to its inherent historical trajectory, South Europe, led by Spain, is at the forefront of irrigated agriculture, technology, and innovation (Soto-García et al. 2013a). The importance and antiquity of irrigated agriculture and water management institutions in East and Southeast Spain is attested by the inclusion of Irrigators' Tribunals (The Council of the Wise Men of Murcia or the Water Tribunal of València, both dating back to al-Andalus) in the UNESCO's list of intangible heritage (Inscription: 4.COM 13.70, 2009). This situation is the result of a long tradition, rooted in the Middle Ages, when irrigated agriculture constituted the main food production strategy of Arab-Amazigh/Berber groups proceeding from North Africa (Puy and Balbo 2013). As a general rule, irrigation systems of Arab-Amazigh/Berber origin were further extended following the feudal conquest of al-Andalus (10th-15th centuries), when Christian settlers introduced an economy specialized in vines and cereals, prioritizing the use of water mills for milling and irrigation purposes (Kirchner 2009; Torró 2006). Further extensions of existing irrigation schemes and the construction of new ones have continued to the present day. In a simplified way, two models of irrigated land can presently be found in Spain, which represent the two ends of a gradient. The first model is that of historical irrigated agricultural systems, usually located near springs or along river valleys. The second model is that of modern, business-oriented irrigated systems. However, their noticeable increase in the last decades has raised sustainability concerns (Martínez-Fernández et al. 2004).

The specific case study of Ricote is embedded in a region currently characterized by stable social and political conditions. Such conditions have greatly favored the development of full collaboration between stakeholders, including scientists, local authorities, specialized technicians, and agriculturalists.

Said that, challenges related to current and foreseeable climatic trends in Southeast Spain are observed in arid and semi-arid regions across the Mediterranean, including e. g. the Near East and sub-Saharan Africa. Likewise, the analyzed historical irrigated agricultural system is widespread across Mediterranean regions involved in the medieval westward expansion of the Muslim world, where it constitutes, to the present day, a cornerstone of local rural economies.

In this sense, insights gained in Ricote are of value in conflict-sensitive regions across the Mediterranean, where the consolidation of local rural communities and economies, leveraging on existing technical, cultural, and environmental assets, is of paramount importance to address some of the greatest challenges of the day, including climate-related distress, social unrest, and mass migration.

In this paper, after describing the historical evolution of Ricote, we proceed to identifying the main foreseeable challenges facing this agricultural and ecological system in the current context of climate warming, increasing water scarcity, rural depopulation, and energy regulations (FAO 2015; Iglesias et al. 2012). We then propose two sets of possible climate adaptation responses, information-driven and infrastructure-driven, considering their social and technological components (Crane et al. 2011; Howden et al. 2007). We end by discussing the potential of information-driven solutions within the framework of smart sustainable rural development (FAO 2013; Naldi et al. 2015; Thissen et al. 2013). Our discussion is framed in the recent understanding that potential solutions for improving water and land management should consider the social organization of water sharing, traditional knowledge about climate, agriculture and ecology as well as digital technologies with potential to facilitate water management tasks (Naldi et al. 2015).

Context and Methods

As case study, we scrutinize the historical evolution of the irrigation scheme of Ricote (Murcia, Spain), from its medieval origins to the present-day. The main strategy applied is case study research to capture distinctive traits in the evolution of the specific context of the Ricote irrigation system (Yin 2013). The village of Ricote (UTM

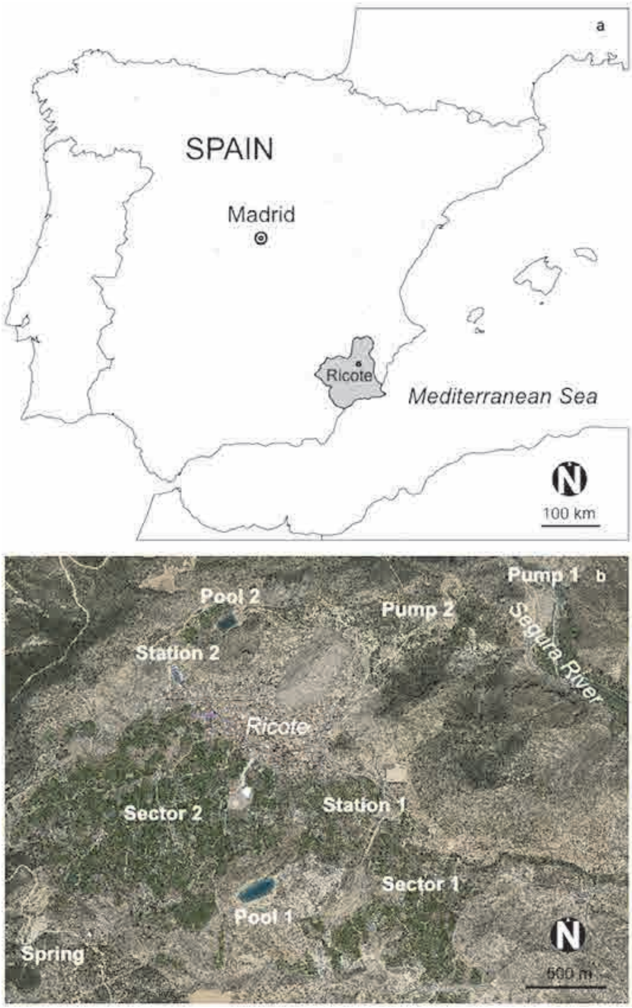

Figure 1: (a) Location map (Murcia region in grey), (b) orthophoto map of Ricote with approximate positioning of main components of the DI system schematized in Figure 3.

30S, 642980.39E, 4223751.54N, Murcia, Spain, Figure 1) and its associated cropland lie in a hoya, a flat basin surrounded by mountains, approximately 235–375 m above sea level (Puy 2014). It can be defined as a huerta. The term defines irrigated areas, many of them of historical origin, where traditional irrigation techniques have been used to tap water from rivers, springs, or underground. Traditionally, these open agricultural landscapes have been characterized by high crop diversity (Mata Olmo and Fernández-Muñoz 2004; Meeus 1995; Meeus et al. 1990). Together with four other villages found along the Ricote Valley, Ricote constitutes a comarca (consortium of villages), and has been recognized as one of the agricultural landscapes with the highest socio-economic, environmental, and cultural value in Spain (Egea-Sánchez et al. 2008).

Climate in Ricote is semi-arid. Average data, derived from the Climatic Atlas of the Murcia Region for the period 1971–2000, indicate average summer (JJA) temperatures of 25.5 °C (annual average summer maximum 31.1 °C) and average winter (DJF) temperatures of 10.2 °C (annual average winter minimum 5.4 °C). Annual potential evapotranspiration (PET) amounts to approximately 1350–1450 l/m^2 and annual average rainfall to 343.1 mm (Garrido Abenza et al. 2013) (Figure 2)[1]. Data from the local AEMET meteorological station La Calera (covering the period 1949–2015, excluding the incomplete series for 2007 and 2010) indicate that rainfall in the region is characterized by a significant annual variance, with lowest annual average rainfall of 140.4 mm recorded in 1970 and highest annual average rainfall of 884.4 mm recorded in 1989. This constitutes a standard deviation of 126.9 mm. Monthly variance in precipitation is also significant, with lowest monthly average rainfall of 3.9 mm in July and highest monthly average rainfall of 43.9 mm in December, i. e. a standard deviation of 11.8 mm.

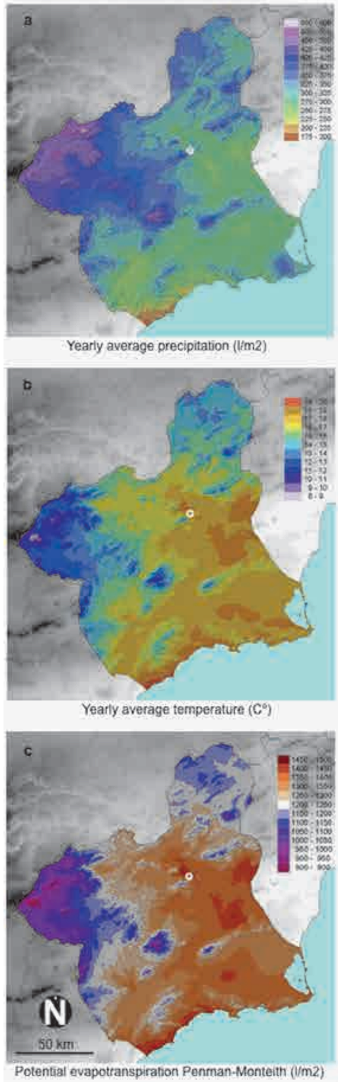

Figure 2: Climatic maps for Murcia region (the position of Ricote is indicated by the white circle).

The origins of the Ricote irrigation system in the Andalusian period (10th–13th centuries AD) have been defined using geoarchaeological, historical, and radiometric methods (Puy 2014; Puy and Balbo 2013; Puy et al. 2016a).

1 (a) annual average precipitation (l/m^2), (b) annual average temperature (C°), (c) potential evapotranspiration based on Penman-Monteith (l/m^2). Data source: AEMET Agencia Estatal de Meteorología. Ministerio de Agricultura, Alimentación y Medio Ambiente (State Meteorological Agency. Ministry of Agriculture and Environment).

Information on the more recent evolution of the Ricote agroecosystem has been retrieved from the study of the archives of the Comunidad de Regantes de Ricote (Ricote Irrigator Community). These documents include communications with the government, legal disputes, financial administration, technical reports, and minutes of regular internal meetings from 1957 to the present. Such archives provide, among others, information on water allocations to the community, infrastructure implementations, as well as energy and water requirements for irrigation. Regular participatory processes, including in-depth interviews with members of the irrigator community were conducted to complete and corroborate archival information, complementing the case study strategy (Boyce and Neale 2006). A participatory focus group was organized between members of the irrigator community and external experts to identify key challenges, strategies, and opportunities.

The historical evolution of the Ricote agricultural system

Historical irrigation schemes have been upgraded through time, consistently integrating available innovations and providing examples of human-environment interaction, human adaptation to external pressure, and sustainable development. In general, the size and complexity of the irrigation infrastructure shared by the Ricote Irrigator Community has increased over time. Successive hydraulic systems deployed in Ricote have all been characterized by their costly installation and maintenance, requiring the joint effort of the community. Water and water distribution systems have thus been historically managed in a participative way. In spite of possibly contrasting particular interests and conflicts, farmers have had to organize and agree on common strategies in order to implement successful irrigation schemes, as they do in the present day. The historical evolution of the Ricote agricultural system is summarized hereafter in terms of: (3.1) an extension of the irrigated area, (3.2) increases in volume of water available for agriculture, and (3.3) the implementation of water distribution systems.

Extension of irrigated area and crops cultivated

In the 10th-13th centuries AD, the initial irrigated area of Ricote extended over approximately 2 ha, and reached a surface of c. about 50 ha around the time of the feudal conquest of al-Andalus (completed in 1492 AD). Following further expansions, the irrigated area extended over 120 ha in 1614 AD (Puy 2014). In 1957, following the concession of water from the nearby Segura River the maximum extension of the irrigated area was set at about 190 ha. Of those, close to 30 ha were converted into constructible areas between 1957 and 2007. The extension of the irrigated area was further revised in 2007, integrating new land to reach the current maximum extension of irrigated cropland of 184.492 ha. In the second half of the 20th century, the irrigated area was divided into two approximately equal sectors: sector 1 and sector 2. Over this surface, Ricote counts with approximately 2400 parcels, distributed among roughly 600 landowners. As for crops cultivated in Ricote, historical texts revised by Puy (2014) inform us that plum, olive, apricot, orange, lemon, lime, fig and cherry trees, myrtle, grapevines, pomegranates, cedar, and alfalfa were cultivated between 1495–1505. By 1613, Ricote had specialized in cash crop production, and olive trees had become the primary crop along with mulberry tree for silk production. The current production of lemon trees as cash crop was initiated in 1962.

Increases in volume of water available for agriculture

Ricote has known successive increases of the overall volume of water available for agriculture. Since its creation, the Ricote agricultural system has relied on the perennial spring El Molino (390 m above sea level, Figure 1b), supplying a consistent flow of approximately 13 l/s, equal to a total of close to 410 000 m^3/year (García-Avilés 2000). Minor water points (including Paul, Balsas, Balsones) have subsequently been captured, potentially accounting for an additional 6 l/s. In addition, Ricote has a concession to withdraw up to 1 035 000 m^3/year from the nearby Segura River since 1957, granted by the Confederación Hidrográfica del Segura (CHS, Hidrographic Confederation of the Segura River), part of the Ministerio de Agricultura, Alimentación y Medio Ambiente of the Spanish Government (CHS 2016). Water allocated may vary on an annual basis depending on precipitation patterns and on political agreements. Water extraction began on 30 April 1962, when the irrigator community deployed a first pump (at about 135 m above sea level), which was replaced in 1982, and again in 2013. Virtually inexistent before the deployment of pumps, overall energetic consumption is now almost 982 762.29 kWh/year (i. e. nearly 1 GWh/year).

Implementation of water distribution systems

Over time, the construction of infrastructure regulating the timing and access to water in Ricote has promoted a similar evolution with regard to the access to increasing volumes of water. Since its creation, Ricote has relied on a dense and growing network of channels and water locks (Puy 2014) and on irrigation schedules to regulate access to water. Between the 17th century and the 1950s, 45 days elapsed before all users received

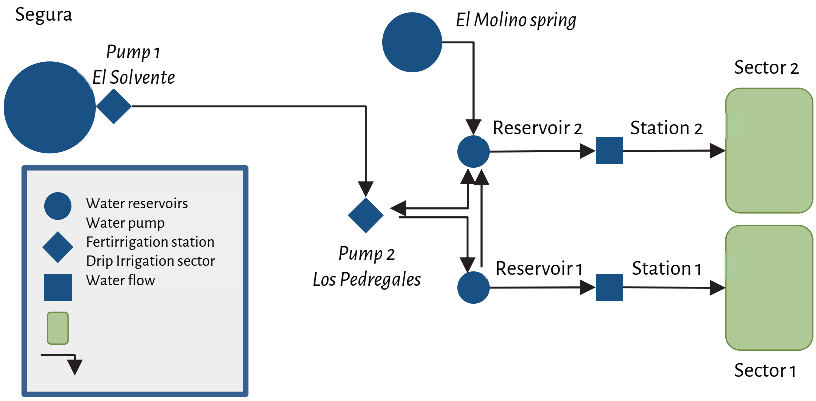

Figure 3: Scheme of the main components of the DI system in Ricote .

one turn of water from the local spring, i. e. until a full tanda was completed (Cabrera and Arregui 2010). Irrigation schedules run continuously and irrigators had to be available 24/7. A bifurcation of the main irrigation channel was implemented in the second half of the 20th century to halve irrigation times and to reduce night irrigation shifts. Since 1982, the community of Ricote posesses a water reservoir (Reservoir 1, Figures 1b, 3) with a capacity of 15 000 m³. In 2007, an additional water reservoir (Reservoir 2) with a capacity of 45 000 m³ was built. In parallel, a centralized electronic Drip Irrigation (DI) scheme was implemented (Figure 3). Nearly 90 % of the parcels in Ricote (1651 out of 1835) were equipped with DI in 2015 (Puy et al. 2016b). Irrigators who equipped their plots with the DI system discarded the traditional hydraulic infrastructure. Currently, water from the Segura River and from the local spring is accumulated in the local reservoirs and distributed to the fields through the DI scheme. DI schedules are planned on a yearly basis and all plots are served with water within the same day.

Two independent networks of pipelines, tubes, and emitters distribute irrigation water across the irrigations scheme: (a) Sector 1 to the West, (b) Sector 2 to the East. A total of 105 station-cabinets spread across the hydraulic system is equipped with consumption meters and mechanical and electronic devices to control counters and inform the irrigator community on breakdowns. The electrical network connects the station cabinets with the irrigator community computer.

The irrigator community computer regulates the functioning of the system, controls the station cabinets, and stores all data relative to consumption and land tenure.

A webpage and related mobile application for landowners affiliated to the irrigation scheme allows irrigators to remotely consult water consumption and other relevant information.

Foreseeable challenges

While improving the economic and working conditions of the local community, historical implementations of the Ricote irrigation scheme are showing possible underlying flaws and potential drawbacks in the face of current and forthcoming social and environmental challenges (Kummu et al. 2010; IPCC 2012; Tacoli and Mabala 2010). Repeated exchanges between members of the Ricote Irrigation Community, local policymakers, and external specialists led to the following catalogue of identified challenges for Ricote over the coming decades: (4.1) increasing water scarcity, (4.2) energetic dependency and CO2 regulations, (4.3) outmigration and loss of knowledge, and (4.4) technological and innovation dependency.

Increasing water scarcity

Over the coming decades, predicted climate change with increasing temperature and precipitation extremes, may jeopardize recent efforts and implementations made in agriculture, including the introduction of mechanical irrigation technologies such as DI (IPCC 2012). In the specific case of Ricote, which can be considered climatically representative for South Europe, modeling of future water availability for the Tajo-Segura River transfer system predict average water shortages of more than 20 % before 2050, accompanied by harsher dry extremes (Estrela et al. 2012; Garcia Galiano et al. 2015; Vargas-Amelin and Pintado 2014). In such scenario, any improvement in the efficiency of water use for agriculture is fundamental for irrigated schemes in drylands.

Energetic dependency and CO2 regulations

The lack of an international agreement since the Kyoto Protocol remains a source of uncertainty regarding the regulation of carbon emissions (Perdan and Azgapic 2011). For example, carbon regulations remain vague for the airlines industry (Engau et al. 2011), and the agricultural sector was explicitly not included in the European Emissions Trading System (EU ETS) (Brandt and Svendsen 2011). However, being responsible for an important portion of global CO2 emissions, the agricultural sector is a key subject of emerging mitigation regulation schemes (IPCC 2012). Specifically, irrigated agriculture has significant energy requirements that add to direct emissions, which deserve being assessed (Soto-García et al. 2013b). Taking advantage of the preexisting historical irrigation network plan, water distribution within the DI scheme of Ricote, from the water reservoirs to the fields through the two fertirrigation stations (i. e. irrigation stations distributing a mix of water enriched in fertilizers), relies mostly on gravity with negligible energetic requirements. However, a major energetic requirement concerns the extraction of pressurized water from the Segura River into the local water reservoirs. To this aim, yearly energetic consumption from the two water pumps and fertirrigation stations can be approximated to almost 1 GWh/year, alimented with electricity from the national grid. Such consumption implies CO_2 emissions of close to 381 311.77 kg/year (IHC 2011).

Outmigration and loss of knowledge

Rural-urban migration is a global phenomenon contributing to the aging of populations in rural areas (Tacoli and Mabala 2010), widely attested in Europe and Spain (Geraghty et al. 1998; Pinilla et al. 2008). Within this context, the agricultural community of Ricote is rapidly aging, facing serious challenges of a sustainable transmission and take-over of knowledge between generations. Ricote had a steady population of nearly 3000 inhabitants between 1900 and 1950, decreasing under 2000 in the 1980s, further steadily decreasing in recent years, and reaching a historical low in 2016, just above 1300 people (INE 2017).

External technological and innovation dependency

With the introduction of ever more mechanized and automated solutions, the dependency of the community on external know how has grown. At present, for example, one of the strongest external dependencies concerns the software used to manage the centralized DI control system. In fact, while most mechanical and electronic components of the DI system can be found in non-specialized markets, the software used in Ricote was specifically designed by the company responsible for the maintenance of electronic parts within the DI system. As a result, the community of irrigators is limited in its capacity to upgrade the DI control system and implement in-house low-cost developments.

Discussion: Strategies and opportunities for continued sustainability

Here, we combine the experience of local stakeholders and external experts to propose a first expert assessment of strategies and opportunities for the long-term sustainability of the historical irrigated agricultural systems in Ricote. While challenges in Ricote are similar to those faced by small agricultural communities in other Mediterranean regions and in drylands worldwide, further and case-specific assessments are required before implementation. Consultations between members of the Ricote Irrigation Community, local policy-makers, and external specialists led to the following catalogue of identified strategies and opportunities for Ricote over the coming decades: (5.1) reduce water dependency, (5.2) prepare the transition to low CO2 emissions, (5.3) fill generational and knowledge gaps, and (5.4) promote in-house innovation.

Reduce water dependency

Three strategies were retained for consideration in Ricote to counter increasing water scarcity.

Water savings using real-time meteorological information. We estimate that fertirrigation could be offset by approximately 7.5 %, by dynamically factorizing actual precipitation (which is 343 mm/year) into current agro-hydrological models and fertirrigation schedules. Such implementation would imply average annual savings of more than 52 500 m^3, i. e. 17 325 € considering current fertirrigation cost of 0.33 €/m^3 (0.23 €/m^3 for water and 0.10 €/m^3 for fertilizers). These estimates are obtained from current yearly water use for fertirrigation in Ricote of about 700 000 m^3/year, defined by agronomists for the predominant crop type lemon tree Verna on the assumption of zero precipitation. In order to allow the development of new dynamic agro-hydrological models, a local meteorological station is being developed that has the capability to send real-time data to the central computer controlling the DI system (Figure 3). The new agro-hydrological models will be designed in accord with end-users to systematically stop fertirrigation after concentrated precipitation events, following irrigation decision support system models developed elsewhere (Tapsuwan et al. 2014). Agronomists suggest that the shortage in fertilizers caused by these short interruptions in fertirrigation flow will have no negative effects on plant growth (Domingo et al. 1996).

Reduction of evaporation from the water reservoirs. We estimate that covering of the water reservoirs in Ricote could reduce water loss to near zero. This operation would however lead to only minor annual water and economic savings, up to 1.5 %, corresponding to 3450 €/year. Our estimates are obtained considering the approximately 1.5 ha surface of the two shallow (<5m deep) reservoirs in Ricote, for which average yearly evaporation is about 15 000 m^3, i. e. an evaporation of close to 1000 mm/year for semi-arid Mediterranean climates (Harwell 2012; Martínez Alvarez et al. 2008). Based on previous economic assessments for the deployment of shadecloth covers for agricultural irrigation reservoirs in the Segura River Basin, several years would be required to offset initial costs (Martínez Alvarez et al. 2009).

Increase in the capacity to capture and store rainwater. We estimate that the development of Managed Aquifer Recharge (MAR) would significantly increase the water storage potential for the irrigator community. However, assessing the full potential of a MAR scheme depends on an extensive hydrogeological evaluation of available groundwater reservoirs. Geoengineering assessments for the potential development of MAR have previously been undertaken in Spain to redirect excess runoff towards artificial sinkholes and to recharge the aquifer using surficial channels (DINA-MAR 2016). However, there has been no MAR project implemented so far in the Segura Basin to our knowledge. In addition, the possibility for rainwater harvesting is severely restricted by the Confederación Hidrográfica del Segura.

Prepare transition to low CO2 emissions

Two strategies were retained for consideration in Ricote to address energetic needs and related CO_2 emissions. However, a detailed assessment of direct and indirect emissions is necessary before implementing such infrastructure. Furthermore, such assessment would provide a clear anticipatory strategy for foreseeable but uncertain regulation (Engau et al. 2011).

Install solar panels on top of the existing water reservoirs. We estimate that Ricote's energetic requirements for agriculture could be offset with renewable solar energy by covering water reservoirs in Ricote with solar panels. Our first approximation suggests that covering the 1.5 ha of reservoir surface available in Ricote with solar panels would potentially produce up to 1.34 GWh of solar energy per year (Energy Manager Today 2016). Such production would offset current agricultural energetic requirements by approximately 0.34 GWh/year. Besides providing solar energy, this solution would reduce water loss through evaporation from the reservoirs, without implying loss of prime agricultural soil and forestland.

Design of an energy adaptation strategy. Considering that legislation is likely to be modified in the near future, the exercise of designing a full energy adaptation strategy provides an opportunity to capture the maximum amount of information on regulation processes and constraints, favoring a rapid transition when new carbon emission regulation appears. The first irrigated agricultural systems to implement such strategies will set the standard for irrigated agriculture schemes based on low CO_2 emissions. Nevertheless, current energetic regulations in Spain provide low incentives for renewable solar energy in the agricultural sector, hampering the coexistence of solar energy and the national grid energy.

Fill generational and knowledge gaps

Two potential strategies have been retained to address rural depopulation as well as intergenerational knowledge and information flow. They provide the opportunity to ease the training of the next generation of local stakeholders, reduce the loss of traditional knowledge (TK), and diversify the local economy based on the valorization of new ecosystem services (ES) (Berkes et al. 2000; Gómez-Baggethun et al. 2010; Martínez-Fernández et al. 2009, 2013).

Digital and participative mapping of the irrigated agricultural scheme. We estimate that the digitalization of local knowledge and information using available Geographical Information Systems (GIS) would help support decision-making while reducing the loss of information on land-tenure, water-management, and land-use. Digital mapping technologies could be used to train young administrative, management, and technical staff, an issue the community is facing due to the imminent retirement of several members of its governing body (Hossain and Sadat 2006). To this end, the records of the Irrigator Community are currently being merged with digital cadastral maps of the Ministry of Agriculture (SIGPAC 2016). This fusion of local data with digital mapping will remove one of the major drawbacks for generational takeover, i. e. the difficulty to visualize complex irrigated agro-ecosystems and underlying social, economic, and ecological processes. Overall, digital technologies facilitate community participation in decision-making and governance (Pérez et al. 2011), while strengthening risk awareness (Berkes et al. 2000; Copus et al. 2011; Dijkstra and Poelman 2008; Gómez-Baggethun et al. 2010). Potential applications of dynamic digital mapping include: (a) the critical management of land tenure transactions to reduce land fragmentation, land tenure, DI system complexities, and associated risks (Baños-González et al. 2015; Heider et al. 2018), (b) the planning of water management priorities in case of water shortage, e. g. establishing emergency irrigation patterns based on cultivar and soil characteristics, and (c) decision-making support for development planning, including e. g. the creation of visitor circuits or the definition of biodiversity conservation areas (Martínez-Fernandez et al. 2009).

Development of benefits based on supplementary ecosystem services (ES). We consider that, by providing facilitated access to information and enhancing overall information sharing, digital technologies will increase the community potential to develop new economic activities and benefits based on the development of supplementary ES. In the nearby huerta of Murcia, more than 30 types of ecosystem were identified, highlighting the potential multi-functionality of such agricultural and ecological landscapes (Gutiérrez González et al. 2015). These can be summarized in provisioning, regulatory, and cultural ecosystem services: (a) provisioning services, i. e. historical irrigated lands are very productive and possess a proven robustness in the face of changes in water availability (Pérez et al. 2011; Gutiérrez González et al. 2015). Such productivity can be oriented to the provision of quality food for the local market (Egea-Sánchez et al. 2008), (b) regulatory services, i. e. historical irrigated lands contribute to maintaining fertile soils, a non-renewable and scarce natural resource, particularly in arid and semi-arid climates (Martínez-Fernández et al. 2013). Moreover, these agricultural systems improve microclimatic conditions, a valuable service under current climatic conditions (Gutiérrez González et al. 2015), (c) cultural ecosystem services are a constituent of historical agricultural and ecological landscapes, preserving traditions and culture, functionalities that have been increasingly recognized in historical irrigated lands (Gutierrez González et al. 2015; Martínez-Fernández et al. 2013). These agricultural systems generate landscapes of high scenic value (Egea-Sáchez et al. 2008). Historical Mediterranean huertas may have lost part of their economic functionality (Rossi 1993, Vos and Meekes 1999), but measures for their viable and sustainable preservation have been taken, including e. g. the elaboration of a Red List of Threatened Mediterranean Landscapes (Rossi 1993).

Promote in-house innovation

At least two possible pathways were identified to address the shortcomings posed by external technological and innovation dependencies.

Integration of solutions involving low degrees of mechanization, low energy consumption, and the integration of traditional knowledge (Barnett and O'Neill 2013). The deployment of tried and tested solutions minimizes the risks of maladaptation, while ensuring low levels of external dependencies. Such solutions can be evaluated within a rich body of locally developed knowledge, made accessible through the development of digital repositories (5.3).

Training of local personnel. Local investments in the training of local youth in more technologically demanding solutions can significantly reduce dependencies on external technology while promoting innovation and qualified employment opportunities within the community. The implementation of water-saving strategies (5.1) would provide the necessary resources to internally fund such training. In the longer term, innovative start-ups can develop within the framework of smart rural solutions (Naldi et al. 2015).

Conclusions

Within the current context of modernization in irrigated agriculture, historical irrigated agricultural systems offer a unique opportunity for the study of the potential adaptive responses that small agricultural communities may consider in the face of foreseeable challenges affecting water consumption and food production in drylands around the world. Water shortages, climate variability, rural-urban migration, market competition, ageing of rural populations, and poor innovation could undermine the viability of historical irrigated agricultural systems. To address such challenges, we have used the case study of Ricote to explore solutions and opportunities aimed at sustaining irrigated agricultural systems that are attractive, viable, and resilient. Opportunities and solutions emerging from our specific context can be summarized in information-driven and infrastructure-driven. Infrastructure-driven solutions, such as solar power plants or MAR systems, require high initial investments. In contrast, information-driven solution, such as dynamic agro-hydrological models and relational mapping, can be implemented at low cost. Leveraging on existing knowledge, management, and governance structures, information-driven solutions have the potential to increase the responsiveness and flexibility of historical irrigated agricultural systems.

Based on the principle that knowledge and innovation are the driving forces for future viability, the emphasis of our work is on knowledge and information-driven innovations, facilitated by the use of digital technologies, for the preservation of local traditional knowledge, the development of sustainable and growth-oriented economic strategies, and the empowerment of rural communities. Acting on the governing rather than the biophysical limitations of irrigated agro-ecological systems, information-based solutions (i. e. smart solutions) show the highest potential for adaptation and flexibility in the face of change. Such solutions increase autonomy and capacity for self-organization within communities, critical attributes to develop dynamic coping mechanisms in a timely way. In addition, they support a bottom-up approach toe governance, bringing existing knowledge and endowments in rural communities to the forefront of smart and sustainable development solutions.

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9 Sustainable access to rural and urban land by integrating local perspectives

The potential of using Information and Communication Technologies

Juan Miguel Rodriguez Lopez, Katharina Heider, Andrea L. Balbo, and Jürgen Scheffran

Abstract

With fast growing human populations over the past decades, access to land has become an increasingly pressing issue. This is the case in urban as well as in rural spaces, and across both emergent and established economies. In this context, the management of land use and land ownerships, formal as well as informal, is of primary importance. Specifically, the balanced partition of land between public space (commonalities) and private property plays a key role in the achievement of sustainable land access policies. In this study, we explore the potential of Information and Communication Technologies (ICT) to promote stakeholder participation and achieve sustainable access to land. Based on research in two case study areas, we show that transdisciplinary ICT-based tools can help us and the local stakeholders to identify specific needs, capabilities and potentials, to analyze emergent patterns and to support the development of place-specific sustainable development strategies.

KEYWORDS: *Rural-urban spaces, sustainable access, participatory approach, Geographic Information Systems (GIS).*

Introduction

Based on our research experience in urban and rural contexts, in established as well as in emergent economies, we here advocate the potential of using Information and Communication Technologies (ICT) to promote stakeholder participation in the definition of innovative regulations for the access to land (Figure 1, Table 1). Our experience focuses on the use of Geographic Information Systems (GIS), which have become ubiquitous across the public and private sectors over the past two decades (Brown 2015; Garson 2003; Janssen 2017). Furthermore, we focus here on Volunteered Geographic Information (VGI) as a tool to promote participatory land use planning and monitoring to integrate the local perspective. The overarching scientific question for our research is how to use ICT to achieve a sustainable access to land. We examine two case studies where the access to and use of land is problematic.

In the following, we examine two case studies where the access to and use of land is problematic. The first case study is located in a conservation zone in the south of Mexico City. Here, informal urbanization is a major issue for urban as well as for ecological planning. This example links directly to the Sustainable Development Goal (SDG) 11: "Make cities and human settlements inclusive, safe, resilient and sustainable". In particular, it deals with a lack of inclusive and sustainable urbanization as well as a lack of participatory, integrated, and sustainable human settlement planning and management. Furthermore, safe, inclusive and accessible, green and public spaces are endangered by informal urbanization and its consequences (Table 1).

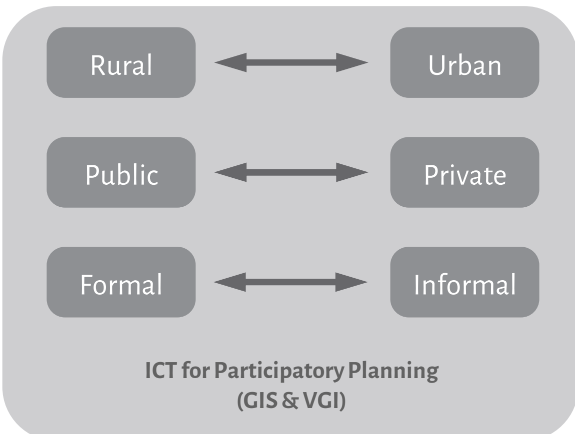

Figure 1: Contrasting tensions in access to land.

Sustainable Development Goal	Targets
2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	2.3. By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists, and fishers, including through secure and equal access to land, other productive resources, and inputs, knowledge, financial services, markets, and opportunities for value addition and non-farm employment. 2.4. By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding, and other disasters and that progressively improve land and soil quality.
11: Make cities and human settlements inclusive, safe, resilient and sustainable	11.1. By 2030, ensure access for all to adequate, safe, and affordable housing and basic services and upgrade slums. 11.3. By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated, and sustainable human settlement planning and management in all countries. 11.7. By 2030, provide universal access to safe, inclusive, and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.

Table 1: Sustainable Development Goals 2, 11, and specific targets. Source: UN 2017

The second case study represents an example from a rural area. This area is located in Ricote in the southeast of Spain. Here, the fragmentation of private agricultural parcels is problematic for sustainable and efficient land use. This example is connected to SDG 2, in particular to the promotion of sustainable agriculture and the target to double the agricultural productivity and incomes of small-scale food producers through secure and equal access to land and sustainable food production systems (Table 1).

Integrating local perspectives in two case studies

Case study 1: Informal urbanization in the conservation zone of Mexico City

In our first case study, we investigate informal urbanization in the conservation zone in the southern part of Mexico City (Heider et al. 2018a; Rodriguez Lopez et al. 2015, 2017a, 2017b). In Mexico, most of the population lives in cities with 80 % urban population (United Nations Population Division 2017). Informal settlements and poor neighborhoods comprise a large part of the newly built-up area (Rodriguez Lopez et al. 2017a). The aim of this part of the analysis is a comprehensive, robust, and valid research of urban dynamics as well as the examination of potential opportunities and future scenarios in both ecological and social aspects.

We propose an evaluated multi-method approach to better understand urbanization dynamics combining data provided voluntarily by individuals (VGI) as well as satellite data and official data (Figure 2, Rodriguez Lopez et al. 2017a, b). We use two forms of VGI in our studies: First, VGI in the form of complaints about informal settlements in Mexico City (Heider et al. 2018a; Rodriguez Lopez et al. 2017a) and second, OpenStreetMap data (Heider et al. 2018a). We describe this approach as a combination of human and remote sensing (Rodriguez Lopez et al. 2017a). Using this data, we perform a hot spot analysis of informal urbanization. The use of human sensing data allows the integration of local perspectives. Remote and human sensing are presented as important new sources of information, but several practical questions arise about the trustworthiness of these sources, which we address in more detail in our articles (Heider et al. 2018a; Rodriguez Lopez et al. 2017a).

The most important results of this case study in terms of a sustainable access to land and a sustainable management of property rights are: 1) Human and remote sensing data work well together and human sensing data can be used to integrate a local perspective promoting integrative management options (Heider et al. 2018a; Rodriguez Lopez et al. 2017a). 2) The main urbanization hot spots are found near the border of the conservation zone of Mexico City. 3) There is a strong correlation between the occurrence of informal urbanization hot spots and socioeconomic factors (Rodriguez Lopez et al. 2017a). 4) Access by roads from and to the city center is likely to be a major factor for informal urbanization in the conservation zone (Heider et al. 2018a).

It was necessary to investigate the driving forces behind this urban growth that usually leads to the loss of ecological areas in the urban periphery. In these places, low-carbon urbanization could be an important mitigation strategy. For example, the monetary compensation for mitigating emissions could create an opportunity for the

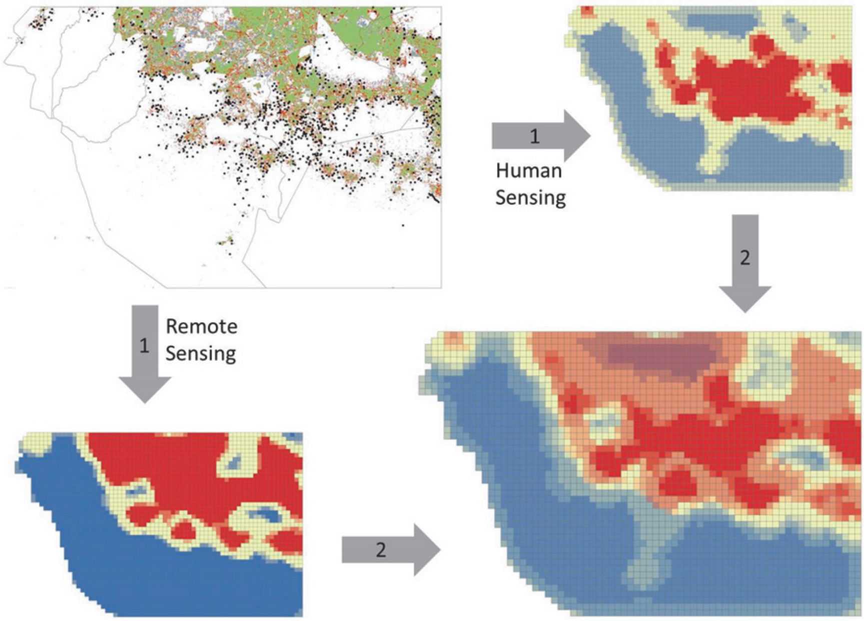

Figure 2: We combine information on urbanization from remote sensing (red pixels, map above left) and information on informal settlements from human sensing (black points, map above left) to detect informal urbanization patterns (steps 1 and 2) in a framework of hot spot-analysis Source: Source: Rodriguez et al. 2017a.

local population by empowering them with an asset of clear property rights and land distribution. In any case, it is a possibility and, at the same time, a risk for informal settlers to make use of their rights to achieve a life in dignity.

Our policy proposals are committed to an inclusive development towards sustainable urbanization, integrated planning. This includes the provision of green spaces and the mitigation of emissions (Table 1). In this context, it is fundamental for policy makers to understand the process of informal urbanization in order to manage this urban expansion. No solution for informal urbanization can be found without meeting the needs of the poor. As long as no affordable living space for the poor is available, informal settlements will continue to grow. Regarding urban planning, we argue that informal urbanization hot spots occur mainly close to major roads that enable access to the city or near existing settlements. Therefore, building social housing far away from the city and from jobs without proper public transportation (as happened in the past, see Connolly 2009) will not solve the problem of informal urbanization in the conservation zone.

Mexico City represents a case study area, in which similar characteristics are present that can be applied to other medium to large cities in developing countries in the coming years. These urban spaces represent a possible future for the urbanization processes in Africa and Asia since the urbanization rate in many cities of both continents is likely to increase rapidly (Davis 2004, UN-HABITAT, 2003, 2012a, 2012b, 2016). The proposed method could be readily used in these regions as well. However, there is a limitation concerning the existence of human sensing information in the form of georeferenced data on conflicts across different scales. Remote sensing data is available for a large number of countries and years, and although it is not always available free of charge, access to this data has become easier. Moreover, this research provides opportunities for the application of new forms of "big data" such as microblogging (e. g. Twitter).

Case study 2: Land fragmentation of historical field systems in Ricote, SE Spain

The second case study has a distinct rural perspective. Here, we focus on the excessive land fragmentation of historical field systems in Ricote, southeast Spain. One of the major issues affecting efficiency in communities of small farmers is the high fragmentation of agricultural land properties and the Valley of Ricote is a typical case for smallholder farming in highly fragmented traditional field systems in the Mediterranean region.

Although the clear definition of property rights is one of the most prominent solutions to the tragedy of commons (Hardin 1968, 1989), privatization can lead to high property partition due to heritages. This is problematic for overall efficiency as higher fragmentation of properties leads to increased transaction costs (Williamson 1981), for example, in the form of required infrastructure or distances that need to be traveled. In other words, if unregulated, the property rights solution for the tragedy of commons could generate a tragedy of property, similar to the "tragedy of the anticommons", which leads to non-use instead of over-use in the case of the tragedy of commons (Heider et al. 2018b; Heller 1998).

In this case, we apply a more transdisciplinary approach in southeast Spain including local stakeholders to address a sustainable social ecological system (Eriksson et al. 2014). The advantages of this approach concern the quality and durability of research (Reed 2008). Participation of local stakeholders encourages the success of the decisions made and promotes new forms of cooperative work (Richards et al. 2004, Stringer et al. 2006), which is a central goal of the project. This project should be seen

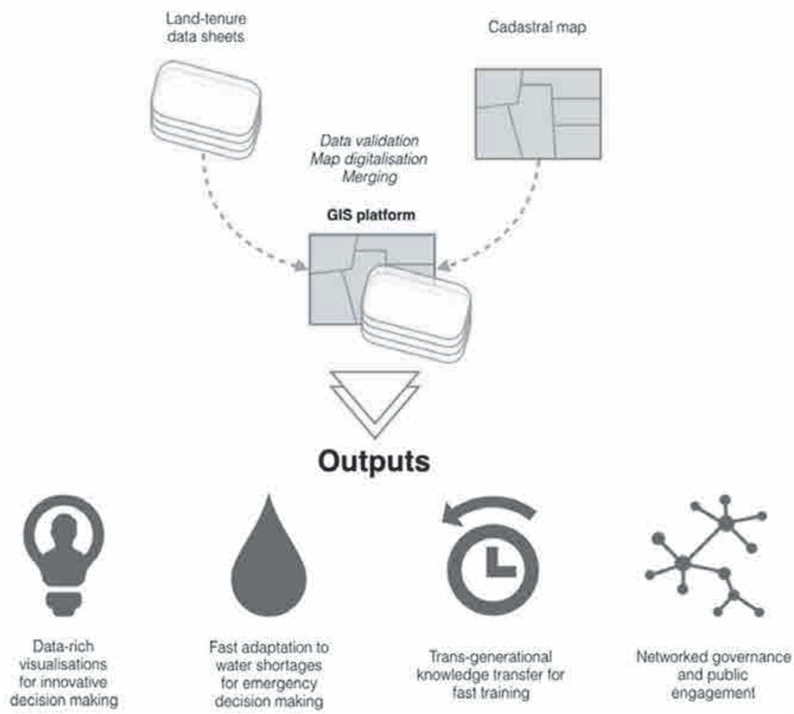

Figure 3: The concept of the GIS platform. Source: Heider et al. 2018b; icon credit: the Noun Project.

as a result of co-design of researchers with local stakeholders in order to understand the needs of the community, exchange knowledge, integrate local expertise, cooperate, and create acceptance for place-based sustainable solutions (Levidow et al. 2014; Reynolds et al. 2014; Scheffran and Stoll-Kleemann, 2003).

A science and stakeholder meeting took place in June 2017 in Ricote as a part of the stakeholder dialogue, on which we have relied on since the beginning of our research in this area in 2010. Members of the Irrigators' Community, politicians, and farmers of Ricote represented the core of the stakeholder group. After defining the priorities and possible pathways for sustainable development with local stakeholders, we introduced a GIS platform (Figure 3) as an interactive map for the community of Ricote (Heider et al. 2018b). The introduction of free and open source digital mapping technologies is suggested to alter efficiency in agriculture enabling in-house experimentation and implementation (Janssen et al. 2017; Wolfert et al. 2017). Moreover, one of the needs highlighted by the local community was that of reducing land fragmentation, thus, promoting monetary savings (deployment and maintenance), and management simplification without weakening the stability of the system (Heider et al. 2018b).

The community has used the GIS platform as the basic tool to explore possible pathways for a sustainable land management and we applied a GIS analysis to assess land fragmentation in the specific context of drip-irrigated agriculture as result of our stakeholder workshop in 2017. Within this analysis, we developed a Fragmentation Index for Drip Irrigation and Distance Assessment (FIDIDA). FIDIDA quantifies farms considering their transaction costs. Based on these costs, FIDIDA brings together mean plot size, degree of separation (i. e. number of parcels per farm) and degree of dispersion (i. e. standard distance between parcels) of land parcels on farm level. FIDIDA generates a new hierarchy of farms that shows possibilities to reduce costs, time and to mitigate emissions by reducing the traveling distance between plots. The index can be used to compare the individual fragmentation of farms or the land fragmentation between different study areas. The definition of FIDIDA aims at supporting the management of reasonable land fragmentation thresholds in the context of communities made of traditional small farms, while suggesting possible pathways for a gradual inversion of land fragmentation trends through voluntary plot fusion where necessary (Heider et al. 2018b).

Further applications of the GIS platform in cooperation with local stakeholders (Figure 3) are planned. We believe that digital technologies have the potential to produce jobs in the countryside, which contributes to reach the targets of SDG 2.3 (Table 1). Furthermore, these technologies counter the loss of knowledge by the digitalization of information. In particular, GIS opens new planning possibilities for emergency water management, collective actions for the control of parasites, planning of ecological agriculture and tourist activities as well as the conservation of traditional knowledge (Figure 3) contributing to a more sustainable agriculture and an increase of income for farmers (SDG 2.3, Table 1).

Conclusions

In this article, we investigate the role of ICT for a sustainable access to land in two case studies. The first case study area in the south of Mexico City is located in an urban setting and describes a public space, in which informal urbanization prevents sustainable access to green spaces and challenges urban as well as ecological planning and management. The second case study area of Ricote is located in a rural setting in the southeast of Spain. It is characterized by a high fragmentation of small agricultural private properties, which leads to limited access to land as well as inefficient and unsustainable land use.

We have seen in these case studies that access to public space in Mexico City is easier and more informally regulated, while the usage of private space in Ricote is prohibited for non-owners. Thus, public space is more exposed to unsustainable usages. Nevertheless, excessive privatization of space can lead to equally unsustainable land use practices, as observed in Ricote. Although in our research cases a conflict of public space occurs in an urban area and a conflict of private space in a rural area, we do not understand these as fixed allocations. Problematic access and use of land can occur on every stage of the rural-urban continuum.

Our transdisciplinary approach proposes the exploration of the potential of ICT to integrate local perspectives and contribute to a more sustainable access to and usage of land. By using ICT in form of VGI (human sensing), a local perspective to locate informal urbanization hot spots in the conservation zone of Mexico City was added, making it possible to identify its drivers. Next to socio-economic factors, we assessed major roads as an important factor for the occurrence of informal settlements in the conservation zone of Mexico City. Human and remote sensing data work well together and human sensing data can be used to integrate a local perspective contributing to integrative management options connected to SDG 11 (Table 1). However, we argue that for sustainable management of property rights, causes and consequences need to be further investigated and research should be open to use new data forms like VGI promoting "bottom up" before "top down" approaches.

The development of transdisciplinary ICT-based tools can help us and the local stakeholders to identify specific needs, capabilities and potentials in different regions (Mediterranean Region, Latin America, and Middle East), to analyze emergent patterns and to support the development of place-specific sustainable development strategies. In order to find these strategies, it is a precondition to include local stakeholders and local knowledge in research.

This is shown in the Ricote case study. Local stakeholders participated from the beginning. In a workshop, they identified their needs. They wanted to address the problem of severe land fragmentation within farms. Thus, a GIS-analysis of land fragmentation in Ricote is our first attempt to support the development of place-specific sustainable development strategies and contribute to sustainable agriculture (SDG 2, Table 1). Moreover, to support in-house innovation, we introduced GIS techniques to the local smallholder community (Naldi et al. 2015; Heider et al. 2018b). The aim is to understand the biophysical as well as the cultural, social, and economic parameters, on which sustainable solutions in rural areas may be built. GIS techniques can help to plan and implement them. As we show in the example of our project in Ricote, local stakeholders need to be included in research as well as management approaches from the beginning to include local knowledge and find solutions in a framework of co-design and co-development.

In current research, we continue to work with SDG 2 (Table 1) and investigate sustainable agriculture in southeast Spain. One question that arises in the context of smallholder agriculture in the historical field systems of the Valley of Ricote is how to support the conservation and re-activation of traditional agrarian landscapes. These landscapes represent the outcome of a continuous co-evolution of humans and environment, which result in a stable and resilient system. In the past, farmers used traditional irrigation technologies like water wheels to transport water to the various heights of terraces. These technologies produced low emissions (Closas 2014) and characterize the landscape of the Valley of Ricote until today but they are hardly in use any more. However, they could be a part of a sustainable rural development strategy mitigating emissions and promoting rural tourism, thus, contributing to an increase of smallholder income and non-farm employment (SDG 2, Table 1).

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10 Drought, flight, conflict: "climate migration" as a driver for conflict?

Christiane J. Fröhlich

Abstract

So-called "climate migration", i. e. human mobility following prolonged drought periods, floods, or other climate-related environmental changes, has been singled out as an important factor connecting climate change effects and (violent) conflict. However, the existing studies on this relationship do not offer a clear picture. Nevertheless, Syria has evolved into a "show case study" for this assumed linear causality: A "century drought" and ensuing internal migration are seen as an untold prequel of the Syrian uprising. This alarmist, determinist, and simplifying image is questioned and reviewed in order to answer the following questions: Was the Syrian drought related to or caused by climate change? Which role, if any, did it play for internal migration in pre-revolutionary Syria? What do we know about "drought migrants" and their role in the Syrian uprising? The article summarizes available research and adds to it by way of interviews with Syrian refugees.

Keywords: Drought, climate migration, climate change, conflict, Syria.

Introduction

The hypothetical connections between anthropogenic climate change, violent conflict, and migration have garnered a lot of attention over the years. The common argument is that in the absence of adequate adaptation measures, the impacts of climate change, such as droughts, storms, heatwaves, floods, and sea-level rise, can be expected to create additional risks for livelihoods, especially among already poor and marginalized parts of a population. Such increased livelihood insecurity is then assumed to stimulate migratory movements to presumably safer or wealthier places (Abel et al. 2019), most obviously when areas become permanently uninhabitable, for instance due to sea-level rise (Klepp 2017; McNamara et al. 2016). Such migration processes are then often assumed to potentially fuel discontent and violence in receiving areas (Braithwaite et al. 2019; Ide 2015), especially when crossing from the Global South to the Global North (Ceccorulli and Labanca 2014). What is more, livelihood insecurity and resource scarcity are also hypothesized to result in higher inequalities and grievances, and hence a higher risk of armed conflict (Hsiang et al. 2013; Burke et al. 2009). Further, researchers are concerned that climate change facilitates a deterioration of the governance capacities of formal and informal institutions (Gleditsch 2012; Scheffran et al. 2012). The potential resulting unrest is often assumed to trigger additional migration flows. However, there are few systematic studies assessing these different causalities and securitization processes (Raleigh 2010; Raleigh et al. 2010; Reuveny 2007, 2008; Oels 2012).

This article singles out human mobility as a prominent assumed mediating factor between climate change on the one hand and conflict escalation on the other focusing on the Syrian case, which has become an often-cited case study of the climate change-migration-violence nexus. The debate on the relationship between the three phenomena is still not settled (Kelley et al. 2015; Selby et al. 2017; Ide 2018; Selby 2019). Drawing on interviews conducted in September and October 2014 in the Jordanian refugee camps Azraq and Zaatari as well as the Northern Jordanian cities Irbid and Ramtha, the paper reviews the assumed causalities between climate change and migration in the Syrian case.[1]

[1] In 30 semi-structured interviews with Syrian farming families from different governorates, I discussed local impacts of the drought, the extent and repercussions of internal migration, the role of migrants and non-migrants in the Syrian uprising, and the overall role of climate change impacts for the political protests, among others. Interviewees included non-migrants who had worked with/employed migrants as well as (a fewer number of) migrants, wage workers and large-scale land owners, activists, and people who did not participate in the protests. I spoke to both male and female heads of households.

Climate migrants as protestors? The case of Syria[2]

The Syrian Arab Republic, as most of the Middle East and North Africa, has been suffering from long-term environmental changes, which are likely to be linked to anthropogenic climate change. In particular, an extended drought period from 2006 to 2009 entailed consecutive crop failures in parts of the country, loss of livestock, and a noticeable increase in internal migration (Selby et al. 2017; Ide 2018). For many commentators, this complex concoction of circumstances partly explains the timing and intensity of social upheaval in Syria (Werrell et al. 2015; Kelley et al. 2015; Bawden 2015; Friedman 2013). From the United States government (White House 2015) to the European Union (Juncker 2015), from US-American to European think tanks (Werrell et al. 2013; Rüttinger et al. 2015), this assumed prelude of the Syrian revolution is continuously gaining traction.

Migration decisions, however, are complex and not determined by environmental factors alone. Scholarship has identified five main drivers for (internal and international) human mobility (Black et al. 2011a, b), namely economic, political, demographic, social, and environmental factors, which are deeply interconnected and mediated through socially, politically, and economically determined institutions and structures. Migration also is not a new phenomenon in Syria. What is more, the securitization of (climate) migration needs to be critically assessed against the facts of global migration flows (Oels 2012). As mentioned above, migration is often seen as a security issue per se, especially with regard to migration to the Global North. With the impacts of climate change become increasingly visible, alarmist discourses about climate migrants are on the rise (Abel et al. 2019). However, it remains disputed how many people will leave their habitat due to climate change: So-called maximalists assume a simple, direct relationship between migration and climate change and thus project comparatively large numbers. Minimalists, on the contrary, underscore the complex nature of migration decisions and stress the respective society's vulnerability and adaptive capacity as major factors for reducing the expected number of climate migrants (Suhrke 1994; Castles 2002; Morrissey 2009; Gemenne 2011; Morrissey 2012). Moreover, orchestrating popular protest requires social networks built on trust and at least some kind of organizational structure (McAdam et al. 1996; Tarrow 2011; Diani and McAdam 2003a; Chesters and Welsh 2011). It remains unclear how new migrants, often living below the poverty line, can initiate large-scale, long-lasting popular uprisings, especially in repressive autocratic regimes like Syria.

This paper analyses the complex migration decision-making in Syria before 2011. It concludes that while climate change effects in Syria are real, and were indeed one of several reasons for internal migration prior to the conflict, they were certainly not the

2 The following is based on Fröhlich (2016).

only, let alone the main reason for the outbreak of the uprising. The paper interrogates the conditions for initiating social protest in autocratic regimes and complicates the relationship between climate change effects, internal migration, and conflict.

Environmental drivers

There is little doubt that climate change effects in Syria are real. In the last 20 years, ten of the driest 12 winters worldwide occurred in the countries surrounding the Mediterranean Sea (NOAA 2011; Hoerling et al. 2012). NOAA's Earth System Research Laboratory concludes that the magnitude and frequency of the drying is too great to be explained by natural variability alone. Nevertheless, it is worth noting that droughts and rainfall variability have been quite common in the region, as the instrumental record shows. It is also not contested that internal migration following a prolonged drought period 2006–09 led to an increase in internal migration, especially from the Northern governorates to the South and the coast; the most commonly cited figure is that of 1.5 million for the period of the drought, but these are estimates only: exact numbers are scant. In 2010 alone, 50 000 families supposedly set off from the North (Worth 2010; Werrell et al. 2015; Gleick 2014) to the cities, mainly due to environmental drivers of migration, as the common argument has it. In order to better understand the drought's impact on the scale and patterns of migration before 2010, however, a look at changes in natural resource availability, especially land and water, as well as intersections with other migration drivers seems useful.

Syria is roughly as big as Spain, but only around 25 per cent of its 185 000 square kilometers are arable land – about the size of Switzerland. Most of Syrian land is desert, some is suitable for grazing, but less than 10 per cent of the surface is permanent cropland.[3] Between 2002 and 2008, Syria's total water resources declined by half, partly through overuse and waste (Gleick 2014; Feitelson and Tubi 2017). In 2011, Syrians had access to just 325 m^3 of water per capita from internal renewable freshwater resources, a number which has been declining for decades (in 1987, it was still 627 m^3)[4], and which is a far cry from the UN scarcity level of 1000 m^3. Ground water resources have long been overused, while Turkey and Iraq have gradually reduced the flow of the Euphrates since the mid-1980s. One interviewee from Deir az-Zur explained the following: "Of course there were changes when Hafiz al-Assad severed the connection to the river in 1986. Something happened between him and Turkey,

3 Cf. http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country_profile&CCode=SYR, last accessed 10 December 2015.

4 World Bank, "Renewable internal freshwater resources per capita (cubic meters)", http://data.worldbank.org/indicator/ER.H2O.INTR.PC/countries/TN-LY-SY-1A-1W?display=graph, last accessed 10 December 2015.

so that he severed that connection. It was about fresh water and they ended our access to the river. Before 1986, it was very good. The people lived, if not from the land, then from fish, from the water" (Interview Zaatari, 28.9.2014). More and more small-scale landholders and agriculturalists depended on rain-fed agriculture, making them particularly vulnerable to weather extremes, drought and precipitation variability. Moreover, misuse and mismanagement of old and new irrigation systems gradually generated infertility in the soil, and unintended consequences of big dam projects caused negative impacts on the ecosystem.

Overall, the limited availability of water, together with bad governance in the natural resource sector, resulted in only 13 500 square kilometers of land being irrigated in 2010, with agricultural production falling considerably (Polk 2013). At that time, the overall population had reached 21.5 million; equaling 0.86 hectare (ha) of arable land per person, of which only 0.062 ha could be irrigated in 2010 due to the drought. The FAO defines the absolute minimum of arable land to support one person to be 0.07 hectares, assuming a largely vegetarian diet, no land degradation or water shortages, virtually no post-harvest waste, and farmers who know precisely when and how to plant, fertilize, irrigate etc. (FAO 1993). In the case of increased water scarcity, rainfall variability, and dust storms, the probability of failing crops and/or decreasing agricultural production tends to rise. In such a context, 0.062 ha are a very small amount of land, especially in a country, in which a high percentage of livelihoods still depends on agriculture. In 2002, more than 30 per cent of Syrians had been employed in agriculture; eight years later, this number had been halved in the overall workforce.[5]

In a nutshell, environmental pressure indeed seems to have been rising, but was also exacerbated by unsustainable governance. Moreover, environmental drivers often operate through non-environmental causes (Hugo 2013). A migrant who moves because he can no longer sustain himself through agriculture as a result of drought and ensuing land degradation will often categorize the reasons for his movement as economic, not environmental. This entails what Castles (2002) has termed "conceptual fuzziness". It is rather difficult to determine the extent to which the environment has played a role in a specific migration decision, unless migration has followed a fast-onset environmental event like a flood. This paper therefore suggests that the outcomes of environmental drivers – migration, displacement and immobility (Black et al. 2013) – are best understood as being embedded in their associated socio-economic, political, and demographic processes.

5 World Bank, "World development indicators – employment in agriculture (% of total employment)", http://data.wordbank.org/indicator/sL.AGr.empL.Zs/countries/1W-LY-tn-eG-sY?display=graph, last accessed 10 December 2015.

Economic drivers

Economy-related phenomena have substantial effects on migration decisions. The term economic drivers refers to differences between income levels in the origin and destination areas as well as to income variability in the originating areas (Lilleør and Van den Broeck 2011). Economic hardships like unemployment and poverty are among the most prominent examples. According to a study by the European University Institute (Aïta 2009), which critically assesses official Syrian data sets as well as data gathered by international bodies like the UN and the International Labour Organisation (ILO), the Syrian state only created around 36 000 new jobs per year between 2001 and 2007, with the agricultural sector losing 69 000 per annum (Aïta 2009, p. 5). At the same time, Aïta estimates the overall unemployment rate in Syria to be 30.3 per cent in 2007 (including Palestinians, non-citizen Kurds and Iraqi immigrants), translating into the need to create 353 000 jobs per year if the unemployment rate were to drop to 11 % by 2015 (Aïta 2009, p. 22). The government's 10th five-year-plan had been to reach 8 % unemployment by 2010 (State Planning Commission 2005).

Thus, employment seems to have been a very serious issue in the Syrian economy long before the drought began. Modernization, rapid de-peasantization and slow replacement of agricultural employment with waged work in industry or services in the formal sector had taken their toll on both rural and urban environments. While the loss of working-age population to urban spaces had slowed down productivity in rural areas, production in urban areas did not rise fast enough for a sustainable urbanization. Referring to Dar`a, where he worked in the early 2000s, a farmer from Deir az-Zur felt that, "Young people like me just wanted to work. They wanted to live. We had nothing to do and were smoking the whole day" (Interview Zaatari 28.9.2014).

Macro-economic policies of the Syrian government, which for decades had regulated agricultural crops, served as another economic push factor. The government's numerous five-year and annual production plans had specified areas for crops, the types of crops to be planted as well as crop rotation patterns, effectively imposing a state-led system on the agricultural sector, beginning in the mid-20th century. This agricultural policy was defined by subsidies for farm inputs and fuels, especially for strategic crops such as wheat, cotton, and barley. A report by Olivier de Schutter, the Special Rapporteur for the Right to Food to the UN, explains this with the national goal of reaching self-sufficiency of main staples in order to achieve food security (De Schutter 2011, p. 15). Ensuing changes in traditional land and agricultural regimes had a detrimental impact on both the productivity in general and the income of already marginalized parts of the population, like small-scale landowners. At the same time, state-led structures introduced strong dependencies into the agricultural sector that were to become liabilities when Bashar al-Assad started to deregulate the

Syrian economy into what the 10th five-year-plan calls “an open competitive economy”[6].

Bashar al-Assad began his first term in 2000 with a speech focusing on reform as his vision for Syria’s further development, and started out addressing the numerous challenges facing Syria by introducing political, economic, and administrative reforms. Overall, this “fresh start” was met with hope and enthusiasm by the Syrian population, but even more by outside observers who especially applauded the neoliberal deregulatory plans of the new government. However, the reforms were half-hearted at best: Bashar al-Assad introduced economic reforms that promoted better tax collection and the reduction of subsidies but failed to address the endemic corruption and the lack of public accountability. While the limited economic reforms are considered responsible for the improvement in growth rates as well as for finding a substitute for decreasing oil revenues (see below), they did not create a diverse and sustainable economy, which would have been necessary to address the above-mentioned deficiencies in the labor market.

Moreover, an economy that had been based on rents from the oil sector started to give way to demographic pressures, a decrease in oil-production, depleting oil reserves, and economic stagnation. These led to an overall decreasing standard of living. Syria’s oil resources (conventional production), which had peaked in 1996, began to place a pronounced and continuous strain on the Syrian economy since the early 2000s. The country’s oil production rate plummeted from approximately 580 000 barrels a day in 1996[7] to around 369 000 barrels per day in 2007[8]. Profits from this sector continuously decreased and added to the fiscal deficit, leading to a cut in fuel subsidies in May 2008 – at that time consuming 15 per cent of the Syrian GDP[9]. The price of petrol tripled (some say quadrupled) overnight, amplifying the pressure on food prices. Since fuel is required to operate water pumps, the rising petrol price led to a rise in water prices, which in turn impacted food prices. However, the drought had already begun to take its toll, adding to a rather strained situation in the food market and the water sector, to say the very least. These economic factors contributed to more and more Syrians needing to diversify their income, often necessitating migration from rural areas to the cities.

6 Cf. http://planning.gov.sy/en_index.php?act=552&cat=172, last accessed 10 December 2015.

7 Equalling approximately 81.2 kilotons per day, see International Energy Agency (IEA), http://www.iea.org/statistics/statisticssearch/report/?year=1996&country=SYRIA&product=Balances, last accessed 10 December 2015.

8 Equalling approximately 51,7 kilotons per day, see International Energy Agency (IEA) http://www.iea.org/statistics/statisticssearch/report/?country=SYRIA&product=balances&year=2007, last accessed 10 December 2015.

9 Cf. http://www.irinnews.org/report/79006/syria-bread-subsidies-under-threat-as-drought-hits-wheat-production, last accessed 10 December 2015.

Socio-political and demographic drivers

Among the most prominent socio-political drivers of migration are political violence, war, discrimination, and persecution. Not unlike other authoritarian states, Syria under Assad rule endorsed the simple formula "loyalty for patronage" (Ghrawi 2015). The rule of law was ambivalent, state institutions were characterized by manipulation and poor performance, the business environment was extremely fragile, corruption abounded, and Syrian citizens had little to no avenue to participate in political decision-making processes. Power and wealth were being distributed along highly informal but extremely resilient patronage networks. Nonetheless, the decade-old strategy of repressing those who advocated taghyir (change), while at the same time attempting to bind those advocating islah (reform) in patronage networks, began to crumble.

Bashar al-Assad's applauded state reforms quickly faced resistance from the governing elite and other stakeholders, the so-called "crony capitalists", who were unwilling to give up privileges. Administrative reforms proved difficult as they threatened the established balance of power. They were soon reduced to limited improvement of services without tackling the public administration's main deficiencies. Where reform had taken place, it did not reach far enough into the rural spaces or urban peripheries. In fact, urban centers such as Damascus and Aleppo had lost touch with the rural areas that dominate the rest of the country, resulting in policies that increasingly marginalized the rural population, further contributing to its hardships. The social contract between government and population began to erode, with socio-political grievances intensifying and calls for change growing louder. In pre-revolutionary Syria, policy incentives such as changes in land ownership regulations also played a part in driving people to leave, as well as the search for educational opportunities and obligations to kin.

With the effects of the war in Iraq, the country also began to experience a gradual islamization. Hoping to contain the rising Islamist movement, Bashar al-Assad sponsored various Sufi brotherhoods and established direct contact with the illegal Muslim Brotherhood, hoping to curb jihadi influence in the country. Yet, insurgents kept infiltrating from Iraq, as became evident in the violent emergence of factions such as Jund al-Sham and Fatah al-Islam. Assad's foreign policy mistakes in Iraq and Lebanon, moreover, set off severe Western diplomatic retaliation and culminated in the collapse of the Syrian hegemony in Lebanon, depriving Syria of billions of dollars in annual revenue, adding to the critical situation on the labor market as well as the difficult economic situation.

Finally, demographic drivers include population density and structure, for instance the pressures exerted by a "youth bulge" (Fuller 2004; Urdal 2006), an unusually large percentage of young people among the overall population. Syria's population growth was estimated at around 2.45 % per year in the pre-war years (Aïta 2009, p. 14). Before the uprising, the growth rate of the working-age population was higher than 4 % per annum (ibid). It is not surprising that the working-age population growth rate was higher in urban areas due to increasing rural to urban migration and the influx of Iraqi refugees (Hoffmann 2016), which these data take into account. Young age groups (15–25) constituted the majority of new job seekers in the Syrian labor market. Between 1998 and 2002, over 200 000 people entered the job market every year. By the 2000s, Syria was facing its largest growth rates of labor supply as a result of the coming of age of the children of the 1980s, a baby boom period, and their ensuing arrival in the job market. The influx of one and a half million Iraqis after the war began in 2003 (Hoffmann 2016) as well as the return of hundreds of thousands of Syrian circular workers from Lebanon from 2005 onwards (Fargues 2009) also affected labor supply and the overall labor market structures in Syria. Beginning in the mid-1970s, many, mostly low skilled Syrians had emigrated to Lebanon, where the civil war had created labor shortages. This emigration continued until 2005 when the former Lebanese Prime Minister Rafiq Hariri was assassinated and Assad withdrew his army, leading to a deterioration of the already precarious living conditions of Syrian workers in Lebanon (Chalcraft 2008).

Pre-established migration corridors

While environmental drivers for migration certainly existed in pre-revolutionary Syria, they were embedded in a complex economic, social, political, and demographic context that heavily influenced migration decisions. Out-migration to Lebanon, Jordan, and the Gulf was a common practice. More significantly, internal migration was by no means a new phenomenon in Syria (Khawaja 2002). Circular, seasonal migration had been quite common for decades, especially since landlessness in Syria had been growing continuously despite attempts to curb its effects by means of redistributive land reform and public land distribution since the 1950s. Nearly half of Syria's approximately 20 million residents (including Palestinians and Iraqis) lived in rural areas before the outbreak of the current civil war. Bashar al-Assad's aforementioned reforms favored large-scale land owners over small-scale farmers or sharecroppers, making the landless the weakest link in the agricultural labor chain. It is specifically the landless who were under high pressure to diversify their income. Over the years, seasonal migration became a common livelihood strategy.

Single males from the Northern governorates of Deir az-Zur, Raqa, and Hasakah usually spent the summer season working on agricultural projects in the South until autumn when they would return. A Bedouin interviewee from Deir az-

Zur, who had to migrate to Dar`a in 2000 because his land was confiscated by the government due to political repression and prosecution, described the process as follows: "We had been employing people who ploughed the land for us. Then it was the other way around, we ploughed for other people" (Interview Zaatari 28.9.2014).

With the beginning of the drought, however, the number of migrants began to rise and whole families began to migrate mostly from the North towards the South and West of the country. One of the farmers I interviewed from Dar`a governorate, which became a receiving area, explained the following:

> *CF:* Did you work with migrants?
> *I:* Yes, they came to us [to work in agriculture]. Most came from Deir az-Zur, some also from Hama.
> *CF:* Did the number of migrants change?
> *I:* It grew. They had a drought in their area, that's why.
> *CF:* When did it begin to increase?
> *I:* From 2005 onwards.
> *CF:* Did they live on the land? Did they bring the whole families or was it just adults?
> *I:* They came as whole families and lived in tents. They came to the areas where agricultural projects were run, worked there, and then went back home. For instance, they lived behind our house and got water and electricity from us. They also got food and water from us.
> *CF:* Do you remember how much they got paid?
> *I:* It varied between 40 and 100 Lira per hour [100 Syrian Lira equaled about 2 US Dollars before the war]. Usually between 40 and 60 Lira, sometimes up to 80 Lira. (Interview Zaatari, 6.10.2014).

The material I gathered contradicts the common assumption that migration patterns in Syria were predominantly rural to urban. It therefore challenges the idea that migrants necessarily placed great strain on already pressured urban populations and thereby contributed to or even single-handedly created the basis for the imminent popular uprising (Werrell et al. 2015). It is, of course, true that those who did not want or were not able to work in agriculture would mostly migrate from rural to urban areas; they were often better educated than the day workers in the agricultural projects. As one interviewee from Raqqa explained:

> There were young people who left their parents to look for work. It was particularly young people with degrees like doctors and teachers. Some were also blacksmiths or car mechanics and went to Damascus, because it is bigger, or to another place (Interview Azraq, 9.10.2014).

Many others, however, would follow established "migration corridors" to rural areas (Özden and Schiff 2007, p. 40f), which had developed over decades. Those involved less transaction costs than non-linear moves, or what is known as "chain migration", to new destinations.

As this section shows, migration decisions are complex and influenced by several inter-related factors that create conceptual fuzziness. We need to unpack these complexities to understand the impact of environmental change on human mobility and the relationship between internal migration movements and social upheaval.

Migrants as protesters?

Could the internal migrants have contributed to the outbreak of the Syrian uprising in Dar`a in March 2011? One way of answering this question is through social movement theory, which sees social networks as the prime mode of organization for collective action – with formal networks gradually substituted by less formal networks on a more grassroots, interpersonal level (McAdam et al. 1996; Tarrow 2011; Chesters and Welsh 2011; Diani and McAdam 2003b). Thus, social networks form the basis of social movements. Consequently, the protests in Dar`a must have been built on at least loosely organized social networks and its initiators must have been embedded in them.

But how does a network of interpersonal relations evolve into collective action? For this, the role of trust is key: according to Niklas Luhmann, trust is what makes collective life possible (Luhmann 1988, p. 97). Trust is also a prerequisite to building a common identity, which in turn is the basis for any social movement. Thus, in order to achieve collective action, individuals have to come together expecting that they will protect and promote each other's interests in unforeseen circumstances with a common goal. In other words, they need to trust each other. This is particularly true, even existential, in an autocratic, extremely repressive state like Syria. As one of my interviewees warned: "The state says: Do what you want. But do not talk about politics and keep away from it" (Interview Zaatari, 6.10.2014). Another common description of the overall living conditions within Syria before the revolution was the image of "the walls having ears". It is common knowledge that the Syrian government had threatened to respond to verbal or physical opposition with brutal force; historical precedents like the protests in Hama 1982 provided an idea of what that may look like. It was extremely dangerous and risky, therefore, to protest against the Syrian government. The question is how likely it is that migrants, who often lived below the poverty line, could have built the trust necessary to mobilize a social movement under such circumstances. How did a large group of people whose identities and daily lives were forcefully oriented towards the private, the personal, and the mundane, decide to participate in collective action? Which role did migrants play in this mobilization process?

I suggest we answer these questions by unpacking three key possibilities. The first is "opportunity", the emergence of a particular situation, in which it appears feasible to achieve meaningful change through collective action. This condition was fulfilled by the Arab revolutions that preceded the Syrian one, namely in Egypt, Tunisia, Libya, and Yemen. They demonstrated the demise of autocratic regimes and the triumph of civil opposition. Information about these developments was available through traditional and new media and through social ties between the Syrian population and the societies affected by the Arab Spring. In this sense, the opportunity existed for Syrian internal migrants to rebel, as it seemed possible that an uprising in Syria could be as successful as it had been in comparable autocratic states like Egypt.

The second issue is what Doug McAdam has termed "threat" (McAdam 1999; Tilly and Tarrow 2012). Disadvantaged and power-deprived people usually live their lives "within a habituated framework of subordination" (Flacks 2004, p. 148). "In Syria, you have to rely on yourself," one interviewee from Ramtha asserted (Interview 10.10.14). Another from Dar`a said: "Generally speaking, our village was isolated. Neither the state came close to us, nor did we come close to the state. Everyone focused on their own business" (Interview Zaatari, 3.10.14). To illustrate the government's practices of subordination, one interviewee from Deir Baba (Homs Governorate) related what happened one day when he went to the traffic bureau to release a friend's clamped car. A police officer asked him where he was going and told him to leave. He said he was quite upset by this and asked why the officer was talking to him in that hostile manner. "I told him I usually come here. I said that I was not coming to his father's house, was I? It is a government institution. They imprisoned me, I "kissed his beard" and slaughtered a sheep until the issue was solved." The interviewee, conveying the exaggerated repercussions of life in Syria, came to the conclusion that "one, who said one word, was imprisoned for life" (Interview Zaatari, 3.10.14).

Such habitually subordinated people become ready for collective action not only because they consider themselves unfree or deprived – this is not more than their day-to-day life for them. They rather mobilize because they share "the perception of a specific threat to their accustomed lifeways" (Flacks 2004, p. 148). Importantly, this perception of threat must be shared and the source of the threat needs to be identified as one specific human actor, as opposed to a natural event (Flacks 2004, p. 148)[10]. In the case of Syria, the different socio-political, demographic, and economic pressures outlined above resulted in the common view that life as it had been under the rule of Hafiz al-Assad, authoritarian and repressive as it may have been, had come to be threatened by Bashar al-Assad's rule.

[10] Nevertheless, social movement theory does not have an adequate answer to the question as to when the reaction to threats and repression turns from submission into defiance and open opposition (Davenport et al. 2004; Earl 2011; Pierskalla 2010).

The third issue is "liberation". There are times in which a large group of people who share a certain way of life may turn to collective action to achieve new living conditions rather than defending the existing ones. In this case, collective action aims at rejecting and overturning established frameworks of identity, achieving rights hitherto denied, and voicing demands for equal treatment, dignity, and the ability to determine one's own life (Flacks 2004, p. 149). This was certainly the case in Syria where demonstrators from the beginning and to this day have demanded freedom and dignity. As Richard Flacks argues,

> Liberatory perspectives arise among groups of people who share a condition of subordination, disadvantage, or stigma over which they have little or no individual control. Such subordination, based on race, ethnicity, gender, sexual orientation, physical handicap, or any other "ascribed" trait, tends to be regarded in the dominant culture as a normal, taken-for-granted feature of everyday life. Those who are so subordinated have typically accommodated to their situation for generations, seeming to reproduce in their own conformity the conditions of their oppression. (Flacks 2004, p. 149)

Leenders (2013) and Gerlach (2015) both cite a story about the immediate causes of the Syrian revolution. Two women from different Dar`a clans had been arrested and abused by authorities. This was, as the story goes, followed by anti-regime graffiti, which had been drawn by 15 school children in their defense. The children were subsequently arrested and tortured. Attempts to mediate their release were met by rejection and insult. The local security chief, Atef Najeeb, shockingly suggested "sending local women to conceive some new kids [to replace the arrested ones]" (Leenders 2013, p. 279). Consequently, the people of Dar`a rallied in protest and defiance, purportedly shouting "to hell with you" to security forces who opened fire. It can be argued that the people of Dar`a collectively identified a common threat, which became the basis for collective action to achieve liberation from it. The shared everyday life provided space to develop both trust and a common language of oppression; in short: a shared sense of identity.

Social movement theory considers social networks to be crucial for the mobilization of collective action, especially in the context of seemingly insurmountable obstacles (Diani and McAdam 2003b; McAdam et al. 2001; Einwohner and Maher 2011). Dar`a's local society was characterized by "dense, interlinked social networks affecting social, economic, and cultural life. These networks informed, motivated and enabled unprecedented mobilization […]" (Leenders 2013, p. 277). Leenders particularly stresses the role of Dar`a's family clan structure in mediating social and economic cross-border ties beyond Syria. These include criminal networks as well as circular labor migration to Lebanon, Jordan, and the Gulf. Such elaborate and trust-based social networks "link[ed] family or clan members, traders, money exchangers, smugglers, truck drivers, taxi drivers and bahara ['sailors', informal taxis transporting people and smuggled goods], and corrupt customs officials" (Leenders 2013, p. 278). While social networks enabled mobilization of liberation movements, however, the cost of the protests was too high for many people. "Of course I believed in the protests," one interviewee from Dar`a exclaimed. "But we are very poor. People like us have been hit [by the revolution] and died. We went to rack and ruins. We, the poor people, suffered most. Whether Bashar al-Assad stays or goes does not matter" (Interview Zaatari, 3.10.14).

Leender's and others' analysis of social movement theory – and the role of trust and shared identity – raises the question about migrants' conditions of involvement. I suggest that migrants could not have achieved a common identity with the people from Dar`a, and thus could not have orchestrated political demonstrations of this magnitude and scale. While many migrants came regularly, they only spent some time of the year in and around the city. Even when numbers rose and migrants began to stay in and around Dar`a permanently, they did not integrate meaningfully with the local populace, and did not identify as Dar`awis. This is indicated both by the way in which locals referred to the migrants – as people outside of the community, as different and alien – and the way migrants themselves spoke about their lives there. The migrants were clearly a group of outsiders according to social identity theory (Tajfel and Turner 1986), as confirmed by the following farmer from Dar`a who had worked with migrants and was familiar with their conditions: "They came from the North, from Hasakah, and this region. Their number increased. In some villages, there were more migrants than locals. They lived in tents. They could be found everywhere and they worked in all [agricultural] projects. They had a difficult life, no assistance, and lived in tents. They had nothing to do with politics. They went to work and back home" (Interview Zaatari, 30.12.2014).

If migrants were not the initiators of the protests, it is relevant to ask whether they sympathized or even took part in the uprising in Dar`a. After all, outsiders may have recognized their own longstanding grievances in the claims made by the local protesters. They may have subsequently joined the uprising and contributed to its diffusion and enduring strength. My research indicates that migrants, if they joined the protests at all, did so in their home governorates and not in the areas they migrated to. In fact, the Dar`awis I interviewed in Jordan were divided between two positions. Some saw migrants as passive outsiders who were incapable of protesting due to their poor conditions. One interviewee from Dar`a pointed out that "in the first year some of the muhajirin (migrants) stayed. But when the troubles grew, they left" (Interview Ramtha, 10.10.2014). Another stated, "they left at the beginning of the demonstrations" (Interview Zaatari, 7.1.2015). Other more skeptical interviewees deemed the migrants to be suspicious pro-regime agents who were against the protests, an aspect that underlines the lack of trust between Dar`awis and migrants. "They were all pro-Assad", one interviewee insisted. "When the troubles started, they shouted pro Assad slogans. Even though they were poor people. Of 100, maybe ten are not pro Assad. They loved him, because many of them and their friends and families were in the army" (Interview Zaatari, 6.10.14). While the three conditions for collective action, opportunity, threat, and liberation, did exist in settings such as Dar`a prior to the Syrian uprising, it was not the (climate) migrants who initiated the protests. My data suggest that the migrants were too marginalized and outside of the strong Dar`awi identity to be able to initiate any social action.

Concluding remarks

This article shows that environmental factors were only one and certainly not the decisive element of individual migration decisions made in pre-revolutionary Syria. While it is true that climate change has had and will continue to have potentially adverse effects on Syria and the whole Middle Eastern region, I have argued here that orchestrating a protest of the scale, intensity, and permanence of the one in Dar`a was well beyond the climate migrants' social capacities and resources. In line with this, the majority of my interviewees considered the protests to be a reaction to state repression and mismanagement. Seeing the drought hit the Northern governorates, seeing the numbers of migrants on their agricultural production sites increase, and seeing men, women, and children work on the fields for very low wages only added to their sense of the increasing decline of the social contract between the government and the population. As one interviewee put it,

> When Bashar came to power, the differences and the gap [between rich and poor] became very big. An employee received thirty thousand a month, while a worker only received four or five hundred Lira per month. Only employees received raises, normal workers received no subsidies at all. I said that the country would collapse if it were ruled by children. Bashar was only 33 years old. He had no wisdom and no leadership. He had a weak personality (Interview Zaatari, 3.1.2015).

As this article demonstrates, connecting the Syrian uprising to climate change via migration is walking a thin line between the noble goal to raise awareness for the potentially severe and adverse effects of climate change on social systems in the hope of engendering an overdue policy shift to save the planet on the one hand, and the risk of absolving the Syrian regime from its responsibility for the unmitigated effects of the drought and of fueling discourses of re-nationalization and walling-off as well as anti-immigration sentiments on the other. This needs to be reflected in all attempts to rebuild Syria, as both large migration flows and climate change impacts are likely to continue to affect the Middle East.

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11 Disrupting the knowledge-power politics of human mobility in the context of climate change

Questioning established categories

Sarah Louise Nash

Abstract

Established categories used to describe different kinds of human mobility, based on a distinction between forced and more-or-less voluntary forms of movement, dominate the discourse on human mobility in the context of climate change. In particular, the phrase "displacement, migration and planned relocation" anchored in the Cancun Adaptation Framework of the United Nations Framework Convention on Climate Change (UNFCCC) has become prominent. Despite being portrayed as objective representations of the world, these categories are not neutral, with terminology being value-laden and taking on different connotations in different contexts. The categories used to describe human mobility in the context of climate change therefore do not necessarily impart knowledge about the realities of human mobilities, but rather say more about the speakers using these categories. This essay provides an impulse to look beyond established categories from policymaking, to strengthen critique of these categories in academic work, and to move beyond policy-relevant research.

KEYWORDS: *Climate change, human mobility, migration, displacement, discourse.*

Introduction: The politics of human mobility in the context of climate change

The interface between climate change and human mobility has become a commonplace concern for politics, research, policy, and civil society alike. It has become an accepted area of discussion at climate change negotiations (Warner 2012, Nash 2018a), is considered in the high-profile reports of the Intergovernmental Panel on Climate Change (IPCC 2014), and has been the subject of large-scale academic research projects (Melde, Laczko et al. 2017). The basic concept is simple: climate change will have (and indeed already is having) an impact on human mobilities. This has provoked a number of different discourses, with the label "climate refugees" having been used to point to either a securitized concern over increased movements of displaced persons, or a humanitarian concern for those who may be displaced (Bettini 2013). In a discursive shift, a discourse has built up around the idea of migration as a form of adaptation to the effects of climate change, which counters some of the concerns of environmental determinism (Gemenne 2011) and securitization (Martin 2010, White 2011) related to the "climate refugees" discourse (Bettini 2014). However, at the same time, concerns have been raised about the concept of migration as adaptation. This discourse has been critiqued for being entrenched in a neoliberal resilience mindset (Felli 2013, Methmann and Oels 2015), having links to "migration management" (Nash 2016), stressing individualized responsibility for adaptation (Baldwin 2016), and losing any kernel of climate justice that the humanitarian iteration of the "climate refugees" discourse displayed (Bettini et al. 2017).

Climate change is also being increasingly understood through the lens of movements of people that are occurring in the wake of disasters. The Nansen Initiative, a state-led initiative whose history is closely linked to the United Nations High Commissioner on Refugees (UNHCR) (Kälin 2012), launched their work on cross-border displacement in the context of disasters (including climate change) in 2012 and since then "disaster displacement" has emerged as an ordering concept (The Nansen Initiative 2015).

These different discourses and continuing developments in various arenas of policymaking have led to a burgeoning (critical) scholarship on the politics and policy of human mobility and climate change (Baldwin and Bettini 2017). However, even though the laundering of categories to describe people on the move has been identified and critiqued as a weakness of scholarship and policy on human mobility and climate change (Nicholson 2014), there has not yet been a systematic analysis of the systems of categorization that are being used to talk about people on the move, i. e. where they come from, and how the boundaries between categories are being constructed. This is therefore the problematic to which this essay turns.

In analyzing systems of classification, a central premise of this essay is that categories and the boundaries between them do not naturally exist, but are socially constructed. Furthermore, categories not only represent the world, but "simultaneously create it and limit it" (Jones 2009: 185). This premise is the first step towards a critique of categories, as it rules out the presumption that systems of categorization can be a neutral ordering process. At the same time, this article recognizes that categories are both pervasive and inevitable (Moncrieffe 2007, Jones 2009), with identifying and differentiating people and phenomena by categorization providing a system through which to understand the world. As a result, simply challenging certain categories is most likely simply to lead to the creation of new categories, or the tweaking of boundaries of established ones.

A second premise of this article is that categorization is imbued with power relations. For Michel Foucault, classification isolates objects of knowledge and as such both creates and limits discourse. Categorization is a dividing practice that works to both include and exclude people, having different productive effects on different categories of people (Foucault 2000). In the context of international development practice, Moncrieffe argues that the process of attaching labels to particular categories allows powerful actors to "influence how particular issues and categories of people are regarded and treated" (Moncrieffe 2007: 2), an argument which holds many parallels for the case of human mobility in the context of climate change. As a result of the (often skewed) power relations present in the politics of bounding, categories often tell us more about those who make them than about people on the move who are being categorized. This is not to say that the motivations for categorization are repressive, indeed the categorization of people may also follow from humanitarian motivations (for example, the allocation to the category of "refugee" brings with it certain international protection standards). However, categorization may also have unintended consequences, and noble motivations do not necessarily lead to a positive outcome.

In the discourses surrounding human mobility in the context of climate change, categories to describe people on the move draw almost exclusively on established categories from human mobility politics. However, the majority of policy work at the international level has taken place within the realm of climate change politics, in particular the United Nations Framework Convention on Climate Change (UNFCCC) (Nash 2019). This is not necessarily surprising, given that the UNFCCC did not have an existing established vocabulary with which to talk about human mobilities. Consequently, language and categories were drawn from elsewhere. In particular, the involvement of expertise from organizations such as UNHCR and the International Organisation for Migration (IOM) in the UNFCCC process has built bridges between human mobility politics and climate change (Nash 2018b).

This essay is therefore concerned with the use of established categories from human mobility politics and their effects on the politics of human mobility in the context of climate change. This analysis necessitates a series of decisions regarding vocabulary, in order to distance this analysis from the categories it is critiquing. Different terms that are used to refer to people on the move and to categorize their movements are avoided. However, in order to write a text that is in some way readable, a term has to be used to describe the phenomenon of the movement of people. In this instance, the term "human mobility" is employed throughout. This selection has been made as human mobility is frequently used (including in the discourse on human mobility and climate change) as an umbrella term that refers to movements of people without making explicit statements about the type of movement. Of course, although portrayed as such on many an occasion, this term is not neutral, with the very emphasis of mobility making a conceptual differentiation from immobility. It is with awareness of these limitations that the term is employed here.

The next section of this essay provides a brief overview of the two central established categories of mobilities: displacement and migration. The section then interrogates the preoccupation with compulsion that pervades human mobility politics and is the basis for differentiation between categories. The third section then moves on to analyze how these categories are transported into discourses on human mobility in the context of climate change, in particular interrogating the set-phrase "displacement, migration, and planned relocation" (United Nations Framework Convention on Climate Change 2010: 14(f)) that structures many of the discussions surrounding human mobility in the context of climate change. The penultimate section is then concerned with critiques of this system of categorization and relates the discussion to the knowledge-power politics of human mobility and climate change. Finally, this essay concludes that work on human mobility is likely to stay closely tied to these categories but at the same time highlights the importance of scholars questioning them. The questioning of established categories is an exercise that could lead to empirical work that moves beyond these categories and therefore to work that moves in new analytical directions.

Categorization and a preoccupation with compulsion

Displacement, displaced persons, internally displaced persons (IDPs), refugees, migration, migrants, economic migrants, illegal migrants – this vocabulary is all run of the mill in discourses about human mobilities, to either refer to a sub-set of the phenomenon of human mobility or to people who are on the move. This cacophony of synonyms has two distinct clusters: terminology that refers to forced mobilities on the one hand, and terminology referring to more-or-less voluntary mobilities on the other. The central defining characteristic of these established categories of human mobility is therefore the degree of compulsion involved in the movement.

This fascination with delineating forced mobilities from voluntary mobilities is a thread running through the heart of global human mobility policies, key international agreements, and institutional arrangements. It is not only the vocabulary that exists to talk about mobilities (and the meanings that are most frequently attached to the various terms) that separates out displacement from migration, displaced persons from migrants. The UN has two agencies that focus on human mobilities, UNHCR and IOM[1]. Separate international agreements exist to protect refugees (UN General Assembly 1951), internally displaced persons (UN Economic and Social Council 1998), and labor migrants (UN General Assembly 1990). The 2016 New York Declaration that focusses on human mobilities is titled the New York Declaration for Refugees and Migrants and the two global compacts that are mandated in the declaration are separated out along similar lines, focusing on refugees; and safe, orderly and regular migration respectively (UN General Assembly 2016).

This split according to forced and more-or-less voluntary movement is not restricted to the world of the UN, but also pervades media and popular discourse, with lively discussions taking place as to which category people should be classified as belonging to. For example, during the peak of the so-called refugee/migration crisis in 2015, a debate emerged surrounding which of the two labels was more accurate to describe the situation playing out at Europe's borders. Two diametrically opposing views were visible in the terminology used by the BBC and Al Jazeera, with the BBC opting for the migration crisis term, with the BBC including a note on terminology in all reporting on the so-called crisis justifying their choice:

> A note on terminology: The BBC uses the term migrant to refer to all people on the move who have yet to complete the legal process of claiming asylum. This group includes people fleeing war-torn countries such as Syria, who are likely to be granted refugee status, as well as people who are seeking jobs and better lives, who governments are likely to rule are economic migrants (BBC 2016).

In contrast, Al Jazeera, which has consistently referred to refugees as opposed to migrants in this context, includes an understanding of the malleability of terminology, with words able to evolve and take on different meanings, in their explanation of their choice of terminology. In a statement made in 2015, the network explained that: "the umbrella term migrant is no longer fit for purpose when it comes to describing

1 The IOM was formerly not a UN agency; however, a new agreement on the relationship between the UN and the IOM was made on 25 July 2016, bringing the IOM into the UN (UN General Assembly 2016).

the horror unfolding in the Mediterranean. It has evolved from its dictionary definitions into a tool that dehumanizes and distances, a blunt pejorative" (Malone 2015).

This difference of opinion between the two news networks highlights two things that are important for the discussion in this article. Firstly, words are made up of both semiotic and ideational components (Saussure 1960), which are not necessarily stable. The meaning of terms can therefore shift over time, according to context, or depending on who is using them. Secondly, what terminology is used tells us less about the people who are moving than about those who are using the terms to describe people on the move. In the examples of language from the BBC and Al Jazeera quoted above, both "refugees" and "migrants" are being used to describe the same movements of people, however the connotations attached to these terms by the respective news outlets has led to different choices in terminology. These examples therefore highlight that particular terms are usually imposed upon people who are on the move and are not used neutrally; they denote how people on the move are being perceived, whether mobilities are seen as virtuous or potentially dangerous, and what political responses might be considered valid. What these terms, corresponding to categories of mobility placed at either end of the forced-voluntary continuum, do not provide is context-specific information about the mobilities of people, what assistance or protection they may require, or what political and policy responses may be useful.

Established categories in the discourse on human mobility in the context of climate change

One particular set of categories to describe the "phenomenon" of human mobility in the context of climate change has emerged as the dominant way to conceptualize the area, with this categorization being expressed in the set phrase "displacement, migration and planned relocation" (United Nations Framework Convention on Climate Change 2010: 14(f)). This phrase is anchored in the Cancun Adaptation Framework of the UNFCCC[2], but has also been adopted and widely replicated by academics and policymakers who praise it for representing a nuanced view of human mobility that recognizes both forced and more-or-less voluntary mobility.

Two aspects of this formulation are of particular interest for this essay. Firstly, when used in this formulation, the meanings allocated to the terms are stable, with displacement referring to forced forms of mobility and migration being used to refer to more-or-less voluntary mobilities. The disparity in meaning as between the BBC

2 Interestingly, language changed in agreed UNFCCC documents that came after Cancun, with agreed-upon UNFCCC texts since 2013 instead including the language "displacement, migration, and human mobility" (UNFCCC 2013, 3/CP.18: 7(a)(vi); 2016, 1/CP.21: 49; 2017, 3/CP.22: 9). However, the Cancun terminology continues to dominate in both academic and advocacy contributions.

and Al Jazeera uses of migration is therefore not present. Planned relocation refers to movements that involve moving entire communities with some degree of coordination from the state. It is not surprising that the meanings of these otherwise heavily contested terms remain stable within the tripartite Cancun formulation, as in order for the system of categorization to have some meaning, the individual components need to be distinct from each other. However, when used in isolation these terms once again have malleable meanings, with IOM's usage of "migration" in particular being used in line with the organization's definition of migration as all forms of mobility, of which forced migration is a sub-category (IOM 2014: 23). Secondly, the differentiating factor (at least between displacement and migration) is still the degree of compulsion that is involved in movement, in line with established systems of categorization in human mobility politics more generally.

The terminology that is used to denote categories of mobility in the context of climate change is therefore stable both linguistically and ideationally, and these categories are also highly political. This categorization is furthermore drawn on and reproduced unproblematically, contributing to naturalizing these terms and system of categorization as depicting a true, objective representation of human mobility dynamics (Nash 2018b). For example, the Advisory Group on Climate Change and Human Mobility states that "'human mobility' is an umbrella term that encompasses displacement of populations, migration and planned relocation" (Advisory Group on Climate Change and Human Mobility 2015: 2, emphasis added). This disregards other interpretations of human mobility, other constellations of terminology, and naturalizes the formulation of "displacement, migration and planned relocation".

However, a close reading of policy documents suggests that fitting the empirical realities of human mobilities in the context of climate change into this categorization is not an easy endeavor, since the core feature of human mobilities in the context of climate change emphasized by the empirical research is the complexity of such movements. As the IOM has argued that "environmental migration may take many complex forms; forced and voluntary, temporary and permanent, internal and international" (IOM 2014: 5) or, in the words of UNHCR, "some of these movements could be considered voluntary and regarded as part of natural adaptation or coping strategies; but climate-related events could also entail threats to life, health, property and livelihoods and therefore lead to forced displacement" (UNHCR 2011: 2).

These examples provide little information about human mobilities in the context of climate change other than their complexity and, by listing every possible form of mobility, are paramount to tautologies (Nicholson 2014). The shoehorning of knowledge on climate change and human mobilities into these categories based on forced or voluntary movements adds very little coherence to the debate. It therefore seems that the adoption of established categories of mobility, in particular displacement and migration, does not serve analytical purposes, leading to the question of what purpose terminology is intended to serve. As a result, a better understanding of the debates on human mobility in the context of climate change entails not only the form that language takes, but also the purposes that it serves.

Questioning established categories to disrupt the knowledge-power politics of human mobility in the context of climate change

In line with the theoretical premises of this article, both the "phenomenon" of human mobility in the context of climate change and categories used to talk about the people at its center are socially constructed. By referring to particular categories of people in this sense "we are in effect inventing a category that corresponds with how we imagine the world to be, not one that describes the world as it really is" (Baldwin 2017: 3). These categories are therefore neither naturally existing in the world, nor should they be immune from critique. Understanding the complex genealogies of the categories that are being used to structure debates on human mobility in the context of climate change can also give insights into what world imaginaries are shaping the debate. Furthermore, an important purpose of critique is to move beyond the boundaries of the thinkable (Death 2014), and as such critically engaging with the use of established categories can help to move the discourse forward in new directions.

In the case of human mobility in the context of climate change, policy and academic worlds are largely indistinguishable, with a complex self-perpetuating circle of research, knowledge production, and policymaking sustaining the debate (Nash 2018b). Policy relevance has thus become a mandatory feature of research, with the dominance of established categories being one clear indication of how deeply intertwined these worlds are. Therefore, the use of established categories of mobility based around a distinction between forced and more-or-less voluntary mobilities cannot be attributed to a dearth of imagination alone. Instead, the high level of interaction between the policy and academic worlds in relation to climate change and human mobility and a clear drive towards policy relevant research makes it difficult to escape these pre-drawn classifications. The resulting debate, prevalent in much of the research on climate change and human mobilities, between "climate refugees" and "climate migrants" is perhaps unsurprising but also analytically limiting.

Policy relevant research, in the sense of research that takes existing policy as its baseline by adopting established policy categories into its conceptual framework, is often deemed to be a necessity. Whilst an approach that moves away from this assumption would be a bold move that could be criticized for lacking in relevance, the necessity to be policy relevant should be interrogated. As Oliver Bakewell has argued, "research which is designed without regard to policy relevance may offer a more powerful critique and ironically help to bring about more profound changes than many studies that focus on policy issues from the outset" (Bakewell 2008: 433). However, a move towards policy irrelevant research would entail rethinking the very motivations of many research projects on human mobility in the context of climate change. One reason for the pursuit of policy relevance lies perhaps at the normative drive behind much of the research on human mobility in the context of climate change. Such aspiration can overwhelmingly be termed "humanitarian scholarship"; scholarship that is somehow motivated by a (perceived) societal problem and intends to contribute knowledge that can improve the lives of those impacted by the problem in question. This is a tendency that has also been identified in the discipline of refugee research, with what Myron Weiner identifies as "advocacy research", "where a research already knows what she wants to see and say, and comes away from the research having proved it" (Jacobsen and Landau 2003: 188). Advocacy research also shows a concerning prevalence in research on climate change and human mobility. Policy contributions on human mobility in the context of climate change have a similar normative basis anchored in the premise of a problem existing and go further by assuming that policy solutions (in whatever form) are required in order to do this. As Andrew Baldwin and Giovanni Bettini have argued, the very existence of the area of research and policy is therefore a value judgement, which constructs human mobility in the context of climate change as a problem complex to which responses are required (Baldwin and Bettini 2017).

It is not just the simple existence of the area of research and policy that is a value judgement. Different types of mobilities are also laden with complex layers of value judgements as to what types of mobilities are to be prevented, what types of mobilities are to be tolerated, and what types are perhaps even desirable. In their analysis of categories and bounding in relation to the European "migration crisis", Heaven Crawley and Dimitris Skleparis argue against "the trap of suggesting, either explicitly or through the ways in which we organise and structure our scholarship, that those places in one category rather than another are somehow more 'deserving'" and that "the move to foreground or privilege the term 'refugee' over 'migrant' does nothing to contest the faulty foundations of the binary distinction between the two categories, it simply perpetuates its logic" (Crawley and Skleparis 2018: 13). However, in the discourse on human mobility in the context of climate change, value judgements are regularly attached to different categories of mobility.

The established categories from human mobility politics of displacement and migration contained in the Cancun formulation of "displacement, migration and planned relocation" are regularly loaded with value judgements, often contradictory to those that can be observed in human mobility politics more broadly. Whilst both discourses share a negative view of displacement as chaotic and damaging (both in humanitarian and security iterations, as either a humanitarian problem for those displaced or a security problem facing states), migration, which is often vilified and used as a political punching bag in the human mobility discourse more broadly, has become a beacon of hope in the discourse on human mobility in the context of climate change. Migration has been identified as a potential adaptation strategy; one that can be implemented by resilient individuals in order to prevent (more chaotic, damaging) mobilities in the form of displacement (Bettini and Gioli 2016). Immobility in the context of climate change also has different, contradictory, value judgements attached to it. For example, immobility can either take the form of populations who simply do not want to move (McNamara and Gibson 2009), or so-called "trapped populations", a category used to describe people who are involuntarily immobile. The latter has been described as "a potentially dangerous policy tool" in that there is a risk "the concept may be misused to seemingly 'protect, save or move vulnerable populations from risk places' while ensuring political or economic gain" (Ayeb-Karlsson, Smith et al. 2018: 14).

Conclusion

Human mobility and climate change is an area of work that is coming of age in both policy and research. Analyses are becoming more sophisticated, and the policy world is increasingly looking towards implementation rather than simply discussion of the links between human mobility and climate change. It is therefore all the more important that conceptual inconsistencies that have been identified, continue to be objects of attention and critique (Mayer 2013). One such area is the categories used to describe human mobilities and people on the move. Given that the policy and research communities are often indistinguishable, it is unlikely that the two will analytically part ways. Indeed, a counter-tendency can arguably be observed, with academic work becoming ever more entwined with policy language through striving for policy relevance. Therefore, realistically, it is unlikely that mainstream work is going to move away from using established categories of mobility to talk about human mobility and climate change.

However, this essay argues that it is important for scholars to do so. Scholars conducting empirical work on human mobility and climate change can benefit from a refreshed perspective by moving beyond established categories. This does not call for a complete disengagement with reality but, following Heaven Crawley and Dimitris Skleparis, the call is "not for an end to the use of categories as a way of making sense of our social and political worlds, but for explicit recognition and engagement with the idea that categories do not simply represent or reflect the world but simultaneously create and limit it" (Crawley and Skleparis 2018: 13).

Most naturally, casting a critical glance on established categories is a job that falls to scholars with a critical inclination who can continue to question the categories that are being used to structure knowledge on human mobility in the context of climate change. There are two main arguments behind this need for this particular continued critical attention. Firstly, the reliance on established categories can serve to restrict the ways in which human mobility in the context of climate change can possible be viewed. By moving beyond these categories, it is possible that the boundaries of the thinkable can be expanded. Secondly, the examination of the use of systems of categorization can provide insights into the politics of human mobility in the context of climate change. As argued above, categories can give insights into imaginaries of the world and into the actors (organizations and individuals) who are using them. In a contemporary context where human mobility is frequently used as a political bargaining chip, understanding how people on the move are being understood, constructed, and categorized has never been so important.

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12 Explaining the diversity of resilience in the climate change and security discourse

Resilience in translation[1]

Delf Rothe

Abstract

The concept of resilience has taken the hearts of Western practitioners and decision makers in development, environmental, or security policy by storm – or so it seems. In the looming "climate of complexity" produced by unfolding global warming, the idea of resilience, as the ability of systems and communities to autonomously recover after shocks and to adapt to changing environmental conditions, appears promising. Yet, different versions of resilience co-exist and compete with each other in diverse political arenas and fields of practice. As a result, resilience resists any conceptual fixation – making it hard for policy-makers and practitioners to agree upon a common definition of resilience. This essay seeks to explain the diversity of resilience by looking at processes of its "translation". The translation of resilience here refers to both the transfer of the concept from one discursive field to another as well as the adoption and reinterpretation of resilience through actors in concrete resilience projects on the ground.

KEYWORDS: *Climate change, discourse, resilience, securitization, United Kingdom.*

1 An earlier version of this chapter has been published as Rothe, D., 2017: Climate Change and Security: From Paradigmatic Resilience to Resilience Multiple, Routledge Handbook of International Resilience: Policies, Theories and Practices, Chandler, D. and J. Coaffe, eds., Routledge, 171–184.

Introduction

Resilience – a concept with a long history in disciplines such as psychology or ecology – has recently made it to the desks of practitioners and policy-makers in policy fields including development cooperation, civil protection, or climate change adaptation. In the current "climate of complexity" (Rothe 2016), the promise of resilience, as a capacity to recover from shocks and to adapt to changing environmental conditions, appears promising. Yet, while everybody seems to talk (about) resilience, there is hardly any consent about the concrete meaning of resilience (Anderson 2015; Simon and Randalls 2016). It remains controversial whether resilience is a property of infrastructure, a capacity of individual persons or collective entities, or a property of systems. Resilience may refer to a status (being resilient) as well as to a process (becoming resilient) to structures or individual actors (Bourbeau 2018). Furthermore, it is disputed whether resilience can be promoted and induced through external intervention or if only the systems or subjects themselves can enhance their own resilience (through processes of learning and self-adaptation). Finally, the normative evaluation of resilience in the literature differs considerably. Many commentators in critical IR understand resilience as a neoliberal form of security that would give up the liberal promise of protection and shifts the burden of protection from the state to vulnerable populations (Evans and Reid 2014; Joseph 2013b). For these authors, resilience represents a form of post-politics, in which "[t]he classic quest after the 'good life', once a starting point for both an art of living and the art of governing, is replaced by the more minimalist, almost realpolitik, striving for adaptive survival" (Vrasti and Michelsen 2017). Others argued instead that resilience might represent a progressive alternative to traditional (national) accounts of security (Corry 2014). Certain forms of resilience might also work in counter-hegemonic ways – for example if understood as the resilience of oppositional groups to state repression – or as a vehicle for the transformation of ingrained social structures (Bourbeau and Ryan 2017).

In short, resilience is everything else than a coherent or fixed program. Rather, it is a flexible concept that becomes translated as it moves between different discourses and policy areas (Grove 2013). In this chapter, I draw upon this observation to seek answers to two related research questions: First, I seek to explain why resilience could recently become such a prominent political concept. Second, I shed some light on the ontology of resilience by exploring reasons for its heterogeneity. While scholars often acknowledge the ambiguity of resilience (e. g. Walker and Cooper 2011), it is seldom taken into account analytically (for an exception, see Simon and Randalls 2016). Advocates as well as critics of resilience tend to present it as a rather coherent discourse or even a political paradigm, thereby blurring contradictions and fissures in the actual political practices of resilience.

In this contribution, I decidedly focus on the ambiguity of resilience and argue that it is exactly the concept's capability of being easily translated from one policy field domain to another that (at least partially) explains the current political prominence of resilience. I establish this argument by tracing the translation of resilience as it travels between different sub-fields of the discourse on climate change related security risks (in the following climate security) in the United Kingdom (UK). The climate security discourse in the UK represents an extreme case to study the translation of resilience. Besides the USA, the UK is the country in which resilience produced the strongest resonance and found its way into all major strategic documents (Joseph 2013a). Thus, one should assume to find a rather coherent governmental take on resilience; and secondly, I will decidedly concentrate on governmental discourses and practices.

The essay proceeds as follows. In the next section, I outline what I would call the *paradigmatic approach to resilience*. I develop an alternative to this paradigmatic approach drawing on Stephen Collier's (2009) concept of topologies of power. In section three, I turn to the empirical case study and start with tracing different storylines of climate security in the UK discourse. I show how each of these storylines draws upon a different understanding of resilience. This approach of studying the deep structure of resilience in the UK discourse is complemented by an analysis of resilience practices in the governance of climate-security risks. I study how resilience becomes translated and reinterpreted by different actors in the climate security field. Finally, I argue that resilience emerges as a "floating signifier" (Laclau 2005; Laclau and Mouffe 1985) – a malleable concept that is flexible enough to bring together diverse practices of governing an insecure future in a complex governmental landscape of UK climate-resilience.[2]

From paradigmatic resilience to resilience as translation

The existing International Relations (IR) literature on resilience often identifies the latter as a defining paradigm of the world-political present – clearly demarcated from earlier forms of security, which has recently become dominant in international politics. According to this reading, the rise of resilience would represent a clear break from earlier – liberal, modernist – forms of security. Resilience is rather understood as a

2 In discourse theory, a floating signifier refers to a signifier that lacks a clear, unambiguous referent and thus means different things to different people. The semantically open nature of floating signifiers allows different political projects to appropriate it and fill it with their own meaning. Examples in political discourse are sustainability or freedom.

single political discourse, ideology, or paradigm. I would call this understanding of resilience as a single political discourse, ideology, or paradigm a paradigmatic approach to resilience. The paradigmatic approach to resilience revolves around a set of assumptions that will be briefly summarized in the following paragraph[3]. First, the paradigmatic approach stresses that resilience draws on a particular ontology of complexity (Chandler 2014). Deduced from complexity theory, adaptive systems thinking, and cybernetics, resilience would problematize the possibility of non-linear change and the connectivity of coupled social-ecological systems. Translated into the field of security politics, resilience thus problematizes the threat of abrupt, unpredictable change resulting from the complex interaction of globally interconnected networks (Kaufmann 2013, 58). Second, authors in the critical IR literature have argued that resilience thinking dwells upon an epistemology of limited knowledge. In other words, policies that follow a rationale of resilience accept the inherent limit to prediction and forecasting in a world of complexity and radical contingency (Boas and Rothe 2016). Other than classical defense policy or disaster risk-management, resilience hence "does not imagine specific scenarios against which defenses (or pre-emptive attacks) must be prepared" (O'Malley 2011). Third, at the level of policy this leads to the acceptance that certain risks and dangers are ultimately inevitable (Zebrowski 2013). Hence, resilience would shift the focus of security policies from the prevention of external threats or risks to the inner vulnerabilities of populations, systems and individuals at risk (Chandler 2013, 218). Fourth, a resilience paradigm is criticized for shifting the burden of security policy from the state to the vulnerables themselves, which are consequently made responsible for their own protection (Evans and Reid 2014). As a result, national and international security policies are increasingly modeled along the lines of a neoliberal (market-based) approach, which seeks to activate the self-help potential of vulnerable populations (Joseph 2013b). Finally, such policies would require a particular type of institutional design based on flat hierarchies and connectivity – as paradigmatically expressed in the Anglo-Saxon notion of network governance (Rothe 2016).

The works I have summarized under the label of a paradigmatic approach have provided valuable insights for our understanding of resilience as a political concept and its problems. In particular, these studies have highlighted the convergence of complexity and neoliberal economic thinking and helped to make sense of a changing understanding of security and a related shift of responsibility from the state to society and the individual (Chandler 2013). Such an understanding of resilience as a mode of self-government under complexity is certainly important – for example, it undergirds many self-improvement manuals that have been quite successful in the mid-2000s

[3] Please note that I use the notion of paradigmatic resilience as analytical ideal type. I do not claim the following list of resilience attributes to be exhaustive. Also, any single publication in the described fields does not necessarily draw upon all five assumptions on resilience.

(O'Malley 2011). However, as I argue in this paper, it represents only one understanding of resilience among many. Understanding resilience as a discourse or paradigm in singular bears the problem that inner contradictions and fissures of resilience practices are downplayed or overlooked (Brassett et al. 2013).

Opposed to an understanding of resilience as a single historical paradigm, I would propose an understanding of resilience as a multiple (Simon and Randalls 2016). Such an approach stresses that there is no single, coherent concept of resilience. The notion of *multiple resilience* implies that there is more than one rationality or logic of resilience but less than many (Mol 1999). In other words, the meaning of resilience is ambiguous but not arbitrary[4]. I argue that the tendency to overlook ambiguities and fissures in resilience thinking partly goes back to the prominence of Foucauldian governmentality approaches in the critical literature on resilience (Corry 2014). Instead of studying the discourses and practices of resilience in an open manner, critical scholars on resilience often rely upon a fixed notion of governmentality as a particular neoliberal form of political power drawing on technologies of self-responsibilization and government at-the-distance (Bulley 2013; Joseph 2013b). As a result of this perspective, critical studies of resilience in the past thus too easily abandoned any understandings of resilience that do not fit the image of resilience as a neoliberal form of self-government (see Bourbeau 2018).

As a way to avoid the harmonization-tendency inherent in governmentality approaches to resilience, I follow Stephen Collier to conceptualize the relation between power and knowledge as a complex topology of power. Collier starts from the observation that Michel Foucault in his later work turned away from his earlier interest in totalizing epochal analyses of power-knowledge formations (or governmentalities) to increasingly "examine how existing elements are taken up and recombined" (Collier 2009). Although Foucault described the emergence of neoliberalism as an economic and political rationality, he never saw neoliberalism as overarching rationality of government. In the words of Collier:

One technology of power may provide guiding norms and an orienting telos. But it does not saturate all power relations. Rather, it suggests a configurational principle that determines how heterogeneous elements – techniques, institutional arrangements, material forms and other technologies of power – are taken up and recombined (Collier 2009).

For the present case, this implies that the concrete form and substance of resilience is subject to a context-specific, (re-)combination of ideas and political practices:

4 Olaf Corry has pointed to the existence of counter-hegemonic projects like the grassroots Transition Towns Movement who have articulated a social-ecological notion of resilience that opposes the official neoliberal version of resilience by the UK government (Corry 2014, 263). While this is a valid point, I would even go beyond this argument and claim that ambiguity is an inherent feature of the official, governmental resilience discourse in the UK itself.

“the space of problematization is a topological space, and thinking is a driver of recombinatorial processes” (Collier 2009). A topological analysis of resilience thus seeks to map multiple versions of resilience and studies how resilience rationales and practices are constantly translated, reinterpreted, and recombined in different contexts. Rather than as a new paradigm of governance, resilience should thus be understood as a configurational principle, which allows for a reconfiguration and translation of already existing political programs, ideas, and policies.

In contrast to earlier discourse analyses of resilience, I move from a diachronic to a synchronic perspective[5]. On the one hand, the sample of empirical sources comprises conceptual defense and security documents: the National Security Strategies (NSS) from 2008, 2009, and 2010 and the Strategic Defense Review (SDR) 2010. On the other hand, the sample includes concrete policy documents on the implementation of climate change and security related policies of the Ministry of Defense (MoD), the Foreign and Commonwealth Office (FCO) and the Department for International Development (DfID), think-tank reports, and NGO publications from the period 2006–2014. Additionally, 12 expert interviews have been conducted with representatives of key institutions in the three fields. In a first methodological step, I looked at the deep structure of the resilience discourse in the UK. Here, I was not so much interested in the actual discursive struggles (that is what is being said about resilience by whom) but in the question of how competing understandings of resilience are framed through collective symbols including metaphors, iconic symbols, analogies, and tropes such as metonymy, pars-pro-toto, or catachresis (Hajer 2006). I traced how these collective symbols become condensed into competing storylines. In a second methodological step, I turned away from this discursive deep structure to governmental programs and practices. I studied how resilience becomes implemented, practiced, or enacted in different institutional contexts. To theorize resilience in a way that accounts for its heterogeneity, I finally distinguished between three privileged translations of resilience. The analysis was operationalized with the qualitative data analysis software MAXQDA.

The UK climate security discourse

Already in 1980s, different voices in academic in political discourse raised concerns over the possible security implications of global environmental change. The UK played a crucial role in the emergence of this discourse early on (Rothe 2016). For example, as early as in the late 1980s then-Prime Minister Margaret Thatcher called climate change

5 That is from a conceptual history or genealogy of resilience thinking towards the study of the multiple meanings of resilience in present discourses.

a major threat to humanity and warned that “it is life itself that we must battle to preserve” (Carvalho and Burgess 2005). However, articulations like these remained occasional and in the 1990s public interest in the problem of global warming dropped – and so did worries about its security implications. In the mid-2000s, however, spurred by a series of disasters like the severe flooding in the UK in 2000 or the 2003 heatwave that killed tens of thousands across Europe, climate security returned to the agenda of high politics (Rothe 2016). Policymakers such as Tony Blair or then-Foreign Minister Margaret Beckett promoted the storyline of climate change as a threat to international security, in part as a strategy to re-establish the UK as a major international power (Carvalho and Burgess 2005). In 2007, the UN Security Council discussed the issue of climate change for the first time in its history – on the initiative of the UK Foreign and Commonwealth Office (FCO). At that time, there was broad consent amongst government officials, strategic think tanks, NGOs, the media, as well as bureaucrats from different UK departments about the security risks of climate change for the UK. By the late 2000s, these different actors increasingly took up the concept of resilience as a way of addressing the security implications of climate change. Resilience soon became one of the most prominent concepts in the discourse (Boas and Rothe 2016).

However, by taking a closer look at the discourse on climate security in the UK, one can observe that the latter is anything but a coherent, consensual debate. While all mentioned actors share a common orientation towards the potential security implications of climate change, they articulate the climate-security link in quite different ways. In doing so, they draw upon competing understandings of resilience. In the following, I distinguish three competing strands within the climate security discourse, each of which uses resilience in a considerably different way.

Climate risk and traditional security

A first, influential strand of the UK climate security discourse frames climate change as a threat or risk to the national security of the UK (Cabinet Office 2008). Voices falling in this category commonly express concerns over two types of risks for the UK that emerge from climate change (Cabinet Office 2009). First, primary risks are those potential harms for the UK that directly result from global warming, for example, a rising risk of flooding due to sea level rise or an increasing probability of dangerous heatwaves. Secondary risks, on the contrary, refer to the possibility that climate change could exacerbate tensions in other parts of the world, which might then affect the UK indirectly through an increase of irregular migration or the spread of instability. Of crucial importance in this threat narrative is the historical self-understanding of the UK as an island and a major marine power (Cabinet Office 2009). On the one hand, this self-image implies that the UK faces particular vulnerabilities both because it is surrounded by water and because it is globally interconnected – and hence particularly threatened by instabilities overseas. Many actors from the development and security field, including think tanks and DfID and FCO bureaucrats, are not so much concerned with the direct impacts of climate change but with the "consequences of consequences" (Smith and Vivekananda 2007). Such actors paint a picture of an increasingly dangerous environment for the UK in a warming world. This picture is then linked to the idea that the UK is a global hub in a globally networked world. As a result, it is feared that "it will be difficult for the UK to isolate itself from the global economic and geopolitical shocks that look certain to be experienced in a warming world" (Government Office for Science 2011). The focus on the consequences of consequences thus makes the vulnerability of the "global South" against climate change – and especially in the UK overseas territories and former colonies with which it still holds close ties – an immediate concern for the UK.

To cope with the primary and secondary risks posed by climate change, the UK has implemented a comprehensive climate impacts strategy that includes for example periodically conducted national climate risk-assessments (Defra 2012). These risk assessments provide the necessary information for the implementation of the UK's National Adaptation Program (NAP). The executive summary of the 2012 National Climate Risk Assessment report argues:

> Although we do not know the likelihood future changes in the UK's climate, we know enough to present a range of possible outcomes, which can be used to inform adaptation planning. For this purpose potential climate risks to the UK have been categorized according to their magnitude, 'confidence' and the 'urgency for action' (Defra 2012, xi).

Unlike the paradigmatic approach to resilience outline above, resilience here does not imply an end of the attempt to calculate and predict future risks at all. Quite the contrary, the compilation of all sorts of potential climate risks to the UK in comprehensive "risk registers" here becomes the basis of a climate resilient UK. This intimate relation between risk calculation and resilience is perfectly expressed by the Secretary of State for Environment, Owen Paterson, in his introduction to the 2013 NAP Report "Making the country resilient to a changing climate"(Defra 2013). In this report he argues that

> […] Britain's expertise in areas such as weather forecasting, flood modelling, infrastructure and insurance are already coming to the fore to prepare us for the kinds of events we might see more often. Indeed, the UK is already one of the global leaders in this industry of the future (Defra 2013, 1, emphasis added).

To sum up, climate conflict and risk storylines, first of all, identify linear causalities between climatic changes and (direct as well as indirect) security risks for the UK. These storylines focus on risks at a particular point of time in the future (e. g. the UK in 2030, 2050, or 2070) and seek to render them present through risk assessment of an expanding UK "industry of the future". In this reading, the UK's "industry of the future" and the foresight products that it provides become a crucial source of climate resilience. However, the anticipation of future climate risks and related knowledge practices are complicated by methodological and epistemological uncertainties, i. e. the uncertainty about the right methods to calculate future developments. Resilience thus becomes a function of predictive capacities and becomes embedded within a broader anticipatory governance of climate risks.

Climate catastrophe

A second strand in the UK climate security discourse (re)presents climate change as a looming global catastrophe (Methmann and Rothe 2012). These articulations of the climate security relationship differ from a classical understanding of security and the logic of risk outlined above with respect to the temporality and spatiality of the constructed threat. Temporally, the notion of climate catastrophe draws upon the idea of a movement towards a final endpoint – that is a global ecological collapse (Aradau and van Munster 2011, 10). This idea of a linear, teleological movement is for example expressed through the notion of the tipping point. A tipping point represents a temporal boundary, beyond which the gradual, linear change of a system (such as the global climate system) becomes non-linear and irreversible:

> Many assume that climate change will be a slow, linear process toward a moderately warmer future. However, scientists agree there are likely to be elements of the climate system that function like light switches – rapidly changing to a qualitatively different state (Mabey 2011, 16).

Sometimes the catastrophe is even elevated through apocalyptic or religious symbols (Methmann and Rothe 2012, Skrimshire 2014). Spatially, such representations of climate change turn away from the UK as central reference object and instead frame climate change as a fundamental threat to whole humanity or the planet as such. Thus, the catastrophe here poses a universal threat, an absolute endpoint both in temporal and in spatial terms. Spatially, the focus of security shifts from the national to the international or global level (see Foresight 2011b). Temporally, the notion of catastrophe puts a strong focus on mitigation: the catastrophe – in this case dangerous climate change – has to be prevented at any cost. This strand of the climate security discourse hence calls for strong leadership and political steering from decision makers. In the case of climate security, such a call for sovereign action is often articulated by Earth System Scientists and the notion of planetary boundaries (Steffen et al. 2015, see also Hardt 2018). However, this capability of the political sovereign to meet this role as leader in climate mitigation is limited both by the global nature of the threat and the epistemological uncertainties inherent to the scientific capacity to detect and predict tipping points of a complex and interlinked Earth System (Steffen et al. 2018).

To sum up, a discourse of climate catastrophe draws upon an ecological teleology: the development towards an endpoint (non-linear climate change), which must be prevented at any cost. At the same time, there are epistemological limits to the detection of existing tipping points in the Earth system (Mayer 2012, 171). Mitigating the catastrophe requires an active engagement with the environment – here international climate governance – to shape a desired future and prevent dangerous pathways of climate change, for example, by building resilience overseas.

Climate complexity

A third strand of climate security discourse understands climate change as a complex and unpredictable phenomenon. According to this rationale, there are not only methodological and epistemological but also ontological limits to knowing climate change. The UK national security strategy from 2013 is a good case in point, which starts from the assumption that we are now living in an "age of uncertainty" (Cabinet Office 2010b, 3). Global climate change is considered as one major source behind the rising global uncertainty, which nowadays shapes the UK security environment. Illustrative is a MoD report that presents climate change as a "ring road issue". A ring road issue is understood as "a driver that is so pervasive in nature and influence that it will affect the life of everyone on the planet over the next 30 years" (Cabinet Office 2010a, 6). Climate change is not only perceived as a global threat (as in the discourse of climate catastrophe) or as a trend that poses a series of direct and indirect risks to the UK, but increasingly also as a complex system whose secondary impacts are literally unpredictable.

What is striking in the UK security strategy and related security documents is the emerging resonance between climate research and security thinking. Climate systems research has informed notions of complexity, which led to a rethinking in current security policy (Kavalski 2011, Mayer 2012). Furthermore, strategic thinkers and security officials have articulated climate change itself as a complex security threat: "The climate is a complex system and most forms of human interaction exist in the realm of complexity. […] Ultimately, complexity itself is a significant risk factor that needs to be addressed explicitly" (Mabey 2011, 91). In the UK security discourse, the belief that we are living in an age of uncertainty went hand in hand with a shift away from classical security policies that seek stability and control. Following the slogan "stationarity is dead", the British think tank E3G for example argues, "[p]reparing for the future means rejecting stationarity as a guide to future outcomes. The first presumption should therefore be that all critical systems will be vulnerable without adaptive measures" (Mabey 2011, 103). In this reading, protective security policies must be as versatile as the perceived threats: "In an age of uncertainty, we need to be able to act quickly and effectively" (Cabinet Office 2010b, 5). As a result, the complexity discourse fuels skepticism towards centrally planned political steering. Hence, in line with the critical literature on resilience, climate complexity storylines promote forms of decentralized governance that shift the burden of security policy from the state to the individual citizen, to local communities, or to the private market (Cabinet Office 2008, 59).

In sum, a discourse of climate complexity stresses the uncontrollability and radical uncertainty of the climate system. In short, in an age of uncertainty, the past does not provide any yardstick anymore to predict future events and trends. Thus, knowing or actively shaping future developments is beyond the scope of human actors. Contingency is not considered a feature of the representation of the world anymore but a feature of the world itself.

Articulations of climate resilience in the UK discourse

In this section, I present the findings of a comprehensive discourse analysis of key policy documents and think-tank reports in three political fields crucially related to the climate change and security discourse: the strategic community, the field of civil protection, and development and foreign policy. Additionally, 12 research interviews with representatives were conducted[6]. The aim of the analysis was to show how linkages between climate change and security – and with it the concept of resilience – become rearticulated and translated by practitioners and political representatives in different fields. The results of this discourse analysis are summarized in Figure 1. The figure shows the most prominent discursive concepts, or signifiers, in different domains. The size of each concept illustrates its relative prominence in each context while its position on the map and the proximity to neighboring signifiers represents its relation to other concepts in the discourse. The map was derived from a comprehensive discourse analysis of the empirical material with MAXQDA. It does not represent a semantic network based on a quantitative or bibliometric analysis. Figure 1

6 For a further discussion of the underlying methodology, see next section as well as Rothe 2016.

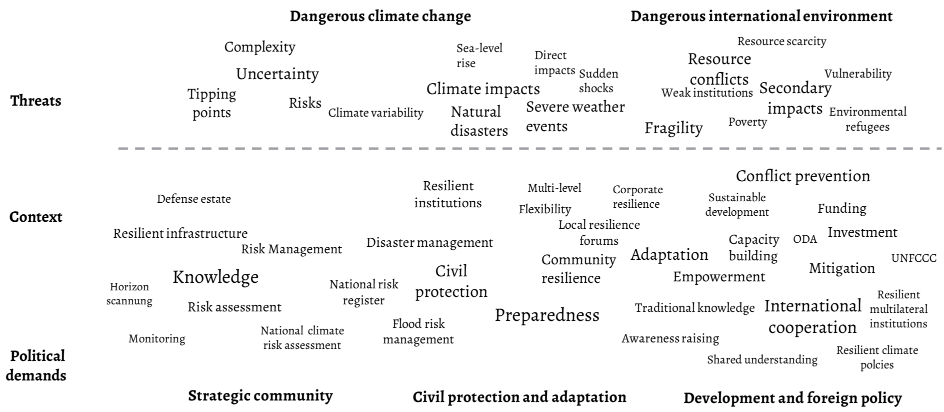

Figure 1: Articulations of climate resilience in different institutional contexts.

gives an overview of the complex landscape of climate security in the UK. It presents the key demands, concepts, and practices that are linked to resilience in three different contexts: 1. the strategic community, i. e. actors from the MoD as well as security-related think tanks, 2. civil protection and climate change adaptation; and 3. development and foreign policy[7]. These demands, concepts, and ideas are legitimized through the identification of a whole range of potential problems, risks and threats (upper part of the figure). These are presented as external, antagonistic threats for the inside community of the UK.

For practitioners and officials in the strategic community, climate security is mainly a function of the resilience of the defense estate against unfolding climate hazards. Resilience promotion is based on all sorts risk assessment and "horizon scanning" activities (Cabinet Office 2009, 44). Thus, resilience is basically about the generation of knowledge about vulnerabilities and ways to overcome them. For example, the UK Ministry of Defense expresses the hope that research on (low-carbon) technologies in the military will increase the resilience of the defense estate under the premise of future climate change (MoD 2010b). The need for research and the promotion of forecasting technologies is mainly justified through the storylines of an impending climate catastrophe and the complexity of the earth system outlined above, which stress the existence of tipping points and uncertainties about future climatic changes.

In the context of civil protection and adaptation (center of Figure 1), resilience is mainly articulated in line with the demand for enhancing adaptive capacities of local communities and individuals. In this context, resilience requires a "multi-level,

7 Figure 1 is based on a qualitative analysis of the UK climate security discourse.

multi sector, bottom-up approach" (Cabinet Office 2009, 90) that would integrate self-responsible communities, businesses, and individuals into UK climate disaster management. In line with the UK's broader "Big Society" agenda (Cabinet Office 2010a, 49), private actors are supposed to become active self-reliant agents that do their bit in the creation of a resilient UK. The overall rationale of the NAP – that is "a society which makes timely, far-sighted and well-informed decisions to address the risks and opportunities posed by a changing climate" (Defra 2013, 9) – perfectly expresses this rationale. Demands for preparedness and self-responsibility are based on storylines of climate risk.

On the right side of the figure, you find expressions of climate security and resilience in the field of development and foreign policy. Actors from the Department for International Development (DfID) or the Foreign and Commonwealth Office (FCO), as well as peacekeeping NGOs have linked climate security to notions of good governance, functioning state structures, and to the principle of sustainable development (Smith and Vivekananda 2007, Smith and Vivekananda 2009). For these actors resilience in the "Global South" is a key concept to produce climate security. In this context, it refers to adaptation funding that includes private sector investments in developing countries as well as Official Development Assistance (ODA) to educate and activate vulnerable communities in the global South. These policies and demands are legitimized against the backdrop of climate conflict and risk storylines that highlight mainly the secondary impacts of climate change. The dangerous "other" is made up by the global South and its problems with fragility, instability, ongoing conflict, and migration.

Three translations of resilience

The different versions of the UK climate security discourse did not simply translate into a clear set of policy measures and governmental programs. As I show in this section of the paper, when bureaucrats and practitioners in the policy fields of development, security or civil protection, adopt climate security storylines, they rearticulate and reinterpret them against the backdrop of their own established routines, conventions, and beliefs. As a result, there is nothing like a single coherent UK climate security strategy. Rather, one can observe the emergence of a complex governmental landscape of climate security – a creative amalgamation of heterogeneous political ideas, instruments, and practices. The malleable concept of resilience provides some orientation for all these practices without subsuming them under an overarching political rationality. Exactly because resilience is so malleable and ambiguous, it becomes possible for actors from very different contexts and backgrounds to translate it into their own language and mindsets. At the same time, however, its meaning is

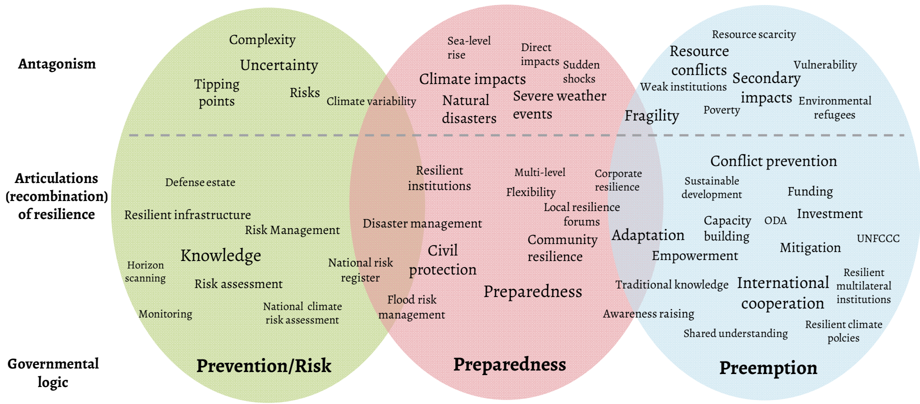

Figure 2: Three logics of resilience in the governmental landscape of UK climate security.

not completely arbitrary. Drawing upon a typology of types of governing the future by Anderson (2010), I suggest that it is possible to distinguish between three ideal-typical translations of resilience that each follows a distinct logic of security: precaution, preemption, and preparedness (see Figure 2). I use Anderson's typology to derive three analytical ideal types that help structuring the complex landscape of the climate security discourse in the UK.

A first translation of climate resilience is one of prevention. Hereby, I refer to the attempts of security actors, governmental scientists (Government Office for Science 2011b), strategic think tanks (DCDC 2010, DCDC 2014), and NGOs (Mabey 2011) in the UK strategic community to anticipate or calculate future climate change related risks. The cooperation and interaction of these actors in workshops, meetings, and joint projects leads to the growing convergence of methods and practices between climate sciences on the one hand and security policy on the other. The currency of resilience understood as prevention is knowledge, which circulates between the described actors in the form of risk registers, future scenarios, or risk matrixes (MoD 2010a). Scholars and think tank members produce this future knowledge through a whole range of monitoring, risk assessment activities, and "horizon scanning" activities (Cabinet Office 2009, 44).

A good case in point to demonstrate how the logic of resilience as prevention works in practice is the MoD's Climate Impact Risk Assessment Method (MoD 2010b). The aim of this approach was to preserve UK's defense capabilities by increasing its resilience to "[…] the risks to global security presented by the complex geopolitical interactions resulting from a changing climate, as well as the risk to our own establishments and equipment from the impacts of climate change" (MoD 2010b, 2). For this, the UK MoD compiled a comprehensive "Climate Resilience Risk Register" (MoD 2010b, 5) that lists, prioritizes, and scores any current climatic risk for MoD's defense estate or infrastructure. In a second step, the MoD combines this risk register with the scenarios developed in the UK Climate Projections 2009. Whereas the paradigmatic approach to resilience outlined above understands the rise of resilience as a reaction to the apparent failure of conventional risk-management methods due to the limits of knowledge in a world of complexity, the example of the MoD proves that the opposite is the case in the strategic community. Comprehensive knowledge of future risks is seen as the prerequisite of resilience. As put by members of the UK think tank International Alert, a resilient society "[…] understands the risks it faces because it has the scientific capacities to do so" (Smith and Vivekananda 2007, 33). Consequently, resilience becomes translated into a liberal-modernist discourse, which stresses the role of technology and science for human progress.

In a second institutional context – that of civil protection and climate adaptation – resilience becomes translated into a discourse of preparedness (Chandler 2014, 56–57). Actors working in this field link resilience to their established routines, conventions, and practices; thereby tearing down departmental dividing lines (Adey and Anderson 2012). The overall rationale is to empower and include local stakeholders and to remove the barriers, which are faced by the institutions of the state in an "Age of Complexity" (Cabinet Office, 2010a, 2010b). Following the ideal of a "multi-level, multi sector, bottom-up approach to resilience planning" (Cabinet Office 2009, 90), state actors seek to incorporate programs to integrate businesses, communities, and individuals into climate adaptation and disaster preparedness activities. The rationale behind this is that these actors would be "better placed than government to understand and respond to the needs of the local community before, during, and after an emergency" (Cabinet Office 2010a, 26). For example, the establishment of "Local Resilience Forums" seeks to initiate a continuous dialogue between local citizens and stakeholders as well as regional administrations and the civil contingencies secretariat on a regular basis (Adey and Anderson 2012, 108). Resilience here transcends popular distinctions between interventionist centrally planned and decentralized market-based forms of governance by integrating public and private actors. The work on preparedness, to sum up, links the practices of very different actors – from disaster planners to private sector consultancies, to businesses, and to communities. It helps establishing novel relations between actors and circulates tasks and responsibilities between them.

A final translation of resilience in the climate security landscape adheres to a logic of preemption. In the field of foreign and development policy, resilience mainly follows the aim of mitigating secondary risks from climate change for the UK. In line with a logic of preemption, actors from the DfID and the FCO actively intervene in the UK's international environment to shape a desired future through diplomacy and development policy. This is perfectly expressed by the notion of an "active diplomacy" (FCO 2006), which builds upon the assumption that:

What happens abroad has never mattered more for our security and prosperity. In an age of rapid global change, the task for Government is to seek to understand and influence the world for the benefit of our people (Blair quoted in FCO 2006, 3).

The UK's active diplomacy seeks to mobilize the international community to join the UK's ambitious climate mitigation efforts. For example, the UK sponsored debates on climate change in the UN Security Council followed this rationale – that is to raise awareness and to activate the most affected countries (Government Office for Science 2011b, 90). At the same time, UK development policy becomes increasingly reoriented towards support of climate change adaptation and resilience building efforts in developing countries. DfID and related NGOs seek empowering local stakeholders and communities in vulnerable regions. The rationale is that increasing the resilience of overseas communities will prevent perceived risks for the UK— such as an increased influx of migrants due to climate change (DfID, FCO and MoD 2011a). A good example is the UK International Climate Fund, established in 2010, which has the aim of funding adaptation and mitigation projects in vulnerable countries and regions (DfID, FCO and MoD 2011b). Climate funding here becomes reframed as investment in resilience and an instrument to produce stability abroad (DfID et al. 2011a). Another good example of how resilience becomes translated into development policy in line with a logic of preemption is the UK strategy to deal with climate-induced migration. The seminal UK Foresight report on "Migration and Global Environmental Change" (Government Office for Science 2011a), for example, argues for proactively promoting planned migration and resettlements in climate hot-spot regions. The underlying logic is that planned migration could be used to preempt uncontrolled and unplanned migration flows from vulnerable regions that might reach the UK (see Government Office for Science 2011a, 17). Other than suggested by the paradigmatic approach to resilience outlined above, the latter here does not imply the end of interventionism, political steering, and planning. Instead, investment in resilience becomes a possibility for government intervention in the world in spite of complexity and uncertainty. Resilience becomes translated into a liberal-modernist discourse with aim of intervening and shaping the world. Rather than autonomous, self-organizing systems, it addresses political subjects that can be influenced, activated, and shaped.

Conclusion: Resilience in translation

As I have shown in this essay, resilience has been translated and reinterpreted by multiple actors in different contexts of the UK's governmental strategy to address dangerous climate change. My study shows that resilience is characterized by a multiplicity and ambiguity that allows resilience to function as a boundary concept that bridges different political communities. Drawing on a topological understanding of power, I was able to sketch a more differentiated picture of the climate resilience landscape in the UK. In this heterogeneous landscape, resilience managed to become a dominant political concept, not despite but due to its ambiguity. Exactly because resilience can be translated in very different contexts and because it allows actors in these contexts to reinterpret resilience in relation to their established routines and conventions, resilience could become a hegemonic demand in UK the climate security field. For some, it resonates with a neoliberal – or better post-liberal – complexity discourse and mistrust in central government. At the same time, however, it easily adopts and integrates diametrically different voices and re-interpretations of resilience (Boas and Rothe 2016). Resilience assembles political actors in a spontaneous and disordered way and links heterogeneous sets of practices and ideas in temporary networks and assemblages. It does so without following any broader political ideological or strategy. I would argue that it is exactly this ability of resilience to forge temporary assemblages rather than stable discourse coalitions or political communities, which makes up the strength of resilience in our age. The UK certainly represents an extreme case given the ubiquity and the popularity of resilience in the political and public discourse. Thus, the question arises whether the findings of this study are generalizable beyond the context of the UK. Further research is required to give a definite answer to this question.

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13 Climate change and planning for the military

Michael Brzoska

Abstract

A core debate about the consequences of climate change concerns its security-related aspects. Elements of that debate include the expected extent of climate as well as definitions of security. Official documents on national security and defense planning are investigated with respect to these two elements of debate. A content analysis of relevant documents from 38 countries reveals a diverse response by national security establishments to the challenges presented by climate change, which also changes over time. Seven potential roles for armed forces in response to climate change are identified and quantified for the selected documents. A predominant expectation is a greater demand for disaster relief by armed forces. However, there are also governments which expect an increase in traditional security threats, as well as governments who do not foresee any security challenge resulting from climate change.

KEYWORDS: Armed forces, defense planning, national security, disaster management.

Introduction

Climate change will affect the conditions under which societies, governments, and institutions in general are going to have to operate. Most probably, this will also include armed forces. Climate change should therefore be of concern to those responsible for the roles and functions of the military. And indeed, the relevance of climate change for armed forces has been widely debated, also by a number of security and defense think tanks (CNA 2007, CNA 2014; CSG 2018), among various militaries (Brzoska 2012a, GMACC 2014, Brzoska 2015, Scott and Kahn 2016, Causevitz 2017) and, more prominently, in political fora such as the United Nations Security Council (Detraz and Betsill 2009, Scott and Ku 2018).

Views expressed in these debates have ranged widely, from seeing a world marked by "climate wars" (Dyer 2008) – implying a great demand for traditional military forces – to a need to cut military spending in order to be able to finance climate adaptation and mitigation measures (WBGU 2008).

Academic analysis has been similarly diverse. Some authors have evaluated the debates on the potential military consequences of climate change as very forceful and effective tool of advocacy or changing the course of climate-related policies (Brauch 2009, Floyd 2010), while others have analyzed them as results of a deliberate effort to push for an increased militarization of societies (Hartmann 2010, Gilbert 2012, Marzek 2015).

The purpose of this paper is to go beyond such contradicting perspectives in two ways. One is to provide a more differentiated analysis of the consequences climate change can have for armed forces. While there are some straightforward connections between climate change and armed forces – e. g. the military's contribution to climate change due to its consumption of energy – others are subject to a number of constructions about the future risks of climate change and the relationships between major powers and weaker states. As a result, a number of different potential "military futures" are identified. The second innovation of this paper is to empirically investigate to which extent these "military futures" are informing current military planning. For this purpose, official documents on military planning were analyzed. While perceptions of the implications of climate change for armed forces and military policies may change in the future, the empirical investigation of the current planning of future roles and functions of armed forces is an indicator of the future effects of climate change on armed forces.

This paper first presents the state of debate on the military and climate change in its various strands. Future pathways for the military, which can be identified in relevant literature, will be illustrated by examples from the two countries, in which the debate on climate change and the military has been most extensive, the United

Kingdom and the United States. The following section empirically reviews how "military futures" are represented in official planning documents. This includes discussing two factors potentially shaping different perspectives on the future of armed forces, namely perceptions of climate change as a security issue and the power status of countries. The conclusions sum up the paper and link the results to the broader debate on the connections between climate change and the military.

The military in the climate change discourse

The military has contributed to the climate change debate in three strands of debate and literature, both as an object of and as a contributor to discourses.[1]

First, and most prominently, there is the debate on security threats or risks marked by major climate change. Some analysts and policy makers have painted dark pictures of an unstable and violent future, implying a greatly increased need to protect people and countries by military means if mitigation of climate change failed (Schwarz and Randal 2003; Dyer 2008; CNA 2014, Wallace and Silander 2018). The large majority of authors with such a pessimistic view of the consequences of climate change argue for drastic changes in climate-related policies in order to prevent future wars. Still, an increased need for armed forces is easily justifiable when substantial security consequences loom (Brzoska 2009; Hartmann 2010; Marzek 2015). Predictions of major disasters, large numbers of refugees, and political instability can be easily understood to imply important roles for armed forces in an insecure future. The literature on climate change-induced security threats and risks is full of rather general remarks on the future demand for activities by armed forces in an environment, in which global warming exceeded two degrees Celsius.

Armed forces have not only been an object of advocates of major changes in climate policies. A second link between the military and climate change has been the prominent voice of active and former high-ranking officers in the climate policy discourse. The importance of officers and institutions associated with the US armed forces, particularly the Navy, for the climate policy debate in the US in the past decade is well documented (Floyd 2010). The above-mentioned study by Schwarz and Randall, one of the earliest scenario studies of climate change, was sponsored by the Office of Net Assessment in the US Department of Defense. Within the Pentagon, the various branches of the armed forces initiated internal and external studies (Brzoska 2012a; Marzek 2015; Thomas 2017). Concerns over consequences of climate

1 This is a slightly revised and abbreviated version of Climate Change and Military Planning, published in the International Journal of Climate Change Strategies and Management, Vol. 7 Issue: 2, 2015, pp.172–190.

change are often focused on particular issues such as demand for military capabilities to meet humanitarian disasters (McGrady et al 2010) or effects of climate change on military bases (Smith et al 2010, National Academy of Sciences 2011, Foley 2012). In most of these contributions, climate change is seen through the lens of the effects of climate change on traditional military operations. In a second strand, the focus is on ways the military itself can contribute to climate change mitigation. In addition to the US military, some others, such as the UK and Australian armed forces, initiated studies on the security effects of climate change and formulated a full-fledged climate strategy (United Kingdom 2009, Thomas 2017). The Global Military Advisory Council on Climate Change (GMACCC), a group of military officers from around the world, has produced a number of reports and policy statements (GMACCC 2014).

A third strand of literature on the link between climate change and the military has been a lively, critical debate on the use of climate change in discourses on future security, and particularly military, requirements (Oels 2011; Trombetta 2012; Rothe 2016; Dietz, von Lucke and Wellmann 2016). Most of this debate revolves around different concepts of securitization. While securitization is a broader concept for the analysis of constructing an issue as a security threat, the military dimension can be easily made a part of it. Taking the predictions about growing instability and disasters as a clue, a number of authors have critically assessed whether the talk about insecurity in the two strands of discussion have led to a discourse dominated by the idea that climate change needs to be met with larger armed forces. Authors predominantly agree (but see Gilbert 2012) that, at least so far, this has not occurred. There have been no major consequences of climate change for armed forces yet. “Exceptional measures” such as large increases in military budgets or major expansions of the roles of armed forces, which would be indicators of successful securitization in the analysis of the “Copenhagen School” of securitization have not occurred (Brzoska 2009; Oels 2012). Authors are more divided on changes in security “practices”, for instance the role of armed forces in border or disaster management. These would be indicators of securitization for authors of the “Paris School” such as Bigo and Balzacq (Balzacq 2010). Nevertheless, there is mostly talk of such change and little empirical evidence of it (Brzoska 2012; Oels 2012). In this strand of critical analysis, climate change is increasingly found to be one element among several such as terrorism and cyber security, which present largely unpredictable future risks (Oels 2011). The type and nature of these risks, including climate change, require broad sets of measures, such as the prevention and strengthening of the resilience of potentially affected people and communities. Attention in the debate on the possible securitization of climate change has therefore moved away from concerns about armed forces to broader issues about the consequences of “riskification”, such as a shift of decision-making away from democratically elected bodies to groups of “risk experts” (Corry 2012, Oels 2012, Trombetta 2012).

In summary, the attention given to potential security consequences of climate change, including possible future "climate wars", has also raised the profile of armed forces in climate discourses, albeit in a variety of different ways. Military officers have raised their voices warning of the security consequences of climate change, but also discussing future military engagements. Militaries have been portrayed as being directly threatened by climate change, for instance because of sea level rise, but also as possible "winners" in terms of additional resources and missions. However, much uncertainty about the consequences of climate change for the future role of armed forces remains dominant, precluding a dominant discourse on prescriptions on what to expect and what to do. The following two sections aim at advancing the discussion by first providing a classification of potential future roles and functions of armed forces in more detail and then assessing the prevalence of these military futures in a set of relevant documents.

Consequences of climate change for armed forces

Potential pathways

The following classification of possible future roles and functions of armed forces, called "military futures", is based on a collection of suggestions found in relevant documents and the literature summarized above. Most of the examples are drawn from the United States and the United Kingdom, the two countries, in which the links between climate change and the military have been most vigorously debated (Brzoska 2012a). While not exhaustive, the six potential "military futures" identified below as possible consequences of climate change for armed forces capture a large part of the various strands of the debate outlined above. By themselves, these "military futures" represent ideal types, which are often combined in particular documents and discussions. While being useful to illustrate different perspectives on the future armed forces, the six' military futures should not be considered to be exclusive. They are likely to influence the future of armed forces in some combination, if at all.

Each of the "military futures" is marked by a particular perspective of the way, in which climate change is expected to affect armed forces. These perspectives will be further explained below. They have consequences for the major characteristics of armed forces, reflecting inputs, internal workings, and output of these institutions. Three dimensions reflecting these characteristics seem to be of particular relevance in relation to climate change (see Table 1). One is the potential changes in what armed forces are actually used for. Force functions may or may not change with climate

	force functions	force structures	financial resource allocations
"greener" military	little change; some reluctance to perform energy intensive operations (Air Force)	little change, some reductions in energy intensive elements (Air Force, Navy)	additional costs through investments into alternative energy; energy savings
"leaner" military	focus on high-priority functions	focus on elite forces	shifts away from military spending to finance climate change mitigation and adaptation
climate change "victims"	none	none	additional costs to preserve base structures and operational capabilities
armed "rescuers"	greater emphasis on disaster management capacities	increased air assets, logistics, equipment for disaster management	additional costs to enhance disaster management capabilities
armed humanitarians	greater emphasis on capacities for low-violence interventions	more transport assets, ground forces for peace-keeping	additional costs for low-violence interventions
climate warriors	greater emphasis on war fighting	more military assets for war-fighting	additional costs for military investments across the board

Table 1: Potential climate change induced changes (compared to baseline without climate change).

change, depending on differing perspectives of the implications of climate change for armed forces. Another indicator is the funding of armed forces. As climate change mitigation and adaptation are costly, there are financial trade-offs.

On the other hand, additional functions of armed forces associated with climate change require additional funding. A third indicator is changes in the composition of armed forces, the relative importance of elements of armed forces performing particular functions. Certain operational elements may become more, or less, important with climate change.

"Greener" military

One aspect of the debate on climate change and the military has been that it has directed a spotlight on armed forces as a major producer of greenhouse gases (see e. g. Klare 2003). While there are no reliable estimates of the global greenhouse gas production by militaries, it is likely that their shares in global greenhouse gas production are similar or higher than the shares of military expenditures in global income because of energy intensive activities such as transport and flying.

By far the largest consumer of energy and producer of greenhouse gases in the world is the US military. Its size, global spread, and military action in places distant from most major installations, such as Afghanistan during the military intervention there, make the Pentagon's agency in charge of supplying energy to the largest single customer of energy in the world.

US armed forces have seriously begun to take energy considerations into account for the full spectrum of their activities (Brzoska 2012a, Thomas 2017; CSA 2018). They have defined energy saving goals and objectives in operations, including combat operations, as well as acquisitions. One of the objectives is the increased use of alternative energy. Substantial amounts of money have been invested in solar and wind energy on military bases as well as the adaptation of systems, such as aircrafts and warships, to use biofuels. Reporting and inspection schemes have been developed and more and more data on energy use by the US armed forces is becoming available (United States 2011; 2016). It is difficult to assess the effects of all these activities compared to changes in US military engagements, particularly the partial withdrawal of troops in Afghanistan. However, overall energy consumption and production of greenhouse gases have been reduced substantially, from 110 billion barrels in 2011 to 90 billion barrels in 2016 (United States 2017). The UK Ministry of Defense (MOD) and military have also adopted substantive measures to reduce greenhouse gas emissions. As in the case of the US, it is difficult to separate efforts to "green" the military to changes in military deployments. Still, the consumption of fuel and production of greenhouse gases have been reduced substantially since 2009 (United Kingdom 2018). Little is known about efforts in other countries. The potential to save energy and reduce greenhouse gas emissions is clearly substantial within the current spectrum of military activities, particularly, with respect to flying and other activities requiring substantial amounts of fuel. "Greening" the military is not necessarily about changing its functions (Table 1), but is obviously linked to military deployments and operations. Saving energy also saves costs; developing alternative energy, however, requires additional investments.

"Leaner" military

Mitigation and adaptation to climate change require investments. In view of the uncertainty of future security risks of climate change and the role of the armed forces in meeting them, defense ministries might be expected to find it harder to justify the allocation of resources to the military. Furthermore, one can argue that the prevention of potential conflicts through spending to limit climate change before conflicts arise is a smarter strategy than investing in the military to later meet these risks (WBGU 2008).

Although this sounds logical, there is little evidence that this argument has been used, successfully or not, in political decision-making on military budgets. However, there is more evidence of an indirect link in many countries, via the distribution of financial austerity measures over government departments. In NATO countries, for instance, military spending has declined during the past few years (SIPRI 2018).

Beyond mitigation, a feature that might facilitate funding shifts away from the military is the increase in general debates on security of comprehensive concepts such as risks and threats. Rather than giving the military a privileged role in providing for security, as was the case with traditional security thinking, it becomes one actor among an assemblage of actors and practices funded to prevent and manage future risks. Climate change, marked by a high degree of uncertainty about its consequences, is one of the risks, for which a good number of actors, such as disaster management organizations, can legitimately claim resources for management purposes.

Global military spending amounted to about 1.7 trillion US dollar in 2017 (SIPRI 2018). Obviously, this offers major opportunities for the redirection of financial resources. Governments wishing to find money for investments into mitigation or adaptation measures therefore might find it attractive to reduce their expenditures on armed forces. The armed forces resulting from such cuts will only be able to perform some of their earlier functions. They are also likely to be "trimmer", with a focus on elite forces (Table 1).

Climate "victims"

One of the effects of climate change on the military mentioned in the secondary literature and some official documents is the threat to low-lying military installations, particularly naval bases. Both in the US and the UK, assessments of the dangers of sea-level rise for bases have been initiated, which conclude that costs of adapting military installations to higher sea levels will be substantial (National Academy of Sciences 2011; US GAO 2014; United States 2014; Union of Concerned Scientists 2016, United Kingdom 2009).

Beyond costs, climate change may have geostrategic implications. It has been argued, for instance, that costs for oversee deployments may rise with the greater likelihood of extreme weather (Foresight 2011, 46). If governments choose to maintain deployments, they will have to allocate additional funding to their armed forces.

Armed "rescuers"

As most predictions of climate change indicate an increase in extreme weather, it is very likely that the number and intensity of disasters will grow. This, in turn, will increase the demand for disaster management.

Disaster management is done by a host of local, national, and global organizations, public, volunteer, and private. Armed forces are already often involved in disaster prevention, management, and relief, both within their home countries and abroad (Schnabel and Krupnaski 2012, Scott and Kahn 2016).

Equipping armed forces with additional capabilities to perform functions related to disaster management will lead to changes in force structures. Additional assets will be required; elements of armed forces able to perform rescue tasks have to be expanded (Oxfam and CNA 2011). A major justification is the associated costs. Armed forces are generally judged to be a cost-effective solution to disaster management because personnel and equipment are predominantly employed for other purposes and only directed to disaster management in times of need.

The role of armed forces in disaster management is partly limited in many countries because disaster management is seen as a civilian activity, within civilian legal and organizational frameworks. Using armed forces in disaster management can be seen as a form of "militarization", even if it occurs for beneficial purposes. One reason the government in Rangoon was reluctant to allow foreign organizations into Myanmar after the devastating cyclone Nargis in 2008 was its fear that foreign humanitarian support with military assets might lead to a military intervention, as indeed suggested by the French government at the time (Brzoska 2017).

Armed humanitarians

Beyond disaster relief, a frequent topic in publications and debates about the future consequences of climate change is complex humanitarian emergencies. These come about because of a confluence of consequences of climate change with a lack of capacity to deal with the causes of violent conflicts. They are marked by a combination of the threat or use of physical violence with shortages of food, housing, and other basic requirements. Examples include the lack of capacities of authorities to prevent disasters from fanning conflicts or the combination of major negative consequences of climate change with state collapse or refugee flows in conflict areas. Frequently, in the literature on climate change, complex emergencies are seen as a major future risk in conflict areas or those already marginalized economically (WBGU 2008; Smith and Vivekananda 2007).

Predictions of an increased number of military interventions by Western powers are often based on such assessments. For instance, authors of the UK Foresight report argue about the combination of climate change and violent conflict:

> […] in many countries that face the double-headed problem, the government is going to be either unwilling or unable – or both – to take on the task of adaptation and peacebuilding. […] The task of helping communities adapt to climate change cannot be left to such governments (Foresight 2011, 23)". Mabey et al write that "… security in the 21st century will require a major increase in the capacity to launch coordinated international humanitarian and preventive missions (Mabey et al. 2011, 133).

Few countries currently maintain armed forces that are optimized for such humanitarian interventions, implying the need to change force structures if the importance of this function increases. Even in countries, in which armed forces already focus on this role, a greater demand for such interventions will require additional funding (Table 1).

Climate warriors

As mentioned above, some authors have argued that climate change is likely to lead to national security problems, implying that larger militaries capable of fighting conventional wars will be needed. Some critics of the argument that climate change presents a national security problem have expressed their fear that climate change may be instrumentalized to legitimize larger and stronger militaries.

While there are many suggestions of future "climate wars" (e. g. Dyer 2008), few governments have adopted the view that climate change is likely to result in a traditional national security problem. Very informative in this respect are the debates on climate change, which have occurred in the UN Security Council in 2007, 2011, and 2018. The majority of governments argued that climate change was a "human security" issue; nonetheless, a good number denied that it was a security issue by any means. However, some of the biggest military powers, including the United States, the United Kingdom, and Russia, are among those who express fears about tensions rising with sea levels, water shortages, the melting of ice sheets, and other consequences of climate change that may amount to national security challenges.

Among the greatest worries are conflicts over resources, their shortage, but also their abundance. A prominent example of a region, in which climate change may change the availability of natural resources, is the Arctic. It is often seen as a region of future competition among major states, including Russia, the United States, and potentially even China. This has already led to military planning and action in a number of countries (Bailes and Heininen 2012, Heininen 2014).

Other potential national security hot spots of climate change have been mentioned in the relevant literature. However, any prediction about future military action resulting from climate change is subject to the assumption that climate change will increase threats to national security. While climate change does have this potential, it need not be this way. As in the prominent case of the Arctic, other factors, including the interest to avoid wars, may offset the tensions created by climate change.

Military futures in overview

The consequences of climate change remain uncertain, and so do the possible changes in the perceived future requirements for armed forces. Predictions based on worst-case scenarios have little basis in current evidence, not only because of the associated uncertainties but also due to the inherently political nature of decisions over size, structure, and deployment of armed forces. The various "military futures" distinguished in this section have partly overlapping and partly differing consequences for armed forces (Table 1). Furthermore, they are partly complementary. Thus, the US military has been striving to become "greener" but at the same time more efficient in fighting wars for more than a decade.

Still, military planners and their masters in governments and parliaments will have to make choices among military and other budget spending as well as about what to prioritize among the potential roles and functions of armed forces. These choices are inherently a political decision, an issue I will turn to in the next section.

Choosing military futures – the evidence from national security documents

Introducing the data set

This section will focus on the available evidence about what decision makers have authorized as views about the future of armed forces in the wake of climate change. The emphasis of the analysis thus shifts from general suggestions on the military implications of climate change to the examination of how changes of the role and functions of armed forces as a result of climate change are described in authoritative documents on military planning. The classification developed above is used for this purpose. Sources for the analysis are official authoritative documents such as white papers and similar official documents on national security and defense planning (see also Brzoska 2012). In total, 53 documents from 38 countries made public between 2001 and 2013 were analyzed (see Brzoska 2015 for more detail). They were collected through an extensive internet search for documents authorized by governments or Ministries of Defense, describing the role of armed forces in national security policies. Because for many countries such documents are not available or not published on the internet, the set of documents used here is not representative. It has a strong bias towards countries from the global North with open political systems and above average per capita income. Still, it presents a fairly broad array of perceptions of the consequences of climate change for military planning. Very few documents contain direct references to future roles and functions of armed forces. However, many contain lines of arguments which imply preferences for one or more of the military futures. Both instances of evidence of perceived links between climate change and the military were linked to the six military futures identified above (Table 1) through a number of keywords, used as frames for the analysis of the documents. In order to capture those cases, in which climate change was not mentioned in a document at all or was explicitly mentioned as not being connected to security or not having an influence on military planning, a seventh analytical category of "naysayers" was added.

Two sets of frames were used. The first set relates to the explicit mentioning of consequences of climate change for armed forces. Such direct connections were related to the six "military futures" identified above (Table 2). The second set of frames relates more indirectly to potential futures for armed forces. It takes particular arguments about policy priorities to meet the challenge of climate change and identifies them as being relevant for the future of armed forces. To explain in more detail: Since the documents analyzed here all are about security, it is assumed that a policy priority on mitigation implies that armed forces should become "leaner" in order to increase the amount of financial resources available for the funding of mitigation. Where adaptation was emphasized as a priority in the documents, this is classified as providing arguments for a "greener military", one that is more adapted to future ecological requirements. Similarly, where "resource re-allocation" was mentioned in the documents as a necessary response to climate change, this was classified as the proposition of a "greener military". These frames are assumed to prioritize particular military futures but may also support other changes in armed forces as well. For instance, arguing for the need for adaptation may not only intend to reduce the energy consumption of armed forces but also be a reaction to expected future vulnerabilities. In both the US and the UK, threats to military installations were a major driving force for adapting energy saving projects[2].

2 I am grateful to Delf Rothe for making me aware of this argument.

	"military futures"						
	"greener"	**"leaner"**	**"victims"**	**"rescuers"**	**"humanitarians"**	**"warriors"**	**"naysayers"**
consequences of climate change for armed forces	"greening"	reduced role of armed forces	threat to military installations	military disaster management capacities	flexible forces	military power and preparedness	none
primary response to climate change in documents	Adaptation, Resource re-allocation	Mitigation	adapt military installations	disaster management	humanitarian action	increase military preparedness	exclude military

Table 2: Frames for the classification of "military futures".

The framing was more straightforward where "disaster management" or humanitarian action was prioritized, as these relate fairly directly to the above identified "military futures", even when the armed forces were not explicitly mentioned as actors performing these functions.

In total, 79 such frames were found in the 53 documents. The following sections first provide a frequency count of the six military futures, which is then enhanced by a time perspective. Two additional sections address the question of potential drivers of different military futures. Two such potential drivers are investigated: the perception of the extent of the threat emanating from climate change and the power status of the relevant governments responsible for the documents. Data for the first driver are also taken from these documents, while the power status is taken from a standard source. These two drivers certainly do not exhaust the list of possible factors influencing perceptions of the effects of climate change on armed forces but rather represent a first attempt at finding explanations.

The quantitative distribution of "military futures"

Among the "military futures", the storyline of the armed forces as "rescuers" is found most frequently in the documents analyzed here (Table 3). This is in line with other research that also found disaster management to be the predominant response to climate change connected with the future of armed forces (Oels 2011; Oels 2012, Brzoska 2012). To some extent, this reflects the high degree of uncertainty about the consequences of climate change, which may be of relevance for armed forces. After the frames linked to "rescuers", three others add up to a similar number of counts, namely "leaner", "greener", and "humanitarians" ("naysayer" frames are similarly frequent). These military futures, while clearly less frequently mentioned than "rescuers", are found in a diversified set of countries. This is different for the two remaining categories, which are mentioned least frequently, "warriors" and "victims". These frames were only found in official documents from the United States, the United Kingdom, Canada, and Australia.

leaner	rescuers	warriors	greener	humanitarians	victims	naysayers
15 %	38 %	6 %	14 %	11 %	3 %	13 %

Table 3: Incidence of "military futures" in official defense documents. Percentage of frame occurrences.

Priorities over time

The debate about potential security impacts of climate change began in the late 1990s and reached a peak in 2007/2008. There is reason to expect that perceptions of the future role of armed forces have changed with the ups and downs of this debate. The analysis of relevant security documents is therefore divided into three periods: documents published prior to 2007, those published during the period of intense debate on the security implications of climate change in 2007/2008, and documents published after 2008 (Table 4).

There are trends over time but there are also some distinct differences between these three periods. The number of documents without any mentioning of climate change or explicitly denying that climate change is a security threat has dropped considerably. The intense debate on climate change and security during 2007/2008 obviously made it difficult for governments not to take a stance in official documents on security strategies and defense planning.

The share of governments indicating a role of armed forces as "rescuers" has declined concurrently. While this remains the most frequently mentioned category, its relative incidence has decreased markedly after 2008. This may be less due to a decreased acceptance of a military role in disaster management in the future but rather to the global financial crisis beginning in 2007. The increased pressure on public finances may have reduced the willingness to propose an increased role of armed forces in disaster management. The data on "leaner" militaries in the future at least also points in this direction. The share of documents that mention the need to reallocate finances and to put an emphasis on mitigation has doubled between the first and the third period, with a big jump after 2008.

period	greener	leaner	victims	rescuers	humani-tarians	warriors	naysayers
pre-2007	6 %	11 %	0 %	50 %	0 %	6 %	28 %
2007/2008	14 %	10 %	7 %	41 %	14 %	7 %	7 %
post-2008	19 %	22 %	0 %	28 %	16 %	6 %	9 %

Table 4: Predominant "military futures" in defense planning documents over time
Percentage of frame counts.

The mentioning of a "greener" future for armed forces has continuously grown, from very small to substantial. While again fiscal issues may have played a role, there seems to be a growing perception that armed forces can substantially contribute to climate change mitigation. It is quite likely that this increase in the official recognition of the need to "green" armed forces reflects broader programs for the reduction of greenhouse gas production, as in the cases of the United Kingdom and the United States mentioned above.

The number of instances, in which armed forces are seen to have a role in complex emergencies ("humanitarians"), has increased as well. Again, the debate in 2007/2008 has had an impact, elevating this "military future" from one being discussed as an option in the secondary literature to one being mentioned in official documents. However, the number of governments that foresee a growing fighting role of armed forces remains low. Correspondingly, the share of the "warriors" category, where climate change is linked to military actions for national security, has not grown.

In summary, the period of intense debate on climate change and security during 2007/2008 seems to have substantially increased the awareness of potential consequences of climate change for armed forces. At the same time, perceptions of what these consequences might be have not converged but rather widened. The analysis here thus confirms the research on a general failure to "securitize" climate change. The majority of governments continue to resist the ideas of linking climate change to "hard" security and requiring military action in the future. They still see the need to change their militaries, predominantly by making them "greener" and "leaner".

Perception of climate change as a threat and military futures

Does the way in which climate change is perceived make a difference for the kind of "military future" one foresees? Many of the documents analyzed here contain assessments of the importance of climate change as a future threat for security. However, perceptions of the type of the future extent of climate change differ. These were coded into four "threat levels" of climate change: None/negligible (this also includes the lack of mentioning of climate change in the document), minor, emerging, potentially large, and major[3].

The data presented in Table 5 indicate that the perception of the severity of climate change, and in particular its relevance for security, makes a difference with respect to some of the potential "military futures". Differences are notable, for instance, for the category of "leaner" militaries, which gets more prominent with increasing perception of the importance of climate change. The same holds for "humanitarians", where the opposite is the case. Obviously, the category of naysayers not seeing climate change as a security issue or not seeing any role for armed forces in future climate change is particularly large when climate change is seen as no or only a negligible threat. For other "military futures", however, no systematic difference is notable in the perception of the danger of climate change.

climate change threat	**greener**	**leaner**	**victims**	**rescuers**	**humanitarians**	**warriors**	**naysayers**
none or negligible	0 %	6 %	0 %	29 %	12 %	0 %	53 %
minor	9 %	18 %	0 %	55 %	0 %	9 %	9 %
emerging	24 %	10 %	0 %	48 %	10 %	10 %	0 %
potentially large	8 %	23 %	8 %	38 %	8 %	15 %	0 %
major	22 %	22 %	6 %	22 %	22 %	6 %	0 %

Table 5: Climate change threats and "military futures" - Percentage of total frame counts.

Powerful versus small countries?

Another possible explanation for differing "military futures" are security policies of governments, particularly with respect to the role they intend to play in global power politics. In an attempt to analyze this potential explanation, countries were grouped into four categories indicating different levels of "power": Major powers, regional powers, local powers, and small states. The classification of countries into these groups is based on the Composite Index of National Capability (CINC), initially created by J. David Singer and maintained by the Correlates of War project.[4] It attempts to measure "hard power" by using the averages of the percentages of a particular country's indices in world rankings of six different components representing demographic, economic, and military strength.

3 For coding rules and procedures, see Brzoska 2015.

4 For details of composition and data see http://www.correlatesofwar.org/data-sets/national-material-capabilities, last accessed 5 August 2020.

power status	greener	leaner	victims	rescuers	humanitarians	warriors	naysayers
minor	14 %	21 %	0 %	50 %	4 %	0 %	11 %
local	12 %	18 %	0 %	41 %	6 %	12 %	12 %
regional	15 %	5 %	5 %	25 %	20 %	5 %	25 %
major	13 %	13 %	7 %	27 %	20 %	20 %	0 %

Table 6: Power status and "military futures" - Percentage of frame counts.

The data (Table 6) show that "hard" power is important for explaining the perceptions of climate change on the future of armed forces. However, it does not suffice as an explanatory factor. Governments differ in their views about "military futures" even if they are in the same power category. This is particularly obvious for the two major powers China and the United States, at least as reflected in the documents published since 2007. While documents from the United States since 2007 portray climate change as a major threat that will shape the future of armed forces in many ways, the Chinese government refuses to consider climate change a traditional security issue. Implications for armed forces are only foreseen in the field of disaster management. However, China is somewhat atypical. In general, perceptions of future roles correspond with the expectation that power does make a difference. States that are more powerful expect militaries to become leaner or "rescuers" less frequently. Instead, they increasingly expect armed forces to have a role in complex emergencies, and even to become victims and warriors. Their generally wider range and greater importance of military efforts also reaffirm their expectations of the consequences of climate change for armed forces.

Conclusions

Climate change has become an issue for armed forces worldwide (Carmen et al 2010; Holland and Vagg 2013). The number of governments that do not explicitly foresee or imply the need for changes in the functions, internal structure and funding of armed forces when presenting their views of national security and the future of armed forces has become rather small.

It is shown that the intensive debate on the security implications of climate change in 2007/2008 has raised the level of attention towards the implications of climate change in security institutions worldwide. Potential consequences of climate change have added another justification for expanding armed forces but have also raised the possibility that funding for armed forces will be cut in order to reallocate money away from armed forces towards investments into climate change mitigation and adaptation. There is a wide divergence of perceptions of changes concerning future shape, size, and structure of armed forces to expect with climate change. The documents analyzed here indicate a broadening of the range of perceptions of the consequences of climate change for armed forces. The most frequent response to the expected challenges is the indication to increase disaster management capacities. However, the relative importance of this “military future” has decreased over the past ten years or so, when climate change first became an issue in documents on security strategies and defense planning. Responses have become more differentiated, albeit not necessarily in the same direction. In some countries the emphasis lies on making the armed forces “greener”, in others it is on increasing their capabilities to successfully address complex emergencies.

Climate change has become a standard issue in national security thinking and defense planning. However, with the exception of a few countries over certain periods (US, UK), climate change has not been a dominating issue. Thus, indications of the effects of climate change on force planning are generally embedded in broader perceptions of the roles of armed forces. Armed forces, which are already used for power projection, are seen as facing a new threat, while militaries that predominantly already have “secondary” functions are predicted to remain focused on these. A general perception of the importance of climate change, combined with much uncertainty about its consequences, seems to feed the expectation that climate change will amplify already existing priorities of armed forces. There are only a few cases, albeit growing in numbers, where investments in climate change mitigation and adaption are already on their way. Correspondingly, “national security” is one of the least-mentioned sectors for which adaptive responses are reported in a recent survey of National Communications prepared by 117 parties to the United Nations Framework Convention on Climate Change (UNFCCC) (Lesnikowski et al 2015, 287). Judging by the official documents analyzed here, climate change has not been generally “militarized” in the way some other threats have in the past, most notably during the Cold War. Tendencies to so, which were notable in 2007/2008 can only be detected in a few countries, such as the US and the UK, and have been weakened since then even in these instances. In the majority of cases, climate change has become another legitimization for the allocation of resources to armed forces, based on the argument that there will be a necessity for increased demand for military capabilities, even though there is no clear understanding of its specificity.

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14 How does path dependence affect the climate change-conflict nexus?

Jasmin S. A. Link

Abstract

In sociology, path dependence can be defined as a self-reinforcing process with the tendency towards a lock-in. This concept can be applied to the climate-conflict nexus to assess how path dependence, this particular characteristic of a process, affects the complex potential causalities of climate-induced conflict. Does path dependence enhance the conflict potential through butterfly effects or does it rather pacify by increasing conformity? The nature of climate change-induced conflict is analyzed with an integrative framework that is based on a review of peer-reviewed related case studies. Using the methodology of mathematical sociology, a complex causal chain is drawn to reflect the influence of path dependence in the situation of climate change-induced conflict. Sociological conflict theories are used to depict, in which way and to what extent path dependence may or may not influence the societal reaction to climate change.

KEYWORDS: *path dependence, climate change, conflict, sociology, feedback loops.*

Introduction

Can path dependence or climate change induce violent conflict? This is the title of my cumulative dissertation, which combines new developments in path dependence theory with research on the climate change-conflict nexus. A key issue is how path dependence affects the climate change-conflict nexus.

> Climate change in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the Framework Convention on Climate Change, where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (Parry et al. 2007, p. 6).

From a sociological perspective, the role of humans is more important than the mere climatic changes as "natural scientists have recognized that climate change is a "people problem": it is caused by human behaviors, it poses real threats to humans, and it requires collective action for its amelioration" (Dunlap and Brulle 2015). An indirect consequence of climate change, which is a threat to humans, can be conflict. Even though conflict is usually something very active, in the discussion of climate change-induced conflict, conflict gets a passive connotation.

Conflict is a main term in sociology and is used in various contexts. However, the induction of conflict by anything else than social agents is only rarely reflected. In the empirical literature on the climate change-conflict nexus, which tries to assess whether or not there is a linkage between climate change and conflict, usually the definition of conflict is drawn from the data used. For example, there are data on conflict within a state or among states differing on whether or not the government is involved [state as an actor] and that vary with regard to the defined minimum number of casualties in a specific time span and region to make it count aws violent conflict. Moreover, of course, only documented or observed conflicts are counted. The identification of "reasons" for conflict onset is even trickier. A statistical correlation does not explain the underlying mechanisms. One main mechanism considered in the climate-conflict nexus is resource scarcity. Explained in terms of action theory, actors are expected to react in a conflictive manner when their resources get scarcer, as is potentially the case due to climate change. Such affected resources can be for example water availability due to changes in precipitation patterns or assets due to losses in extreme events. However, particularly for water, scarcity has often led to cooperation instead of violent conflict, which is documented in many international water agreements. And sometimes even the opposite effect can be discovered: in parts of Kenia violent conflict is more present when more cattle are available and

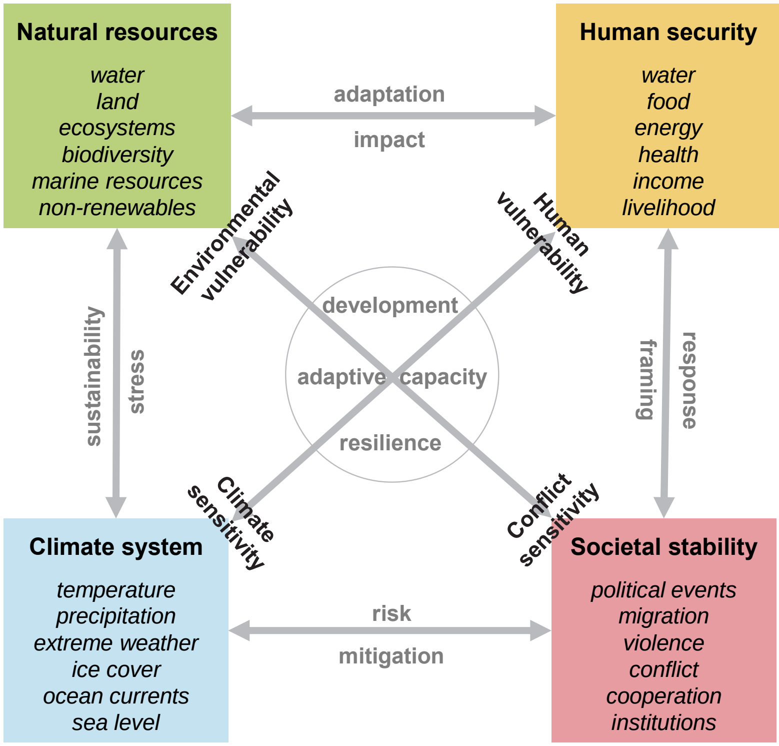

Figure 1: Analytical framework of linkages between the climate system, natural re-sources, human security, and societal stability. Source: Scheffran et al. 2012a.

in good shape for raiding during the rainy seasons (Schilling et al. 2012). Thus, the climate change-conflict nexus is complex (Figure 1).

Path dependence is generally used in social sciences in a sense of "history matters" or "former events shape later ones" where the "path" is formed by a sequence of events and the order matters (for further reading on reactive sequences, e. g., Mahoney 2000). For example, the invention of the steam engine (one event) has triggered the industrial revolution (next event), which has triggered climate change (subsequent event). In this example, the industrial revolution depends on the invention of the steam engine and climate change depends on the industrial revolution. Thus, climate change depends on the invention of the steam engine. However, if the steam engine had been invented without triggering any substantially large-scale applications during the industrial revolution, it is likely that less carbon dioxide would have been emitted in the

20th and 21st centuries and climate change would have been less intense or would not have occurred at all. Thus, each of the events matter as well as the logical order of the events. A more process-oriented view of path dependence considers self-reinforcing dynamics such as positive feedbacks and the occurrence of lock-ins such as tipping points. In this definition, which I use fundamentally throughout my work and also in this essay, a path-dependent process is defined as a self-reinforcing process with the tendency towards a lock-in (Sydow et al. 2005, 2009).

By now, of course, there is substantial literature on climate change and violent conflict. Some of this research addresses whether or not a linkage exists in theoretical or meta-study reflections. Furthermore, there are case studies in various regions with diverse stakeholders and differing conflict intensity. However, none of these peer reviewed published studies reflects on the role of path dependence on the linkage between climate change and conflict, how path dependence shapes the intensity of the outcome or the dynamics of the involved mechanisms (Link 2018). This issue is addressed in this essay. The research question is how climate change can induce a path-dependent process that self-reinforces conflict. To answer this research question a mix of three methods is used:

1. An analytical framework on climate change and conflict (Figure 1; Scheffran et al. 2012a);
2. A comparative review of the peer reviewed scientific literature on the linkages between climate-related indicators and data on violent conflict using large-n designs, published between 2004 and 2012: "To come to conclusions about the effect of climate change on violent conflict with validity beyond single cases, we limit the analysis to (quantitative) empirical studies using regression analysis based on conflict and climate data because of their increasing importance in the recent debate and the difficulties associated with the comparison of (qualitative) field-research studies. We analyze the results of recent relevant studies, classifying them with the help of a number of criteria such as specified climate-conflict link, conflict type, region, analyzed period [...] and data used to carve out differences and similarities. We limit the analysis to studies published since 2004 and accept their academic credibility as articles published in peer-reviewed scientific journals" (Scheffran et al. 2012b);
3. Theoretical deductions about potentially induced dynamics based on the results of the above methods and path dependence theory, especially self-reinforcing processes.

Within the analytical framework (first method), I note the potential mechanisms extracted from the empirical literature (second method). Then I describe in further theoretical deductions (third method), how these mechanisms can be triggered by climate change and in particular, how they link conflict to climate change in a self-reinforcing spiral via increasing vulnerabilities. This is done using aggression theory and rational choice as conflict theory, which is basically resource conflict theory.

This essay concludes with a short summary of the findings, including a short note about another application of path dependence theory on climate change-induced conflict.

How can climate change induce a path-dependent process that self-reinforces conflict?

The main conflict theories used in the climate-conflict nexus are resource conflict theories and aggression theory, as these are action-centered and related to natural resources and human security, which are both depicted in Figure 1. Resource conflicts can be triggered by altered resource distribution or changes in resource availability. Aggression theory incorporates the idea that conflicts may worsen or break out if people get more aggressive. This can potentially be the case if physical conditions vary due to climate change.

Human aggression can be defined as the violation of a norm, which implies current or potential harm by a responsible person. The act of the violation can be means or end of action but without any arguments or excuses (following Mees 1990, p. 286). The classical frustration-aggression-theory tries to include the reason for human aggression before the act, an inner frustration. An environmental component, which is necessary to be able to reflect on climate change-induced conflict, is empirically studied by Berkowitz:

> Take high temperatures as a case in point. Have you ever found yourself in a very hot room that you couldn't leave for several hours, for one reason or another? If you're like many other persons, according to a growing body of research, there's a good chance that you became irritable and perhaps even openly hostile (Berkowitz 1993, p. 51).

Berkowitz' neoassociationistic aggression model is a revision and development of the classical frustration-aggression-theory (Bonacker 2008). The model describes that automatically feelings of fear or anger arise in affected people. These feelings are then connected to "flight or fight". Experiments have shown that the larger the changes in environmental conditions are (room temperature during the experiments) and the worse the considered person is feeling, the lower the threshold to actually perform aggression and violence on others becomes. In the experiments, the presence of weapons has significantly increased the likelihood of the considered people to interpret their own feelings as anger, which increases the likelihood to act aggressively (Berkowitz 1993, p. 72ff.). Thus, existing conflicts can increase the likelihood of further aggression even if this aggression is not directly related to the existing conflict constellation. Aggressive behavior can induce further conflicts and enhance existing ones. The inclusion of the environmental component makes it applicable in the context of potential climate change-induced conflicts.

In climate-conflict research, the conflict theoretical basis is often not clearly defined. In my research, I base resource conflicts on rational choice theory. Rational choice theory is a very large field of sociology at the intersection to economics seeking to explain every potential social behavior as the outcome of individual interaction, which is supposed to be basically rational (Coleman 1990; Esser 1993). One fundamental model is RREEMM:

> Resourceful: man can search for and find possibilities; he can learn and be inventive;
> Restricted: man is confronted with scarcity and must substitute (choose);
> Expecting: man attaches subjective probabilities to (future) events;
> Evaluating: man has ordered preferences and evaluates (future) events;
> Maximizing: man maximizes (expected) utility when choosing a course of action;
> Man (Lindenberg 1985).

RREEMM is a sociological development of the homo oeconomicus who is a special case of RREEMM. Within this model thinking, actors can be considered to their subjective expected utility (SEU) on the micro level and play pairwise prisoner's dilemmas. Even though both would be better off in performing cooperative behavior, each individual is better off defecting and thus the Nash-equilibrium is the situation of both defecting, i. e. the situation of conflict (Bonacker 2008). Rational choice theory and the SEU can be applied to explain arms races and resource conflicts (Scheffran 1989, 2008; Scheffran and Hannon 2007), too. In the further deductions, these theories are used as broader background theories but they are not applied via utility functions or game theory. The idea is to show the overall linked mechanisms and their interaction dynamics with regard to climate change and conflict.

How does path dependence affect the climate change-conflict nexus?

Here, I start with the second method, the comparative literature review of research published between 2004 and 2012 that is presented by Scheffran and others (2012a) and further elaborated in a second paper (Scheffran et al. 2012b). There are large differences between regions and time periods, different types of conflict are addressed, and even the variables that have been studied vary among the different cases. Still each of the papers analyzed states whether the authors have found a correlation of the analyzed variables, changes in precipitation, temperature changes, occurrence of disasters, land degradation or changes in the vegetation, and conflict with or without involvement of the state and using different data sets. Geographic foci range from African regions, East Asia, or Europe to global analyses. While this variability points to no direct comparability, 16 of the 27 studies have found a link between the analyzed climate change variable and conflict. Most of these examined the relationship between precipitation change and possible conflict onset, other key drivers studied include temperature, disasters, and land use change (Scheffran et al. 2012b), with a focus on conflicts that involve state actors. In contrast, six explicitly stated that there was no link among their analyzed climate variable and conflict variables. That leaves five studies, which state that in their cases the linkage has been ambiguous, giving arguments both for and against a climate-conflict-link. These studies look at water resources and land use change as conflict drivers and point to increased conflict likelihood for substantial deviations of the drivers from current mean states. And even if long-term historical studies rather suggest a linkage and studies that are more recent rather do not: a mere statistical correlation does not reveal the underlying mechanisms of induction.

Thus, searching for the underlying mechanisms of induction, the next focus is not only on the climate variables and potential conflict variables they induce but also on potential intermediate factors, taking into account that a potential induction is not necessarily direct.

> Since the 1990s, there has been an extensive scientific debate on how the scarcity of natural resources such as minerals, water, energy, fish, and land affects violence and armed conflict (Bächler 1999; Homer-Dixon 1994). While many case studies suggest that environmental degradation and resource scarcity undermine human well-being, the effect on violent conflict "appears to be contingent on a set of intervening economic and political factors that determine adaptation capacity" (Bernauer et al. 2012, p. 1). Particular attention has been placed on the following intermediate factors (Scheffran and Battaglini 2011; WBGU 2008) (Link 2018, p. 91f.).

These intermediate factors can be summed up as:

- precipitation change and variability,
- freshwater resources and scarcity,
- land and food,
- weather extremes,
- environmental migration.

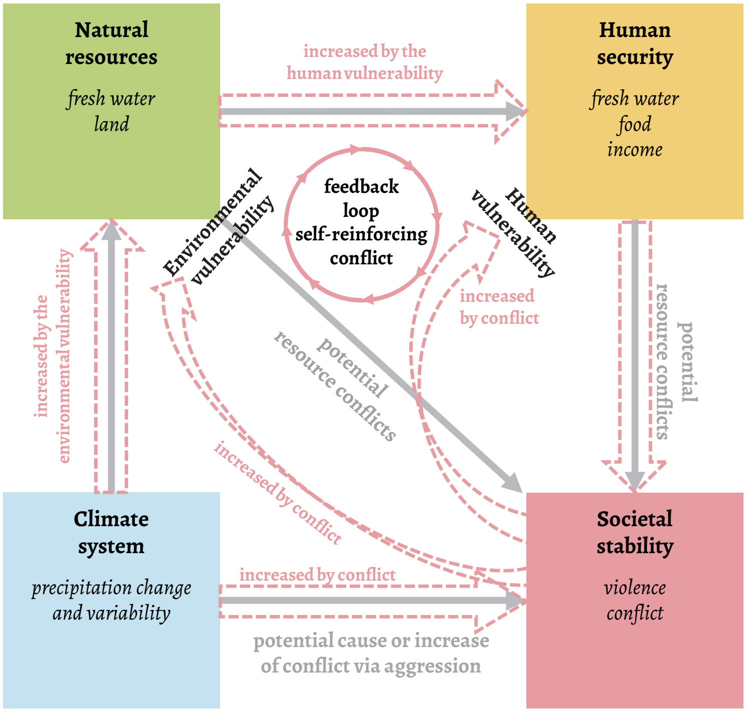

Figure 2: Central intermediate factors in the analytical framework (Figure 1). *Note: Marked in red are the potential feedbacks via violent conflict and vulnerability, induced by climate change.*

Focusing on the region that is affected by climate change, environmental migration as outmigration is rather an adaptation measure and likely to reduce conflict in the originally affected regions. Whether or not weather extremes lead to local crises still needs to be studied because some cases of crisis have induced cooperation rather than conflict. The rest can be connected by causal chains such as precipitation change and variability can lead to impacts on the availability of freshwater resources and to impacts on land and food production. Associated conflicts that have been analyzed are framed as potential resource conflicts, thus fitting with the theoretical basis of this deduction. For freshwater resources, rather induced cooperation is mentioned instead of conflicts due to the increasing number of international water agreements.

Therefore, the extracted linkage of intermediate factors is that climate change can cause precipitation change and variability in water availability, which in turn can lead to impacts on land and food production. In the following, I describe in detail how I place this linkage in the context of the framework mentioned above (Figure 2).

In the next step, I selected these intermediate factors, which are considered to play a crucial role in the process of induction of conflict by climate change from the components in the analytical framework of linkages between the climate system, natural resources, human security, and societal stability (Figure 1).

> In Figure [2], the final three intermediate factors and the conflict potentials have been sketched in the scheme of the complex analytical framework (Figure [1]). Afterwards, I have added the potential feedbacks that conflict can have on the vulnerabilities, i. e. the human vulnerability and the environmental vulnerability, via the conflict's potential impacts on the adaptive capacity and the sensitivity to climate change, referring to: Vulnerability can be broken down into three factors: (i) exposure to climate change, (ii) sensitivity to climate change, and (iii) adaptive capacity (Parry et al. 2007). The last two can be affected by conflict (Link 2018, p. 60).

That way, conflict can increase environmental vulnerability, which increases the effect of changes in the climate system on the environmental system (Buhaug 2015). Along the causal chain, conflict can increase the impact of changes in the environmental system on human security as well by increasing human vulnerability (Matthew 2015). The accumulated impacts can further lead to increased resource conflicts (Vivekananda et al. 2014). This causal deduction describes a feedback loop induced by climate change, in which conflict feeds back on increasing conflict and thus self-reinforces conflict (Link 2018). Does this self-reinforcing process of conflict approach a lock-in? That depends on the kind of conflict. There are lock-ins possible for resource conflicts: on the one hand, a theoretically trivial lock-in would be reached if the conflicting parties destroyed each other or if only one of them survived. Another lock-in could be reached if the conflict was institutionalized such as the conflict over land between Israel and Palestine (Chapman and Benson 2015; Gerner 2018). In the first type of lock-in, the level of violent conflict escalates up to destruction while in the second type of lock-in, the conflict becomes an institution, which can be fought out on various levels without destroying each other. Instead, it maintains the conflict even in times of lower levels of intensity of violence (Link 2018).

Consequently, climate change can induce the path-dependent process of self-reinforcing conflict. This matches the discussion of climate change being a threat multiplier of existing conflicts rather than causing them initially. But the application of aggression theory allows the description of one mechanism how climate change could induce conflict, i. e. if people react increasingly aggressively due to the feeling of being affected by environmental change (Figure 2, arrow at the bottom directly from the climate system to the societal stability) (Link 2018).

Conclusion

This essay describes my research in the context of the Research Group Climate Change and Security (CLISEC) and my dissertation (Link 2018) on the specific question how climate change can induce a path-dependent process that self-reinforces conflict. From empirical literature, potential mechanisms for climate change-induced conflict are extracted and connected in the analytical framework of the interacting climate system, natural resources, human security, and societal stability. This framework is used to visualize how these extracted induction mechanisms can form a self-reinforcing process that reinforces conflict by stepwise increasing environmental and human vulnerability, which intensify the effects of climate change on the induction mechanisms. Based on aggression theory and the theory of resource conflicts during the described self-reinforcing process, climate change acts as a multiplier enhancing existing conflicts and increases the likelihood of triggering or spreading further conflicts.

Current political developments such as global climate demonstrations reveal even more applications of path dependence theory on climate change induced conflict: In my dissertation, I have shown mathematical sociologically that the more an agent is affected by path dependence, the more that agent tends to perform a following behavior. Considering opposing hierarchies such as climate change activists and climate change deniers, path dependence reinforces their opposition whenever an event triggers their path-dependent social network (Link 2018). That way, climate change can induce conflict among those opponents, which is reinforced via path dependence. This is another example of how path dependence affects the climate change-conflict nexus, highlighting the necessity to more strongly appreciate the role path dependence plays in determining people's actions.

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15 Critical evaluation of the implementation of the concept of environmental security

Case study of the Environment and Security Initiative (ENVSEC)

Judith Nora Hardt

Abstract

This paper analyzes the theoretical and empirical conceptual approaches to the link between environment and security in order to test their ability to function as guiding concepts in the multiple and complex challenges posed by the Anthropocene. For this purpose, the Critical Environmental Security Studies (CESS) are proposed and further developed in order to bridge the theory-practice gap and inform the literature on the conceptual approach carried out by the Environment and Security Initiative (ENVSEC).

The empirical research that attempts to pinpoint and evaluate the dominant conceptual use of environmental security in reference to geopolitics, status quo maintenance, and normative change relies on document analyses of the period from 2001 to 2014 and semi-structured interviews with decision-makers of ENVSEC.

KEYWORDS: Environmental security, Anthropocene, Environment and Security Initiative, geopolitics, socio-ecological change.

Introduction

Since the year 2007, we have observed a strong trend of securitizing environmental phenomena (especially climate change)[1]. These developments in international relations are particularly critically observed by academics working on the subject, as the links between environment and security are still being discussed. The narratives that are generally located in the literature of environmental security embrace different (and partly contrasting) strands and theses. These range from describing resource scarcity or climate change as a cause for conflict (see Homer-Dixon 1994; Gleditsch 2015; Zhang et al. 2007), as an opportunity for peace (Wappner 2013; Matthew 2014), cooperation, and common management (see e. g. Conca, Carius and Dabelko 2005), as an opportunity for development, to the concept of human security[2] (O'Brian, St. Clair and Kristoffersen 2010; Barnett, Mathew and O'Brien 2010; Floyd and Matthew 2013). Furthermore, they are related to the apocalyptic discourse of the destruction of our habitat (Dalby 2013; Burke et al. 2016) and Transformation Studies (Brauch, Oswald Spring and Scheffran 2016).

This last discourse has particularly gained attention driven by the definition of the new geological era of humankind, the Anthropocene[3]. The term was coined in 2002 by Eugene Stoermer and Paul Crutzen and describes how human societies have pushed planet Earth out of its usual ranges of ecological processes. As it puts the basic division of society and nature into question, the acknowledgment of the Anthropocene has been referred to as an "awakening call" (Leinfelder et al. 2012, 13) that will lead to paradigm shifts (see Bennett 2011; Schellnhuber et al. 2004; Hamilton, Bonneuil and Gemenne 2015). The new conceptions of space, time, and human-nature relations carry a fundamental need to re-visit the world we thought we knew.

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1 The initiation of this trend is often attributed to the publication of the fourth Intergovernmental Panel on Climate Change (IPCC) report that acknowledged human activity as the major cause of inducing climate change. In the same year, the Peace Prize was awarded to Al Gore and to the IPCC. In addition, the United Nations Security Council for the first time discussed the inclusion of climate change in its mandate (Brauch 2011). Since 2007, the UNSC has conveyed several sessions on climate change and security, during which many representatives of states strongly argued for including climate change among the mandate of the UNSC. The latest session on climate change in July 2018 was titled: "Maintenance of international peace and security. Understanding and addressing climate-related security risks".

2 The concept of human security was defined in 1994 in the Human Development Report of the UNDP. Along with the succeeding discussions (see among others CHS 2003) it is based on the pillars of freedom from fear and freedom from want with seven defining and interrelated dimensions – one of which is the environmental dimension termed environmental security. It has been further developed since its first definition and is widely implemented and referred to, mainly in the context of Peace and Conflict Studies and Development Studies.

3 The Anthropocene enjoys scientific and social acceptance and approval; it is in the process of formalization by the International Union of Geological Sciences.

The answers to the questions of who, what, and how need to be ascertained, and how these concerns are interrelated with ecology has to be re-visited. This is why the conceptual association of environment and security once again appears promising to many academics and practitioners as providing theoretical guidance on how to deal with the extremely threatening dimension of the Anthropocene discourse (see Hardt 2018b). The central claim to link environment and climate change with security is mainly articulated based on hope to identify effective solutions and thereby ensure peace and sustainable futures. In contrast, the critics of environmental security highlight the implications and negative consequences, which are described in the eventual militarization of environmental or climate politics and in the misuse of the agenda for geopolitical interests (see e. g. Floyd 2008; Trombetta 2008). The implementation by different institutions is therefore discussed in the literature as "to be handled with caution"[4]. Another critical evaluation of the empirical use of environmental security is that the mere existence and therefore implementation of the concept is doubted. Most analyses are based on the securitization frame of the Copenhagen School (see Buzan, Weaver, and De Wilde 1989). In other terms, an overview of the research shows that most analyses stop at the very question of whether environmental security stands at its practical inception or not and discusses the evaluation of a future implementation of a defined environmental security concept in practice.

This paper addresses the major questions of the conceptual definition of implemented environmental security projects and of its critical evaluation in the context of the Anthropocene. It therefore focuses on the theory-practice gap and aims to inform theory through the case study analysis of the Environment and Security Initiative (ENVSEC). ENVSEC has received little attention from academia and yet has to be seen as bundling some of the most important international organizations into implementing environmental security in practice. ENVSEC is a consortium and was established by the Organization for Security and Cooperation in Europe (OSCE), the United Nations Environmental Program (UNEP), and the United Nations Development Program (UNDP) in 2002 and 2003. By 2006, the initiative had added the North Atlantic Treaty Organization (NATO) (which withdrew in 2015) as an associated partner and the Regional Environmental Center (REC) and the United Nations Economic Commission for Europe (UNECE) as partners. ENVSEC acts in the so-called crisis regions of Central Asia, Southern Caucasus, and Southern and Eastern Europe and presents itself under the guiding theme: "Transforming risk into cooperation."

4 The question of whether the United Nation Security Council should take action in relation to the link between climate change and security remains an important debate in the literature (see e.g. Detraz and Betsill 2009; Cousins 2013; Scott 2015).

The presented research on ENVSEC is based on discourse analysis of 53 reports and documents of ENVSEC, available mostly on the website in addition to some gray literature and semi-structured interviews with ENVSEC decision-makers and staff[5]. The period analyzed extended from 2002 to 2014. The analysis was based on a chronological approach, differentiating three phases to capture the evolution of the concept of environmental security. In addition, an interview analysis was carried out with the aim of confirming and enriching the results of the document analysis.

The paper consists of four sections. In the first section, I introduce the theoretical framework for analysis, which is called Critical Environmental Security Studies (CESS). In the second section, I present ENVSEC in its structure, projects, regional foci, and its definition of environment and security. The critical analysis is carried out in section three, which leads to the conclusions, described in section four. In summary, I show that the central insights of ENVSEC activities can be categorized as a mainstream approach to environmental security and that we must carefully listen to the critical voices that highlight possible dangerous implications.

Critical Environmental Security Studies (CESS) as a theoretical framework for analysis

The literature on environmental security arose in parallel with the evolution of the concern of global environmental change as a threat and a threatened global environment, with its first reference at the United Nations Conference on the Human Environment in 1972. The genealogy of environmental security has passed several research phases and is still concerned with discussions about who and what needs to be secured and whether the link of environment and security should/does exist. Deviating from the understanding that environmental security is not to be tied down to one single concept, I established a framework for analysis called Critical Environmental Security Studies (CESS) (Hardt 2018a) that conceives of a loose aggregation of discourses and discussions. CESS is informed by the critical approaches to Security Studies (mainly by the Copenhagen [see Buzan, Wæver, and De Wilde (1998)] and the Welsh Schools [see especially Booth (2005; 2007], as well as some approaches of the Paris School [see Bigo (2010)]), such as Green Political Theory and Political Ecology. A central category of CESS is the analytical concept of environmental security. This research tool consists of a questionnaire that focuses on tearing out the central value of protection, priority, and fear (security), and the perception of the human-nature relation (environment).

5 Most of the interviews were carried out in the year 2012 during a 3-week research stay at the headquarters of ENVSEC, Geneva, UN Environment. Additional phone interviews were carried out in 2016 and 2018.

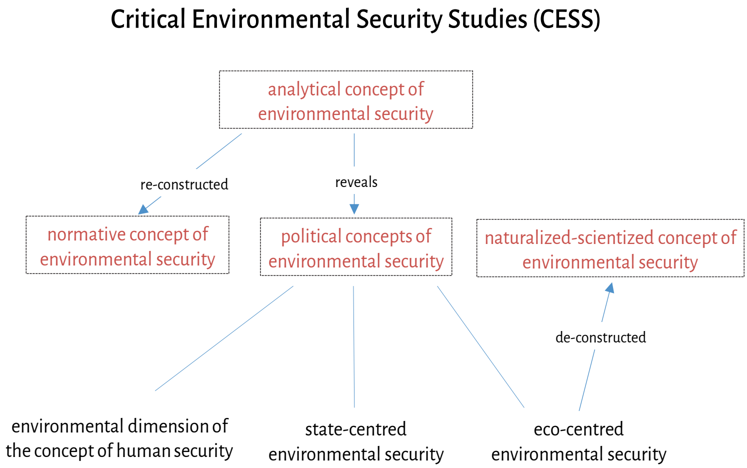

Figure 1: Framework for analysis. Source: Hardt 2018a, 121.

Therefore, it collects questions such as who is to be secured?, what is the threat?, and how is the human-nature relation perceived?, which are then applied to the discourses of environmental security. Discourse is thereby understood as "ways of representing areas of knowledge and social practice" (Fairclough 1992, 3). In Hajer's (1995, 44) terms, discourses are an "ensemble of ideas, concepts and categorizations that are produced, reproduced and transformed in a particular set of practices and through which meaning is given the physical and social realities".

As illustrated in Figure 1, the critical framework is centrally based on this analytical concept of environmental security, which was applied to an exhaustive literature review (see Hardt 2018a) and has thereby revealed several different conceptual categories of environmental security and three major political concepts that are defined in relation to their referent object.

The first is focused on the state and is mostly concerned with maintaining state security. It makes references to environmental threats in the form of causing conflict, instability, and in pursuing resources or establishing environmental cooperation and is also strongly motivated by the quest for geopolitical interests.

The second is related to the concept of human security and the focus on the individual and more precisely on its environmental dimension. In this context, environmental threats are conceived in relation to an increase in vulnerability, causing conflicts, illnesses, food insecurity, energy poverty, and injustice and as an obstacle for human development in terms of overcoming the North-South divide.

The eco-centered approach is the third concept, which focuses on the environment, and paints the threat discourse of environmental deterioration in reference to Planet Earth and its consequences for the human species. It is strongly informed by the scientific-technical narratives of the Earth System Sciences and the planetary boundaries (Rockström, et al. 2009), which aim at steering human agency on planet Earth "into a safe and just operating space" (Raworth 2012; Hajer et al. 2015). This is why the concept is called the naturalized-scientized concept of environmental security due to the de-construction.

In addition, I propose a fourth concept that presents a normative approach to environmental security and is related to the Anthropocene in the sense of carrying the major concerns of inducing socio-ecological change in the search for pathways of change along the ideals of ethics and safe, sustainable, and just futures for humanity. Therefore, the normative concept of environmental security is to be understood as an ideal type. The difference between this normative concept and the eco-centered concept is that it is not reduced to a scientific-technical narrative of steering the planet back into the Holocene, and that it has a critical political understanding of causes and pathways for change. The causes are not seen in CO2 production as in the eco-centred environmental security concept but in structural relations such as injustice and human cosmology. The difference between this normative concept and previous work in a similar spirit in the context of environmental security (see Barnett 2001; Barnett, Mathew, and O'Brien 2010; Brauch, Dalby, and Oswald Spring 2011) is that it consists of a blank questionnaire that is to be filled with normative content[6].

In sum, these four different concepts are used as a possible interpretation, uniting different discourses of environmental security. Bringing these conceptual approaches into a critical analysis in the underlying major goals and concerns (see Table 1), the environmental security concepts are evaluated in relation to the major references of geopolitical interest, status quo maintenance, ethics, and socio-ecological change. Thereby, the analysis shows that all political concepts of environmental security are strongly focused on status quo maintenance, and that the state-centered and the environmental dimensions of human security often receive the criticism of being motivated by geopolitical interests.

In order to bridge the practice-theory gap, CESS is slightly adjusted with regard to the applicability to the case study analysis and to the evaluation of the conceptual implementation of environmental security (see Figure 2). Thereby, the concept of environmental security in practice is directly set in relation to the extreme poles of geopolitics and status quo maintenance and to ethics and socio-ecological transformation.

6 In a former paper, I therefore proposed filling the questionnaire with the key pillars of Green Political Theory and Critical Security Studies approaches (Hardt 2018a).

Focus	Normative concept of environmental security	Political concepts of environmental security		
		State-centered environmental security	Environmental dimension of human security	Naturalized environmental security
Formulated goal and concern	humanity	maintenance of the state	empower vulnerable and powerless	nature
Underlying major goals and concern	normative informed process of socio-ecological change	stability of the state system and of the political system of power	stability of the political system of power	steering humanity back into the Holocene to environmental stability
		assumed geopolitical interests		

Table 1: Comparison of the normative concept of environmental security and the political concepts of environmental security. Source: Elaborated by the author based on Hardt 2018a, 122.

Another important specification is that, in contrast to most securitization theorists based on the so-called Copenhagen School approach, who define the successful securitization of an issue in relation to the necessary characteristic "breaking free of rules" and put extraordinary measures in place (see Buzan et al 1998), the analysis focuses on the discursive use of the label security. Furthermore, the securitization process is informed by the so-called Paris School. The leading author Didier Bigo of the Paris School outlines, in the context of how migration politics is slowly turned into security politics, that security is not necessarily defined in relation to urgency and exceptionality but as routinized practices and as a continuum (Bigo 2010). Security thereby is understood in Foucauldian terms as a "technique of government" (Foucault 1994) and it focuses on other "practices, audiences and contexts that enable and constrain the pro-

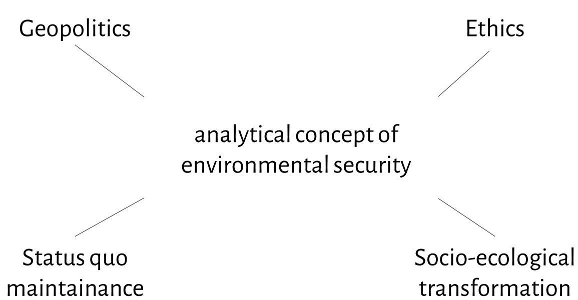

Figure 2: A heuristic guide for evaluating the implementation of environmental security concepts.

duction of specific forms of governmentality" (C.A.S.E 2006, 457). This stands in contrast to the limited speech act of the Copenhagen School. In the Paris School framework, issues can be viewed as security over time, even institutionalized, even without dramatic moments (be it military interventions or conflicts). For the analysis presented here, both the approaches of the Copenhagen School and the Paris School are understood as complements to securitization. In addition, a successful act of securitization is understood here as the acceptance by some audience affected by the securitization acts in the form of allowing intervention to happen and also as payments for activities that are labeled as (here environmental) security.

The Environment and Security Initiative (ENVSEC)

The Environment and Security Initiative (ENVSEC) is a consortium, which, as of September 2019, consists of the following partner organizations: UNEP, UNDP, UNECE, REC, and OSCE. From 2006 until 2015, NATO was an associated partner, having a specific status due to its geopolitical image[7]. The retreat of NATO is very likely related to the Crimea Crisis[8] (ENVSEC IP 2016).

ENVSEC has referred to its multi-agency character as an innovative strength, letting it act as an umbrella or hub and giving it the capacity to bundle responses, knowledge, contacts, and finances. The multi-agency character is at the same time understood as a weakness in the sense that the cooperation and the coordination of the network is difficult, complex, and ultimately expensive to maintain. The association of the different organizations is based on a Memorandum of Understanding (MOU), which means that ENVSEC lacks a legal status. As a consequence, the structure is relatively loose and many tasks are shared, such as the post of the Management Board and the Chair, which rotate annually. The only physical location of ENVSEC is the Regional Office of UNEP at the International Environmental House in Geneva, Switzerland, where the Secretariat is hosted. The network of ENVSEC exists in the form of counterparts, consisting of civil society; academia and experts, included as technical and advisory support; and regional officers, which are located in each of the four ENVSEC regions and who are in charge of disseminating information to ENVSEC partners and stakeholders. The stakeholders are the Ministries of Foreign Affairs and the Ministries

7 It is important to highlight that NATO was involved in ENVSEC with its scientific division called Science for Peace and Security Program (SPS). The military division of NATO was not involved.

8 The reason for NATO to withdraw was not officially stated. The relation to the Crimea Crisis is a suggestion stated by an ENVSEC decision-maker. Nevertheless, there is an important credibility to this because the four ENVSEC regions lie in the former USSR and close to Russia. The fact that NATO was part of ENVSEC was handled from the beginning with caution in relation to Russia. By September 2019, no trace of NATO as a former associated partner organization is left on the website.

of Environment of the receiving countries. A fundamental principle for ENVSEC is state sovereignty. Therefore, ENVSEC projects are only set up on request and by assigning the accountability of the projects to the states.

Characteristic for ENVSEC is that it relies almost entirely on donor funding and on the contributions of the member organizations, whereby most of the funds come from external donors. This is how the initiative is strongly dependent upon, and also susceptible to, the donors' will and interests in terms of defining ENVSEC's activities and how it operates. Information on the total budget, such as on some donors, is relatively difficult to acquire. As the partner organizations are in charge of the projects – i. e. staff is working only part time for ENVSEC – the assessment is difficult. According to a quote from 2013, ENVSEC had a total budget of US$ 60 million for its ten years of existence (ENVSEC 2013c, 2).

ENVSEC donors and their cumulative share for the period 2003 - 2013. Source: (ENVSEC 2013c; ENVSEC 2013a, 11).

Donor	***Share***
Finland	35 %
Austria	19 %
Canada	17 %
Belgium	2 %
Others (Czech Republic, Hungary, Spain, USA)	1 %
Germany	1 %
Italy	2 %
Norway	3 %
Netherlands	1 %
Sweden	16 %
Switzerland	1 %
European Commission	2 %

ENVSEC donors and their share for 2014. Source: ENVSEC website9.

Donor	***Share***
Finland	30,86 %
Swiss Development Cooperation (SDC)	2,74 %
Swedish Environmental Protection Agency (SEPA)	6,46 %
Swedish International Development Agency (SIDA)	16,38 %
UNOPS Austrian Development Agency	0,03 %
UNOPS Finland	1,44 %
UNOPS Swedish Environmental Protection Agency (SEPA)	2,02 %
Austrian Development Agency (ADA)	35,66 %
Government of Switzerland	4,39 %

Table 2: Overview of ENVSEC donor contributions 2003–2014.[10]

9 For this article the website http://ensec.org was used which became inactive in March 2020; links to related documents were no longer accessible. Some of the ENVSEC documents are available on other websites, e.g. http://envsec.rec.org. Where web links are no longer available, reference is given to the title of the cited publications.

10 This overview is limited because there is a difference between the donors that only contributed to certain projects and donors, such as Finland, that in 2012 contributed 92 % to the ENVSEC Secretariat costs. Furthermore, some donors, such as e.g. Statoil, a major Norwegian oil and gas company and the International Atomic Agency (IAEA) (ENVSEC 2013a, 23) are not mentioned in these overviews provided by the ENVSEC website. Additional information

It can be observed that Finland has been one of the main donors of ENVSEC. In 2014, several donors started to cut back their donations, while Austria and Sweden have increased their share for ENVSEC[11]. The motivation of the donors is described as follows:

> Many donors who fund ENVSEC […] see the environment as a platform for the preservation of peace and strengthening of international security in accordance with the principles of the UN Charter. The promotion of international cooperation and the consolidation of democracy, the rule of law, human rights, and fundamental freedoms are other dimensions to which ENVSEC contributes.[12]

The organizations involved in ENVSEC are understood to be complying with and serving the interests of their member states. This also reflects the major character of ENVSEC, acting as a tool for state interests that is based on the foundational principle of state sovereignty.

ENVSEC acts in so-called "crisis regions" of Central Asia, Southern Caucasus, as well as Southern and East Europe and has a transboundary focus. It is important to highlight that ENVSEC activities are characterized by focusing on former member states of the USSR, except the Baltic States. This exclusion of the Baltic States is striking and I will come back to this point further below.

Corresponding to the leitmotif "Transforming risks into cooperation," all focus regions suffer from conflicts such as transboundary environmental problems, water resources, water and air pollution, or uncontrolled population growth. Economic questions, transportation, and energy are also important. The projects are usually implemented for three years, carried out by one partner organization and are categorized into one of the following focus areas: 1. Natural resources and security risk management (a. Natural resources); 2. Hazardous substances and environment and security risk reduction (b. Hazardous substances); 3. Population pressure on environmental security, frozen conflicts, and climate change adaptation (c. Climate change). The expected impact formulated for an ENVSEC project is to either reduce the "risk to security from selected environmental threats" or aid in conflict resolution in relation to shared environmental resources in the ENVSEC regions (ENVSEC 2009).

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missing relates to the donations by the partner organizations. From an overview of the ENVSEC reports, there is very little information on this issue, whereby NATO is described as the providing most founds to ENVSEC (2010c, 62).

11 Canada, Norway, Germany, Belgium, Spain, Hungary, Czech Republic, Italy, and USA cut back their support long before 2010.

12 Source: http://www.envsec.org/index.php?option=com_content&view=article&id=63&Itemid=178&lang=en . This link became inactive in March 2020..

Official presentation of the ENVSEC concept of environmental security

As pointed out before, ENVSEC presents itself according to its overarching theme: "Transforming risk into cooperation" and describes its concept of environmental security as a bi-directional interpretation. The negative link between environment and security stipulates that environmental issues can trigger or aggravate situations of tensions and conflict and therefore can present a risk. The link is described as "destruction and over-exploitation of natural resources and ecosystems", which may present a threat for the security of communities and nations[13]. Environmental accidents, disasters, or transboundary pollution might also affect the relations between neighboring states in a negative way[14]. The positive interpretation holds that environmental issues and/or risks "can act as a bridge for cross-boundary cooperation" (ENVSEC 2006, 3). The assumption is that the initiation of a process of communication between several parties, groups, and countries contributes to transforming the former existing tensions into better transboundary relations and even leads to long lasting peace and stability.

Three other dimensions of the ENVSEC concept are presented in the ENVSEC Report (2013a, 4). These include a) a regional approach with a transboundary focus; b) a participatory approach to defining problems and solutions with the stakeholders; and c) a multi-level approach uniting local, national, regional, and international levels. Most interesting is the so-called "trademark" of the initiative, which holds that the definition of environment and security issues is participatory and therefore open. As one interview partner (ENVSEC IP02 2012) stated, "The definition of environment and security is difficult because it has to be seen through the prism of the countries. That is why we tried not to stick too much to the paradigm. It depends on the region, the people." In spite of this broad definition and despite the fact that many projects have already been implemented, the concept of environmental security still remains unclear and vague in the documents. Apparently, this vagueness also is a main concern of ENVSEC, because even the interview partners were not able to clearly define the connections between environment and security. Some framed this vagueness as a positive and open possibility; but generally, confusion was clearly manifested, as for example in the statement: "Sometimes we do not know ourselves." At this point I reach the conclusion that in spite of this broadness and confusing con-

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13 At: http://www.envsec.org./index.php?option=com_content&view=article&id=60&Itemid=176&lang=en, this website is inactive since March 2020.

14 At: http://www.envsec.org./index.php?option=com_content&view=article&id=60&Itemid=176&lang=en, this website is inactive since March 2020.

tent, the ENVSEC concept of environmental security is being implemented and joining many different actors together for a common approach. Furthermore, it should to be emphasized that ENVSEC attempts to join several needs and interests of different organizations, countries (donor and receiving), and people under its hub of environmental security implementation.

Analysis and evaluation of the ENVSEC concept of environmental security

This section attempts to categorize the ENVSEC concept of environmental security. Up front, it is important to highlight that the comparison of the three distinct chronological phases of ENVSEC have shown that the conceptual approach of the initiative has been almost stable throughout its entire existence and applies to all four regions in a very similar way. This result is striking as ENVSEC has changed throughout the years regarding its regional focus, partner institutions, and thematic foci. We can therefore conclude that the approach to environmental security is not an open frame (as claimed), but is instead tied to a fixed meaning. This furthermore supposes that the basic goals, values, and strategies have been (consciously or unconsciously) taken for granted since the creation of ENVSEC and that most of them remain until today. This research result also complies with the statement of the former Secretary General of the United Nations, Ban Ki Moon, who called ENVSEC a "common denominator to address environment and security challenges" (ENVSEC 2013a, 20). The so-called ENVSEC community, endorsing this mainstream approach, includes the following actors, which (independent from their different interests and backgrounds) to some degree actively participate in, agree to, or benefit from supporting ENVSEC: the partner organizations[15], all contemporary donors and past donors[16], and the benefiting countries[17]. This also shows that despite the fact that ENVSEC is not widely known, it has an impressive conceptual reach by working with several actors, countries, and institutions. These include 30 partner countries, over 100 local and international partners, and approximately 170 million people benefited (ENVSEC, 2013b).

15 The partner organizations include OSCE, UNDP, UNEP, UNECE, REC, and formerly NATO.

16 The donors include Austria, Belgium, Canada, Czech Republic, Hungary, Spain, USA, Finland, Germany, Italy, Norway, Netherlands, Sweden, Switzerland, and the European Commission.

17 The countries, which have benefited from ENVSEC projects are Albania, Armenia, Azerbaijan, Belarus, Bosnia, Bulgaria, Croatia, Georgia, Herzegovina, Kazakhstan, Kosovo (territory under UN administration), Kyrgyzstan, Macedonia, Moldova, Montenegro, Romania, Serbia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.

Evaluation of ENVSEC in CESS

In the search for a clear definition of the ENVSEC environmental security concept, the comparison to the four concepts inherent in CESS proves to be useful. In comparison to the three conceptual approaches to environmental security tied to the referent object, several incompatible and mutually exclusive elements can be detected. In the case of the state-centered environmental security concept, these lie in the fact that solutions of the state-centered concept of environmental security have military character, while the ENVSEC concept excludes any possibility of military measures and has a regional approach.

In comparison to the conceptual approach of eco-centered environmental security, the most significant excluding element of the ENVSEC concept is that the latter does not make any reference to planetary threats or to the scientized technical narrative of the Anthropocene, nor to the basic dimensions of ecology. Instead, ENVSEC's target group is limited to developing countries with a conflict context and with a geographical focus mostly on countries of the former Soviet Union. This is a distinguished and outstanding characteristic of ENVSEC's, as the legacies of the former USSR are described throughout all three phases as structural causes[18].

The comparison to the environmental dimension of human security provides a fit. The descriptions of the problems and threats as well as the solution presented by ENVSEC's concept and of human security are seemingly identical. The broad concept of security includes issues of traditional security, development, vulnerability, and human rights. Especially the focus on development is an important commonality between the concept of human security and the ENVSEC concept. The same applies to the concepts of environment, as in both cases (in ENVSEC and in human security) it is reduced to a dimension between others. In other words, the environment is not perceived as the living basis for humans and as an unquestionable underlying condition for every human activity. Another congruity is the strong influence of liberal theory. For the ENVSEC concept, such influence can be seen in its categorized basic values, which include diplomacy, economy, peace and democracy, rule of law and good governance. Rationality is also important and especially detectable in the role of scientists within ENVSEC. Education, legal compliance, and information are practiced by ENVSEC, especially in the fourth focus area (d. Information). Interdependence is also a fundamental assumption for ENVSEC performance. In addition,

18 It needs to be emphasized that in a publication on its evolution, the references to the USSR are almost entirely absent (see ENVSEC 2013a). The only reference to the USSR in a recent report is that it is responsible for Mélange, a toxic rocket fuel component. In the rest of the document, the legacies are attributed to the broader formulation of former political and economic systems (ENVSEC 2013a, 16).

the following basic assumptions of the international systems can be depicted in liberal theory, ENVSEC, and human security: the importance of the governance system of international institutions, the importance of trust, cooperation, and economic development, and the aim to strive for security and prosperity. The congruity of human security and the ENVSEC concept stands in stark contrast to the fact that most of the interviewees have expressed a strong disregard for the concept of human security[19] and the concept is mentioned scarcely in the documents.

The ideal type description of the normative concept does not apply to the ENVSEC concept. This incompatibility will be particularly emphasized in the next section.

Evaluation of ENVSEC's concept of environmental security: Geopolitics and status quo maintenance vs. normative socio-ecological change

In spite of the fact that the normative concept of environmental security does not apply to the ENVSEC concept of environmental security, the comparison between the two helps to point to several deficits in ENVSEC when contextualizing its approach in the Anthropocene. Analyzing the main conception of the environment by ENVSEC, a clear focus on natural resources can be observed[20]. At the same time, the environment is seen as a dimension that plays a minor role. This becomes evident in a comparison of the environment with football, music, and school, and the statement that "if people talk about that [environment, football, music, and school], then they can hopefully talk about much serious things" (ENVSEC IP02 2012). At the same time, the environmental dimension is understood as having the potential of transporting other issues. In other words, the environment serves as a vehicle in terms of dimension and in terms of the established structures of governance.

In the overall analysis, ENVSEC's conception of environment shows that several key premises of the ecological challenge, depicted in natural/climate science and the legal and institutional dimension of global environmental governance either are totally absent or only evoked without major implications. This is surprising as ENVSEC's approach is informed by the description of the environment by natural scientists and heavily relies on an institutional approach. The key characteristics of the ecological challenge (intractability, variability, multi-interdependence, and complexity[21]), as well

19 The criticism mostly referred to human security because it is too diffuse and in its definition, forwarded in 1994 in the Human Development Report, only related to one partner organization, the UNDP.

20 In the ENVSEC Memorandum of Understanding (ENVSEC 2003) the only references to environmental issues are "natural resource management" and natural disasters.

21 I found only one reference that describes a possible finitude. However, it is concerned with finitude of environmental resources: the "[O]veruse of resources will have long-term consequences that will affect the region long after the oil and gas resources have been used up" (ENVSEC 2008a).

as the mainstream of legal, economic, and political frameworks of global environmental governance (such as the approach of mitigating CO2, the principle of polluter pays, the principle of taking into account present and future generations, and the principle of irreversibility), however, are not addressed by ENVSEC. Another important point of criticism is that environmental politics and the structure of global environmental governance are used for other purposes, which vary from the achievement of other political interests to the resolution of conflicts. The concern of tackling the environmental problem seems to be of minor importance.

The geographical scope of ENVSEC is also limited, in that the problems are only addressed in the focus regions themselves. Therefore, the detected causes are limited to the target countries, concentrating and framing the problem at the geographic level and with regard to the history of the state or region. Other external influences and demands (for example, the extraction of resources by wealthy countries) are not taken into account. This can be seen by the fact that external demand or economic resource cycles, for example, in the case of mining or energy issues (e. g. the interest in the extraction and transportation of resources), are only mentioned as presenting an opportunity for economic growth and development or even as a necessity and condition for economic development.

Finally, ENVSEC does not problematize the human-nature dichotomy that is a defining characteristic of the Anthropocene, and does not address the notion of socio-ecological transformation. A central assumption is that the human impact on nature and nature as such are controllable and manageable. That is how ENVSEC ultimately aims at stability, maintenance of the status quo, and balance of the international system, using the environment merely as a dimension and vehicle to secure these.

In addition to this strong focus of status quo maintenance, geopolitical interests also play an important role and even shape the ENVSEC environmental security concept. Before entering into detail, it should be emphasized that the following citations and references (also in form of entire sections titled “Geopolitics”) in the reports of ENVSEC clash with the total absence of reference to them in the descriptions of the conceptual approach, the projects, and the regional focus ENVSEC presents. Therefore, my analysis provides a better insight of whose security lies at the center of attention of ENVSEC, even though it is not explicitly stated in relation to ENVSEC’s environmental security concept.

In a critical geopolitical analysis of ENVSEC, it can be seen that the main geopolitical concern lies with the European Union and its geographical neighborhood. The focus is to secure stability and prosperity beyond the borders of the European Union (ENVSEC 2007, 19) and to make the “neighbors a little less miserable” (ENVSEC IP02 2012). In other terms, the stability of the European neighborhood is important because this reduces the probability of the emergence of transboundary threats. The main problem afflicting neighboring countries in that regard is the "security vacuum" and instability that enables criminal networks to gain power (ENVSEC 2007, 92). Another geopolitical concern is the risk of environmental accidents – nuclear or of any other type – which makes allusion mostly to the Chernobyl nuclear accident in 1986 but also to environmental pollution. ENVSEC's interest in the direct European geographical neighborhood is also expressed in relation to climate change adaptation, for example with regard to the Ukraine.

Furthermore, the choice of the regions shows a traditional geopolitical focus on natural resource abundance. Among the first documents, the description of Central Asia starts with the enumeration of resource wealth (see ENVSEC webpages, ENVSEC 2002, 17). An interesting trend in the ENVSEC documents is that, especially since 2005, the concern about fossil fuels in Central Asia has been growing. This can be seen in close relation to the "gas crisis of winter 2005–6 when Russia's Gazprom cut off natural gas supplies to Ukraine" (ENVSEC 2007, 47). In the aftermath of this event, energy became a key issue of national and international politics and even of national security, as is expressed in the following quote: "In a context where fossil fuels are of paramount importance for the global economy, energy policy is a key area in which stakes for both, the environment and security, are very high. The issue of stable energy supply becomes a matter of national security and the center of geopolitical interests" (ENVSEC 2007, 8). The transit route for energy (especially gas) is another geopolitical concern that is repeatedly mentioned in the ENVSEC documents. In fact, the term transit security is applied by ENVSEC and mentioned as a major concern for Eastern Europe. The term transit security is especially interesting, as it has not been manifested so far in literature reviews on environment and security.

Another important energy-related geopolitical concern is that the demand for fossil fuels will grow in the future. In addition, the global competition between China, India, and the United States of America will grow and increase the pressure on the energy market. Central Asia and the Caspian Sea are thereby of high interest for China (ENVSEC 2008a, 25–28). ENVSEC highlights the importance of securing the geographical locations of energy resources. This is of utmost importance because the possible unsustainable use of alternative energy sources "could also intensify resource disputes on local, national, and regional level" (ENVSEC 2008a, 25).

This strong euro-centric focus of ENVSEC indicates that this initiative acts in the interest of the member states of the European Union. The strong focus on energy and the regions chosen by ENVSEC imply that one goal of ENVSEC is to secure energetically interesting resources and the corresponding transport routes. Another indicator of the underlying goal of securing European energy access is that several ENVSEC maps of environment and security issues include in some way or another geography or infrastructure related to energy[22]. Furthermore, it should be emphasized that ENVSEC regions are geographically congruent with the trajectory of alternative gas pipelines such as the Nabucco pipeline[23]. The strong geopolitical concern for energy provides a new perspective on ENVSEC donors who also might have proper and partly hidden interests in their support. Therefore, one motivation to finance ENVSEC could be to increase the speed with which alternative sources of gas and oil from Central Asia and the Caspian Sea will become accessible. Finland, the major ENVSEC donor, for example, could be interested in preventing the pollution of the Baltic Sea and other possible environmental threats that originate in the neighborhood of Eastern Europe. Another strong geopolitical motivation for Finland to support ENVSEC could be its almost total dependence on Russia as its major supplier of gas and oil (IEA 2012)[24]. The same could apply to Austria, another donor that greatly depends on Russian gas and to the Instrument of Stability of the European Commission (IFS), a donor of ENVSEC since 2012. Indicators for this assumption are the minor concern of the IFS for environmental issues[25] and the fact that the aims of the EU Security Strategy (EU 2008b) and of ENVSEC (2008a) are similar, both referring to the same regions with the major focus on energy security.

Another critical geopolitical analysis shows that ENVSEC is also supposed to contribute in some manner to the war against terrorism. Almost all interviewees cited the events of September 11, 2001, as a decisive driver for the establishment of ENVSEC. While this specific focus and reference is absent in the documents, there are also several references made to terrorism throughout the ENVSEC documents[26]. Another indicator for this is the strategic location of the ENVSEC regions in relation to the adjacent countries Afghanistan, Iran, Iraq, and Pakistan. The war in Afghanistan is not mentioned at all in the ENVSEC documents, but Afghanistan and the Middle East are mentioned as unstable regions that increase insecurity (see ENVSEC 2008a, 25–28).

22 The maps of Southern Caucasus, for example, include the major transportation route, i. e. the Asia-Europe Corridor.

23 The Nabucco pipeline was a project that aimed at transporting gas from the Caspian Sea to Europe. Probably due to the geopolitical tensions with Russia in the context of the crisis in the Ukraine, the Nabucco pipeline project is being discussed again, in order to decrease the dependence on Russian gas.

24 Strong concern over the dependence on Russia and the securing of its energy supply can be deduced from the fact that Finland has put in place an early warning system that allows it to "monitor real time gas flows in Russia and generate early warning of potential disruptions in order to implement contingency plans, switching to the parallel gas pipeline or deploy[ing] emergency response measures" (IEA 2012 19).

25 See IFS website at: https://ec.europa.eu/europeaid/sectors/human-rights-and-governance/peace-and-security/instrument-contributing-stability-and-peace_en, last accessed 3 March 2020.

26 One example is that "potential links with international terrorism" are an important concern for the Ferghana Valley (ENVSEC 2002, 26). Another example is the established link between the protection of mountain areas and terrorists and the ensuring of dam safety from terrorist attacks (ENVSEC 2005).

In light of these manifold geopolitical interests documented in ENVSEC reports, the fact that particular regions (such as the Baltic countries) are not included in the ENVSEC regions might be related to the absence of geopolitical interests or the fact that the countries are member states of the EU and of NATO.

In general, a critical geopolitical analysis of ENVSEC shows that the initiative might not only be dedicated to preventing and solving certain types of threats in order to ensure the status quo but that it has a strong additional bias towards geopolitical interests that it perpetuates under the guise of environmental security.

Conclusion and prospects

The literature on environmental security is still discussing the conceptual existence and/or the future implications, potentials, and risks of the implementation of environmental security. The analysis of the Environment and Security Initiative (ENVSEC) presented here shows that environmental security has been carried out for more than 16 years in a unified conceptual approach by some of the most important international organizations. A main enriching element of this theory is that the ENVSEC concept of environmental security can be categorized as a common or mainstream interpretation. This stands in contrast to the weakness, which is generally assumed in the literature, that no mainstream of environmental security can be defined and that an accomplished process of securitization has not yet occurred. In other terms, the analysis has shown that in contrast to the criticism in the literature that no concept and agreement exist, there is in fact an important mainstream approach that has been practised by several very important international organizations. In case of ENVSEC, the securitization move has been accepted by its audience through the provision of funds, and the several states and other actors that are actively involved in the projects of ENVSEC.

In criticism of the concept of environmental security, ENVSEC activities appear at first glance to be very diffuse and arbitrary. With the help of the analytical framework Critical Environmental Security (CESS), this analysis revealed a specific conceptual implementation by ENVSEC and furthermore helped to detect several issues that do not fit with the officially communicated image of ENVSEC. The main contradictions are that instead of the communicated basic defining characteristics of a participatory, open definition process, ENVSEC has worked with a concept of environment and security, which remains unaltered across regions, projects, and organizations for its entire existence.

Another research result is that the ENVSEC concept shares most characteristics with the environmental dimension of human security defined in CESS. This is due to the fact that ENVSEC functions in a strictly non-military manner, focused on peace-building, development, technical expertise, as well as the improvement of resilience and adaptation strategies in developing countries.

Contextualizing ENVSEC's concept and projects in the Anthropocene, I have detected several basic limitations concerning its understanding of the ecological challenge as the environment is seen as a mere dimension of secondary order that can act as a vehicle for hard political concerns like conflict and peace. In addition, ENVSEC does not take into consideration already existing environmental policy and environmental governance regulation and ignores important legal, institutional, political, and scientific dimensions of ecology. Therefore, I conclude that the projects of the ENVSEC Initiative to some extent certainly contribute to the mitigation of some environmental degradation or pollution and raise consciousness and disseminate information about environmental problems. However, I argue that the problems depicted by ENVSEC will not be solved in the long run. Due to their lack of a broader future time perspective and a critical approach of the causes, environmental problems and conflicts are not being solved but instead displaced in space and time (Hardt 2018a, 238). Therefore, this research result complies with the broader criticism of the human security concept that this displacement will neither ensure stability over there nor at home but that it only reinforces the structures that proliferate the ecological challenge and ultimately also the vulnerability of the North (see Ryerson 2010; Newman 2010).

Another important insight is that the ENVSEC concept of environmental security is not only concerned with conflict prevention, peacemaking, and the restoration of environmentally polluted sites but also includes the prevention of trans-border environmental and migratory threats as well as access to and control over natural resources related to energy in specific trans-border locations. The geopolitical dimension is focused on energy security in the sense of lowering the dependence on Russia and achieving transit security for the transport particularly of gas from Central Asia through the Caspian Sea. Another important interest and aim of ENVSEC is to foster political and economic stability in the geographical neighborhood of the European Union. Therefore, a major conclusion is that the ENVSEC concept of environmental security is heavily influenced by geopolitical concerns, which is highly problematic as it undercuts its credibility and proves the critics of the environmental security link right.

This research has focused only on one specific case study. Furthermore, it should be emphasized that the prospects of ENVSEC are not very bright, even though the consortium still exists, Board Meetings take place, and a Memorandum of Understanding that binds the partner organizations together might be revoked/amended (ENVSEC IP 2018). Nevertheless, it seems as though ENVSEC is currently in a frozen state[27]. It remains existent but no projects are being carried out, which is, according to ENVSEC IP (2018), due to the fact that the partner organizations are increasingly focused on

27 The webpage of ENVSEC has not been updated since 2016 and is inactive since March 2020.

their own activities related to environment and security. A further in-depth analysis is needed to take stock of these new developments and the possible future scenario of a dissolution of ENVSEC would allow for new conclusions. I propose that a (potential) failure of ENVSEC is more related to how it is institutionally constituted or to other regional interests (that diverge from the former Soviet region) than to its conceptual focus. This assumption is based on the fact that the link between environment and security remains a vibrant concern for each of the organizations involved in ENVSEC.

Apart from these doubts about the future prospects of ENVSEC and from the fact that this paper has focused on a single case study, I want to emphasize that the concerns and criticisms in the literature of the concept of environmental security for functioning "as a cover for the purchasing geopolitical or other strategically powerful interests" (Hardt 2018a, 186) and to enforce the status quo need to be taken seriously. The fact that a mainstream approach to the concept of environmental security exists in practice needs to be further analyzed and verified in relation to other actors and institutions (see e. g. Dellmuth et al. 2017). A vibrant research agenda that stretches between geopolitics, maintaining the status quo, normative socio-ecological change, and human-nature relation lies before us and must be adequately addressed in the context of the Anthropocene in theory and practice.

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16 The Anthropocene: an opportunity for transdisciplinary and inclusive science?

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Abstract

The informal understanding of the Anthropocene has sparked a significant worldwide debate across disciplines, including cultural studies, arts, literature, philosophy, law, sociology, political science, and international relations. Beyond its geological and chronological formalization, the Anthropocene is being discussed as a "new planetary real", a state shift in the Earth system, where humanity becomes aware of the role of collective human agency as the primary planet-transforming factor, with dramatic ecological, social, and economic implications. As such, the Anthropocene debate offers a unique opportunity to address limitations of established divides between academic communities and of their representativeness in issues involving science and society. Obvious imbalances in terms of disciplinary, ethnic, and gender inclusiveness emerge from the review of the composition of the Anthropocene Working Group, in spite of improvements over its predecessor, the Holocene Working Group. A strong polarization between the Earth and Natural Sciences on one side and the Humanities and Social Sciences on the other also emerges from the analysis of term co-occurrence in scientific publications mentioning the word "Anthropocene". Based on these findings, we draw some propositions for the development of a transdisciplinary and sustainable anthropocene science, embracing inclusiveness, openness, curiosity, and knowledge sharing.

KEYWORDS: Science, knowledge, epistemology, transdisciplinarity, inclusiveness.

Introduction: Towards a formalization of the Anthropocene

On 29 August 2016, after seven years of work, the Anthropocene Working Group (AWG) officially proposed to formalize the Anthropocene as the most recent geological epoch of planet Earth at the 35th Congress of the International Union of Geological Sciences (IUGS) in Cape Town, South Africa. With only one exception, the 37 AWG members decided that there was sufficient stratigraphic evidence for the Anthropocene epoch to replace the Holocene, the interglacial period previously defined by the Holocene Working Group (HWG), beginning approximately 11,700 years before AD 2000, as ratified in May 2008 (Walker et al. 2009). The AWG recommendations are part of an ongoing debate, mostly contained within the Earth and Natural Sciences (ENS), on the pros and cons of a formalization of the Anthropocene as a geological epoch and on its start date (Ruddiman et al. 2015).

Formalizing the Anthropocene is justified by the recognition that human activities have now profoundly altered geologically significant conditions and processes at the planetary level (Waters et al. 2014, Waters et al. 2016). Accepting this claim implies officially recognizing the end of the Holocene, and defining a clear chronological boundary between the two epochs. The AWG proposes the world's first explosion of an atomic bomb on July 16, 1945 at Alamogordo, New Mexico, as the "stratigraphically optimal" marker for the beginning of the Anthropocene (Zalasiewicz et al. 2015). Anthropocene deposits are therefore those lying above this globally distributed primary artificial radionuclide signal. Competing proposals for an earlier beginning of the Anthropocene, in prehistory, following the Neolithic agricultural expansion (Ruddiman 2003, Fuller et al. 2011), or during the industrial revolution (Zalasiewicz et al. 2015, Steffen, Crutzen, and McNeill 2007), were excluded for lack of a comparably defined "golden spike' (Ellis et al. 2016).

The following discussion of this perspective follows a debate held on September 22–24, 2011 at the International Symposium "Limits to the Anthropocene", chaired by Paul Crutzen at Universität Hamburg. The focus here is on the limits of Anthropocene science and the state of knowledge integration between the Earth and Natural Sciences (ENS) on the one hand and the Humanities and Social Sciences (HSS) on the other. Thus, this piece provides a sample of one of the characterizing traits of the CLISEC network over the past decade, namely its efforts towards the integration of expertise from the ENS and HHS to explore linkages between climate change and security.

Our analysis of the composition of two IUGS working groups (the Holocene WG and the Anthropocene WG) finds an opening of the scientific community coupled with the acknowledgement of an epistemological shift from pure ENS towards the inclusion of HSS. Yet, bibliometric analysis of scientific publications on the Anthropocene suggests that the debate continues to be split and disjoint between these two camps. The ENS, concerned with the formal definition of the Anthropocene; the HSS, concerned with the social, political and philosophical implications of human impact on the Earth system.

Nearly a decade after "Limits to the Anthropocene", the Anthropocene concept provides an opportunity to transcend this schism. Acknowledging the transformative implications of this new epoch, in which the boundaries between humanity and its natural environment collapse, is required for the emergence of a dedicated transdisciplinary and inclusive branch of science.

Beyond the Earth and Natural Sciences

The Anthropocene debate has generated a scientific tension within the ENS but also between those disciplines and neighboring fields of knowledge. In fact, the recognition of collective human action as responsible for pushing the Earth system into a new state (Barnosky et al. 2012), questions the ability of the Earth and Natural Sciences to adequately define this new epoch without inputs from other disciplines (Chakrabarty 2009, Brondizio et al. 2016). Questions have arisen on how knowledge of the Anthropocene is produced, by whom and with which methods, and on how it is circulated and authorized (Baghel 2012, Lövbrand et al. 2015). Ultimately, the prominent role of human agency in the Anthropocene debate has attracted the attention of disciplines outside the ENS. This epistemological shift is reflected in the composition of the AWG, in comparison to the HWG (Figure 1).

While the HWG was composed of 17 members, the AWG has 37. While all HWG members proceeded from ENS (Quaternary Sciences, Geography, Geology, Climatology, Glaciology, Oceanography and Biology), the AWG includes 8 representatives of the Humanities and Social Sciences (HSS, namely History, Archaeology, Philosophy, Literature and Law). Members from European institutions are the majority in both groups, with 58 % representatives. In addition to European members, the HWG had 3 members from North America, 3 from Oceania (Australia and New Zealand) and 1 from Asia (Japan). The AWG in turn reflects a somewhat more global composition, with 10 members from North America, 1 from Oceania (Australia), 1 from Asia (China), 1 from South America (Brazil) and 2 from Africa (Kenya and South Africa). No women were included in the HWG, while the AWG comprises 7 (Figure 1). Overall, the AWG shows a more inclusive composition than the HWG, opening up interesting avenues for interdisciplinary cooperation between ENS and neighboring disciplines, as well as for gender and global diversity. Nevertheless, both working groups remain dominated by European and American members, and scientists from other continents, as well as members from the Humanities and Social Sciences (HSS) and female representatives, remain a minority (Raworth 2014).

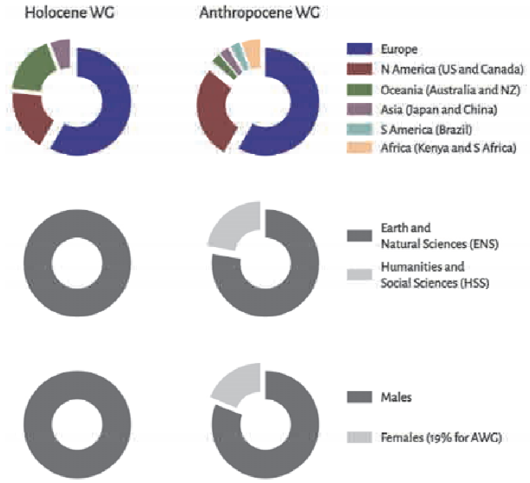

Figure 1: Holocene Working Group (HWG) compared to Anthropocene Working Group (AWG). *Note for B&W printing: Earliest related keywords are clustered on the left, latest on the right of the graph (as shown in legend).*

Anthropocene or anthropocene?

The integrative potential of the Anthropocene debate is limited by the desire to formalize the epoch and by the demand of ENS scientists to defend established epistemological and methodological conventions. To allow for a broader disciplinary involvement, Ruddiman and others (2015: 39) suggested "[…] to use the term informally (with a small a)". In such terms, unlike previously defined geologic epochs, the anthropocene debate has escaped boundaries, resonating across disciplines, and challenging the traditional structure of academic knowledge and scientific thinking. As a result, two opposing discourses have emerged from the two major interpretations of the anthropocene – the formal geochronological definition with an upper-case "A" and the informal and more inclusive debate using anthropocene with a lower-case "a". Besides isolated calls (Ellis et al. 2016, Brondizio et al. 2016, Castree 2017), little demand for cooperation and exchange between these two discursive fields seems to exist, not only due to a missing conceptual vocabulary but also due to diverging scientific paradigms and approaches (Belli 2016). In fact, the demand to formalize the Anthropocene in a stratigraphically robust way excludes most scholars in the HSS from the upper-case "A" debate. On the contrary, the anthropocene debate in the

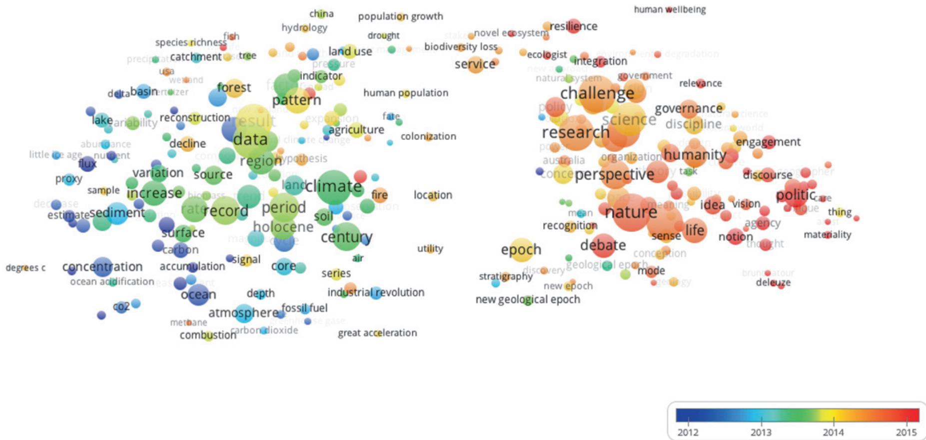

Figure 2: Co-occurrence analysis of keywords in the Anthropocene debate.
Note: Terms represented with larger circles appear more often and the proximity between terms is given by their co-occurrence within the same article. Keyword co-occurrence was elaborated for a total of 1416 papers included in the Web of Science database (as to 14th of March 2017) that contain the word "anthropocene" in the title or abstract, conducted in VOSViewer (van Eck and Waltman 2014). Note for B&W printing:Earliest related keywords are clustered on the left, latest on the right of the graph (as shown in legend).

HSS has taken up a vibrant life of its own. The HSS will continue discussing the anthropocene as a theoretical or philosophical concept – independent of the question of whether or not it will be formalized as a new geological epoch.

This divide is illustrated in Figure 2, showing the co-occurrence of the most relevant terms appearing in titles and abstracts of scientific papers mentioning the word "Anthropocene". The emergence of two clusters of keywords indicates two clearly defined epistemological approaches. The cluster on the left side of Figure 2 includes core concepts and keywords of the upper-case Anthropocene debate, a scientific discourse dominated by the ENS and structured around such terms as "Holocene", "climate", "CO2", "sensitivity", "trend", "data", "pattern", or "indicator". On the contrary, the keyword cluster on the right side includes keywords and concepts that are commonly used in the lower-case anthropocene debate, dominated by the HSS and engaging the anthropocen"e as a "concept", "narrative", "challenge", "discourse", or "debate". This is a more reflexive discourse, focusing on the anthropocene as a new "perspective" on "humanity" and its relation to "nature". This cluster also includes the implications of the anthropocene concept for "politics" and "governance", "resilience", or "human well-being".

Figure 2 illustrates the time-constrained development of keyword usage. It clearly demonstrates how the early Anthropocene debate was dominated by climate science (blue and green keywords on the left side). Early authors such as Crutzen and Stroemer (2000), for example, used the term Anthropocene to make a case for the severity of climate change. More recently, the Anthropocene debate within the ENS cluster has been directed toward the formal definition of the Anthropocene, as signaled by light-green, yellow and orange circles associated with keywords such as "Holocene", "record", "period", "industrial revolution", or "agriculture". The cluster on the right clearly shows that the more reflexive anthropocene discourse of the HSS has set in more recently, between 2014 and 2015 (yellow, orange, and red circles). For example, recent works include investigating "politics" and "governance" in the anthropocene and assessments of their implications for global welfare, justice, or security (Hamilton, Gemenne and Bonneuil 2015, Biermann 2014, Dalby and O'Lear 2016).

An opportunity for transdisciplinary and inclusive science?

In the anthropocene narrative, the transformative effect of collective human action is assimilated to that of large geological and climatic events, once perceived as gigantic and now dwarfed in the face of the realization of humans' own impact on the Earth system. The idea that humanity has become a telluric force similar to volcanism or tectonic plate movements is so radical that it triggers considerable debates about the appropriateness of core ontological and epistemological assumptions, such as the clear demarcation between nature and culture found at the roots of Western philosophical thought (Hamilton et al. 2015, Dalby and O'Lear 2016). Present understandings of the complexity and interconnectedness emerging from the interaction of environmental and social phenomena are showing the limitations of traditional academic, disciplinary, and knowledge boundaries (Lüthje, Schäfer and Scheffran 2011). A collective and inclusive effort promoting the trespassing of disciplinary boundaries is necessary to study the complex network of actions, feedbacks, and interactions linking the different elements of the Earth system, including humans (Ellis et al. 2016). Such intellectual challenges imply inevitable structural changes from 20th century "ecology of science" (Lüthje et al. 2011). We thus look beyond the formal and narrow definition of the Anthropocene epoch, and reiterate the primary importance of a broader anthropocene discourse connecting citizens and scholars from different parts of the world, with different gender as well as cultural, educational, and disciplinary backgrounds.

This vision of the anthropocene debate is to provide a fertile test ground to define novel research practices based on experience from a broad number of knowledge and scientific sectors. These novel research practices require a new "ethos of cooperation" and the development of a common, and richer, conceptual vocabulary that enables interdisciplinary cooperation (Brondizio et al. 2016). The "shock of the Anthropocene" (Bonneuil and Fressoz 2017) might be the necessary impulse to collapse the defensive walls erected by oppositional academic and non-academic fields. In this new theoretical space, HSS scientists would learn that humans and social systems could not be studied independently from the Earth system (Clark and Gunaratnam 2017). Social sciencists need to confront the new dimension of "the planetary" when engaging concepts such as well-being, security, or justice (Brzoska et al. 2012; Hardt 2018; Rothe 2016). ENS scientists, on the contrary, need to acknowledge that the destiny of the Earth system in the Anthropocene is imbricated with understanding of the social and the political spheres as never before, in a complex reality that is not amenable to the principles of stratigraphy.

Finally, independent of the agreed formal start date, it will be crucial to recognize that the Anthropocene is the result of a long chain of cultural, social, and technological innovations, initiated thousands of years ago (Ellis et al. 2013, Ruddiman 2003, Ruddiman 2015). Without them, humanity would neither have been capable of changing planet Earth at the present scale, nor would it be aware of ongoing planetary changes, for our current knowledge of changes of the Earth system stems from a massive socio-technological assemblage of planetary dimensions, including, for example, weather satellites, in-situ sensors, computers, simulation models, or visualization algorithms. Just as the atmosphere, the lithosphere, the hydrosphere, or the biosphere, the "technosphere" should be seen as part of the present Earth system (Edwards 2017, Rosol, Nelson, and Renn 2017). This implies a completely new reality for academia, in which social and data scientists, tech start-ups, or commercial visualization specialists become essential actors in the production of sustainable scientific knowledge. Much work remains to be done to provide viable and fair perspectives for the future of humans and non-humans within the Earth system. Embracing the anthropocene debate stimulates inclusiveness, openness, curiosity, and knowledge sharing, all necessary qualities in the planning of collective human actions for the definition of our current and future relationship with planet Earth and beyond.

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